A Quality Improvement Program to Standardize and Improve the Perioperative Management of Total Knee Arthroplasty Patients at St. Michael’s Hospital in Toronto, Canada

by

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A thesis submitted in conformity with the requirements for the degree of Master of Science
Institute of Health Policy, Management and Evaluation
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Abstract

We undertook a quality improvement program designed to improve patient outcomes, decrease costs and improve the efficiency of care, and to improve patient experience for patients undergoing total knee arthroplasty at St. Michael’s Hospital in Toronto, Canada. Using the model for improvement, we decreased knee buckling (from 45% to 5%), decreased knee immobilizer use (from 7% to <1%), increased knee flexion at hospital discharge (from 70 to 80 degrees), increased day of surgery mobilization (from 21% to 71%) and decreased length of stay (increased percent of patients discharged home within 2 days from 17% to 71%). A standardized clinical pathway was then developed incorporating the improved processes developed through this quality improvement project. Several of the process improvements as well as updated patient education materials were based on qualitative data obtained through a series of patient interviews and patient shadowing undertaken during the problem characterization phase of the project.
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Chapter 1

1 Introduction

1.1 Importance and relevance of the problem

Total knee arthroplasty (TKA) is a common procedure used to treat end-stage joint disease in the knee. Close to 65,000 TKAs are performed in Canada each year, with the annual rate of these procedures having increased by over 20% between 2009-2010 and 2014-2015. The perioperative management of TKA patients has changed dramatically since the advent of this procedure in the 1970s. Previously, patients were kept in hospital for extended periods of time following surgery, mobilized gradually and often sent for inpatient rehabilitation prior to discharge home. Over recent years, accumulating evidence has demonstrated that patients recover more quickly with earlier and more aggressive early mobilization, leading to the development and popularization of various “enhanced recovery” and “fast-track” protocols. Furthermore, discharge home has become the norm, with inpatient rehabilitation now reserved primarily for frail elderly patients or for those with significant pre-existing mobility challenges.

In Ontario, TKA is a Quality-based Procedure (QBP). Introduced as a component of the Ministry of Health and Long-Term Care’s (MOHLTC) Health System Funding Reform (HSFR), QBPs were developed in response to the Excellent Care for All Act of 2010. QBPs are groups of clinical diagnoses or procedures for which evidence-based interventions exist that offer the potential for process improvements, cost savings and improvements in clinical outcomes and patient experience. More recently, MOHLTC has moved toward an “integrated funding” or bundled payment model for arthroplasty procedures. First trialed in six settings across the province for diagnoses and procedures including acute stroke, COPD, cardiac surgery, cellulitis...
and urinary tract infections, this model is now being expanded to include total hip and knee arthroplasty at early adopter sites, including St. Michael’s Hospital (SMH) in Toronto. Integrated funding will involve the provision of a pre-determined bundle of funds (initially set at $8,626.69 for TKA for 2018/2019) that will follow the patient and is expected to cover all related care from the time of initial referral to 90-days after surgery. Along with the integrated funding, the MOHLTC is also mandating the collection of patient reported outcome measures (PROMs), which became mandatory in April 2018. The Ministry plans to track outcomes, including wait-times, length of stay (LOS), and clinical outcomes such as PROM scores, readmissions, 30-day mortality and revision rates. With the move to this bundled payment model, it is more essential than ever for providers to ensure that care for TKA patients be as efficient and effective as possible.

1.2 Gap between existing and ideal practice

Despite the transition to QBPs and bundled funding, practice still varies considerably from institution to institution and from surgeon to surgeon with respect to the perioperative management of TKA patients. In 2015, three senior arthroplasty surgeons were active at SMH and each had their own individual protocol for managing TKA patients. Practice varied significantly in a number of areas, from patient education to post-operative mobilization, to the type of dressing and choice of venous thromboembolism (VTE) prophylaxis. It has been well-established that unnecessary practice variation contributes to inefficiency as well as increased the potential for errors and patient safety incidents. As Deming stated, “uncontrolled variation is the enemy of quality.” In addition to being highly variable, the existing protocols being followed by the arthroplasty surgeons at SMH in 2015 were not evidence-based, having not undergone a thorough review for a number of years. Ongoing practices were no longer supported by best-
evidence, including the use of continuous passive motion (CPM) machines and the avoidance of mobilization until 24 hours or more after surgery. Increasing focus is being placed on developing standardized evidence-based clinical pathways to guide care for patients undergoing high-volume similar procedures such as TKA. The adoption of standardized pathways has the potential to reduce costs and improve efficiency as well as to improve patient outcomes and reduce errors. Furthermore, there is some evidence that clinical pathways and, in particular, the provision of standardized patient education and support, can improve patient experience\textsuperscript{8-11}.

1.3 Study AIMS

In order to improve care for TKA patients at SMH in Toronto, the overarching goal of this project was to create an evidence-based standardized clinical pathway incorporating the triple aims of:

1. Improving patient outcomes;

2. Decreasing costs / improving efficiency; and,

3. Improving patient experience.

In September 2016, at the outset of the study period, the study team developed a series of specific SMART aims to address each of these priorities.

1.3.1 Improving patient outcomes

To improve patient outcomes, the following aims were developed:

1. Decrease knee buckling during post-op mobilization to \( <10\% \) by May 1, 2017.

2. Increase day of surgery mobilization (to at least dangling) to \( 75\% \) of TKA patients by May 1, 2017.
3. Increase average knee flexion at discharge to 90 degrees by Dec 1, 2017.

Knee buckling had previously been identified by the physiotherapy team as a barrier to early and frequent mobilization in TKA patients. When knee buckling occurred, it often meant that patients were delayed in their ability to mobilize independently, which sometimes increased LOS. Furthermore, some patients required use of a knee immobilizer, which could be difficult for the patient to put on and take off and could therefore limit their ability to undertake their post-operative knee range of motion (ROM) exercises, in turn potentially reducing their knee flexion at hospital discharge. From previous unpublished work undertaken by the study team, we know that average knee flexion at discharge prior to the implementation of process improvements had been approximately 49 degrees. From the same work, we had found that poor knee flexion at discharge was associated with poor knee flexion at 1-2 year follow-up, with stiffness being a known complication of TKA that can lead to poor long-term outcomes.12-14

1.3.2 Decreasing cost / improving efficiency of care

Specific to the goal of decreasing hospital costs and improving efficiency, we identified the following aim:

1. Decrease LOS to 2 days for 75% of TKA patients by Dec 1, 2017.

LOS for this study was defined as the number of nights in hospital (i.e. a 2 day LOS would mean that a patient admitted on the day of surgery was discharged on the second post-operative day). Work was ongoing to reduce LOS following TKA at SMH prior to initiation of this project. However, the average LOS remained approximately 3 days. While this was lower than the MOHLTC mandated target (4.4 days), further reducing LOS was an important corporate priority at SMH in order to maximize bed flow and contain costs. Furthermore, SMH is in the midst of a
major redevelopment project, with the construction of a new patient care tower currently underway. Projected to open in 2018, the new tower will house a dedicated 29-bed orthopaedic inpatient unit. The current mobility inpatient wards are separated on two floors and serve neurology and ENT patients as well as orthopaedic patients. The new 29-bed unit will represent a slight decrease in bed capacity and it is therefore essential that the orthopaedic team be able to decrease average orthopaedic bed utilization to 29 beds or fewer to avoid the need to bed-space orthopaedic patients. Reducing LOS for arthroplasty patients, who represent a significant proportion of orthopaedic inpatients (many other elective orthopaedic cases being performed as day surgery), therefore also has the potential to improve patient flow and ease bed pressures.

1.3.3 Improving patient experience

The final overall aim was to improve patient experience. Given limitations related to the availability of data relevant to this aim, we elected to address patient experience through qualitative methods. A reliable measure of patient satisfaction or patient experience specific to this project was not feasible for a number of reasons, including ongoing work by the corporate SMH quality and performance team, which made the use of generic discharge satisfaction measures routinely used by the hospital unreliable, as any improvements identified could reflect changes being undertaken at the corporate level, rather than changes being implemented as part of the TKA pathway project. Furthermore, sufficient personnel were not available to administer a project-specific tool regarding patient experience for the duration of the project.

As a result, we elected to perform a qualitative analysis of patient experience and patient preferences as part of our baseline data collection. We then used this qualitative data to incorporate improvements to our TKA patient education materials, incorporating aspects of patient co-design into the redesign of the educational bundle. Future studies will focus on
evaluating patients experience within the new standardized clinical pathway and identifying further opportunities for improvement.
Chapter 2

2 Literature Review

2.1 Improving Patient Outcomes

Patient outcome following TKA is multifactorial. Efforts to improve outcomes through prosthesis design and surgical technique may have largely been maximized, with a variety of recent innovations showing little additional benefit.\textsuperscript{15-17} Factors such as surgeon and hospital case volume have been shown to affect outcome. Wilson\textsuperscript{18} recently undertook a review of outcomes from more than 250,000 TKAs identified through an administrative database and was able to show that complications are reduced for surgeons performing higher volumes of TKAs annually, while post-operative mortality is also reduced at the highest volume hospitals. While there may remain an opportunity for marginal gains related to optimizing surgical technique, designing better implants, or ensuring surgeons performing TKA perform a sufficiently high volume of procedures, greater opportunities for improvement would seem to exist through reorganizing and redesigning processes of care around TKA.

The development and use of clinical pathways is one method of organizing and standardizing care around total joint arthroplasty that has been shown to improve outcomes, while also having the potential to contain costs.\textsuperscript{19-32} Clinical pathways (also known as critical or care pathways) were defined by Barbieri et al as “a methodology for the mutual decision making and organization of care for a well-defined group of patients during a well-defined period.”\textsuperscript{19} Lawal et al developed a four-part operational definition
of what constitutes a clinical pathway, with the four criteria being: “(1) the intervention was a structured multidisciplinary plan of care; (2) the intervention was used to translate guidelines or evidence into local structures; (3) the intervention detailed the steps in a course of treatment or care in a plan, pathway, algorithm, guideline, protocol or other ‘inventory of actions’ (i.e. the intervention had time-frames or criteria-based progression); and (4) the intervention aimed to standardize care for a specific population.” This operational definition can be used to ensure that studies evaluating the effectiveness of clinical pathways are, in fact, assessing similar types of interventions. The definition may also help those developing clinical pathways to ensure they address all four key components of a clinical pathway.

Barbieri and colleagues undertook a meta-analysis to examine the role of clinical pathways in total joint replacement, finding that patients managed in accordance with care pathways suffered fewer post-operative complications, had a shorter hospital length of stay and incurred lower costs during their hospital stay.19 Several other studies have had similar findings regarding clinical pathways. Duncan et al conducted a self-paired comparison study comparing outcomes before and after implementation of a standardized clinical pathway in patients who had their first knee replacement prior to pathway implementation and their subsequent knee replacement after pathway implementation.24 They found that patients had a shorter LOS (associated with lower direct hospital costs) and less post-operative pain and confusion following pathway implementation while there was no difference in complication rates.24 In a randomized controlled trial, Gooch et al compared a new clinical pathway with standard of care, finding that use of the clinical pathway led to improved patient outcomes and health-related quality of life (HRQoL), as
measured by greater increases in both the WOMAC (Western Ontario and McMaster Universities Arthritis Index) and SF-36 scores in the group of knee and hip arthroplasty patients treated in accordance with the clinical pathway. In 2010, Vanhaecht and others, through a cross-sectional multicentre study focused on investigating the organization of care processes around total joint arthroplasty within the Belgian-Dutch Clinical Pathway Network, concluded that the use of clinical pathways has a positive impact on the organization of care processes and also improves patient outcomes, including length of stay, pain and elapsed time to discharge.

Given the evidence that clinical pathways are effective tools for improving patient outcomes following total joint arthroplasty, several groups have investigated the design of clinical pathways and which key interventions should be included. Van Citters et al performed an exhaustive review incorporating both quantitative and qualitative methods to develop a generalizable clinical care pathway for primary total joint arthroplasty encompassing the entire process from the presurgical office visit to 12 months after hospital discharge. The group elicited input from multidisciplinary panels selected from arthroplasty centres identified as high performing and also gathered qualitative input from patients through semi-structured interviews. Through this work, they developed a care pathway framework incorporating a total of 40 suggestions for improving care, 37 to reduce waste and 55 to improve communication. While exhaustive, the suggestions developed through this work are relatively high-level and require significant customization prior to application within a specific clinical and organizational setting. Van Herck’s group conducted a systematic review of the literature to develop a list of key interventions for inclusion in clinical pathways for total joint arthroplasty. They
summarized, chronologically, common interventions described in the literature at each stage in the joint replacement process, beginning with pre-admission patient education and ending with long-term patient follow-up. Van Herck also identified key outcome measures that have been used for evaluating clinical pathways and noted that most research has focused on process, financial and clinical outcomes, while studies investigating team and service outcomes (e.g. staff and patient satisfaction) has been lacking.31

Another concern regarding clinical pathways is the fact that they are inherently quite variable as a result of the specifics of the clinical context within which they are developed and implemented. Segal et al suggested that such variation among clinical pathways has the potential to have negative consequences with respect to quality and patient safety.34 In a study comparing clinical pathways within the Belgian-Dutch Clinical Pathway Network, they found significant variation with respect to both the inclusion and timing of 18 key evidence-based interventions that had been gleaned from guidelines published by the British Orthopaedic Association (BOA), American Academy of Orthopedic Surgeons (AAOS) and Map of Medicine (MOM).34 For clinical pathways to remain relevant, they must be continuously reviewed and updated based on the most current best evidence. Simply organizing care processes into a clinical pathway is likely insufficient without ensuring a mechanism by which such care pathways can respond to changes in our understanding of what constitutes best practices. Kim et al investigated this concept by comparing adherence to and healthcare providers’ perceptions of a clinical care pathway for TKA before and after a period of continuous improvement to both the medical and non-medical components of the care pathway.30 They found that
patient dropout (i.e. nonadherence to the pathway) decreased and healthcare provider perception improved following improvements to components of the pathway.30

Determining the specific components to include within a clinical pathway for TKA is challenging. Clinical pathways provide a framework for organizing care processes as well as standardizing key clinical and non-clinical interventions. Evidence-based clinical interventions, in particular, change as the scientific literature evolves. For example, many clinical pathways were initially designed when LOS following TKA was typically 5 days or longer. However, newer evidence supports the safety of “rapid recovery,” “enhanced recovery,” and “fast-track” protocols following total joint arthroplasty, allowing patients to be safely discharged as early as 1-2 days after surgery (or even sooner in some cases).2,4,35 A common feature of the newer rapid recovery protocols is the combination of specific bundles of interventions aimed at rapid return to normal function following surgery. Key interventions include minimizing pre-operative fasting, using regional anaesthesia with or without peripheral nerve blocks or local infiltration analgesia (LIA), day of surgery mobilization, opioid-sparing multimodal analgesia, and interventions to limit post-operative nausea and vomiting and encourage early oral intake.2,3,36-42 Selecting the most appropriate components for a rapid recovery clinical pathway for TKA has the potential to both improve patient outcomes as well as to reduce costs by shortening length of stay and potentially eliminating wasteful practices that are not evidence-based.

2.2 Decreasing Cost / Improving Efficiency of Care

Standardizing care through the use of clinical pathways can, in addition to improving patient outcomes, also improve care efficiency and thereby decrease costs.
An example of a clinical practice that is costly, frequently used and yet not supported by the current evidence is the use of continuous passive motion (CPM) machines following uncomplicated primary TKA. A recent Cochrane review concluded that there is no evidence that CPM confers an advantage over conventional physiotherapy alone.\textsuperscript{43} This conclusion is supported by the American Physiotherapy Association, that has adopted a statement recommending against the use of CPM as one of their 5 Choosing Wisely statements\textsuperscript{44} as well as by two recent randomized controlled trials which both found CPM to be of no benefit.\textsuperscript{45,46} Eliminating the use of these expensive machines has the potential to decrease equipment costs directly and to free up the time of nurses, physiotherapists and physiotherapy assistants, who are then free to provide additional direct patient care. Well-designed clinical pathways incorporating evidence-based practices can therefore be used to standardize care and thereby contain costs.

Several groups have reported on the outcomes of care pathways and quality improvement measures designed to improve efficiency and quality of care while at the same time decreasing the cost of that care\textsuperscript{33,47,48}. Dundon \textit{et al} showed that, through multiple simultaneous improvement strategies, a large tertiary care urban academic medical centre was able to reduce the average 90-day cost per episode of care by 20% while simultaneously decreasing LOS, discharges to inpatient facilities and all-cause readmission rates.\textsuperscript{49} The strategies employed included pre-operative risk factor optimization by surgeons, enhanced care coordination, and changes to both venous thromboembolism prophylaxis and infection prevention protocols.\textsuperscript{49} Benham\textsuperscript{50} argued that the development of clinical pathways for arthroplasty patients can be viewed as a manifestation of managed care for this patient population, linking the evolution of care
pathways with that of the US healthcare system, including increasing demand for cost containment. In any event, the implementation of clinical pathways has consistently been shown to decrease costs associated with total joint arthroplasty.19,20,24,28,29,51-53

Decreasing LOS may be one of the most significant impacts of clinical pathways, with each day of in-patient hospital stay that is reduced representing a significant cost saving.19,24,26,28,54 However, it is important to evaluate whether or not clinical pathways and fast-track protocols that shorten LOS result in overall cost savings or if they simply transfer costs from the in-patient stay to the post-discharge period. For example, if shortened LOS results in more emergency room visits or a higher rate of readmissions following discharge, this would lead to concerns about the overall benefits of shortening the LOS following surgery. Several studies have investigated outcomes other than LOS following “enhanced recovery” type clinical pathways following hip and knee arthroplasty. In fact, clinical outcomes are generally improved when care is provided according to standardized pathways that adhere to enhanced recovery principles.35,55 Malviya et al showed a decrease in 30 and 90-day mortality as well as a significant reduction in LOS following implementation of an enhanced recovery protocol for hip and knee arthroplasty.56 Another group showed a significant reduction in LOS, post-operative urinary catheterization and transfusion rates without any adverse impact on post-operative complications (thromboembolic events, infection and mortality) following implementation of an enhanced recovery program.57 Salmon et al evaluated patients’ impressions of early discharge following total hip and knee arthroplasty and found that patient evaluations of the care received did not suffer as a result of being cared for in a unit with a protocol encouraging shortened LOS.58
2.3 Improving Patient Experience

Improving the patient experience around TKA has become an increasing priority in recent years for several reasons. Patient expectations have been identified as a key predictor of several outcomes following total joint arthroplasty including length of stay\textsuperscript{59}, discharge disposition\textsuperscript{60,61}, and patient satisfaction\textsuperscript{62-64}. Interestingly, the majority of previous work regarding predictors of patient satisfaction following TKA has focused on demographic and patient factors other than patient expectations. For example, Jacobs \textit{et al} attribute dissatisfaction at 2-5 year follow-up with higher post-operative Knee Society Pain Scores and reduced passive knee flexion\textsuperscript{65}. Some literature has emerged, however, investigating the effect of patient expectations and patient psychology on satisfaction following knee replacement. Gandhi \textit{et al} reported in 2008 that pre-operative SF-36 mental health score was an independent predictor of outcome, even after adjusting for all other covariates\textsuperscript{66}. In 2016, Tilbury \textit{et al} undertook a study to investigate what patients’ expectations were following hip and knee arthroplasty as well as to determine how well these expectations had been met by one year following surgery. They found that, for TKA, 12 of the 19 patient expectations identified had not been met by one year in more than 30% of patients\textsuperscript{63}. Squatting and kneeling down were expectations that were not met in the largest proportions of TKA patients, with other unmet expectations including the ability to walk at least 1.5 km, improved ability to ascend and descend stairs, ability to return to paid work, recreational activities and sports and the ability to change positions easily and to return to social activities as desired\textsuperscript{63}. In a similar study, Scott \textit{et al} investigated patients’ pre-operative expectations as well as the extent to which these were met following surgery\textsuperscript{64}. They found that the fulfillment of pre-operatively identified
patient expectations was strongly correlated with post-operative patient satisfaction. These studies support the hypothesis that patients’ perception of the likely outcome of TKA may not be consistent, at least not in all cases, with the actual outcome. It is likely that the difference between some patients’ expectations for their new knee and the reality of their post-operative function may account for at least some of the patients who report dissatisfaction following TKA. It therefore stands to reason that attempting to ensure that patients achieve a realistic expectation of their likely post-operative function prior to surgery may lead to improved post-operative patient satisfaction, although this has yet to be studied.

While standardization, the use of well-defined and evidence-based clinical pathways and the incorporation of enhanced recovery principles has proven benefits, additional gains are likely to be made through increasing patient-centredness around total joint arthroplasty. Focusing on patient-centred care may be one way to ensure that individual patient desires and expectations can be addressed, thereby improving patient satisfaction after surgery. Zeineddine et al, in a well-reasoned review article, make a strong case for incorporating more patient-centred care into protocols for total joint arthroplasty. Difficulties exist, however, with defining what exactly constitutes patient-centred care, as well as with selecting measures to assess patient satisfaction. Zeineddine et al also point out the importance of distinguishing between evaluations of patient satisfaction with the processes of care and patient satisfaction with the outcome of care. While satisfaction with the process of care is certainly of importance, satisfaction with the final outcome is certainly of greater interest and importance to orthopaedic surgeons and it is in this area that the most significant potential gains are to be made.
Given that TKA is an elective procedure for a non-life-threatening condition, Zeineddine and others have made the argument that surgery should not always be considered the option of choice, even in the presence of significant disease. Chhabra et al make the case for shared decision-making when deciding whether or not to pursue surgery for several diagnoses, including appendectomy for uncomplicated appendicitis, colectomy for diverticulitis and TKA for osteoarthritis of the knee. For all three diagnoses, surgery has been shown to offer some benefit over non-surgical management, but at the expense of a greater risk of complications. The argument put forth in Chhabra’s article is that shared decision-making through a patient-centred approach allows for tailoring the exact treatment plan for the individual patient, rather than applying “the “one size fits all” model that is often prevalent in health care delivery.” Thus, incorporating patient-centredness into standardized clinical pathways for TKA patients may provide a solution to the usual critique of such pathways, which is that they do not offer sufficient flexibility to treat each patient as a unique individual. By ensuring that any standardized pathway incorporates aspects of shared decision-making, patient specific goal and expectation setting, and identification of patient factors that may be predictive of outcome or of the need for care outside the parameters of the pathway, surgeons may be able to have the best of both worlds: a standardized clinical pathway that nonetheless allows for patient-specific tailoring when the need arises. Hast’s group developed a 6-step methodology for incorporating patient-centred care into practice and applied this approach to improving the patient-centredness of pre-operative preparation for total joint arthroplasty at their institution. The six steps described include selecting a care experience, which in this case was the pre-operative preparation of patients scheduled to undergo joint
replacement. Next, they established a guiding council for the project, including front-line staff as well as influential leaders, in keeping with quality improvement principles for appropriate team selection. They then evaluated the current state and attempted to develop a sense of urgency to drive the desired changes. The next step was to identify a smaller working group, followed by the development of a shared vision for the project. Finally, the group identified what they described as a “blue sky story,” representing the ideal patient and family experience, and developed specific improvement projects and project teams to work toward achieving the “blue sky” state. Over a period of approximately 5 months, Hast et al were able to achieve significant improvements in the two areas selected for their initial improvements by using this methodology.

The ability to identify patients who are likely to fall outside of the parameters of a standardized clinical pathway is an issue that has been previously investigated with somewhat conflicting results. While it may seem intuitive that certain patients would do poorly when cared for according to an accelerated or “fast-track” pathway, for example, the results of studies conducted to date are not so clear-cut. Holm et al found that pre-operative pain score, muscle power, functional performance and physical activity level did not seem to be predictive of LOS following total hip and knee arthroplasty. Starks et al demonstrated that patients over 85 years of age achieved the greatest benefit following implementation of an orthopaedic enhanced recovery program, with readmissions in that patient group dropping to 45% below the national average following program implementation. Hence, relying solely on patient factors such as age or pre-operative function may not, at present, be sufficient to identify which patients will successfully complete care according to pathway and which patients will require pathway deviations.
of some sort. However, ongoing monitoring of pathway adherence may allow for iterative refinement of clinical pathways following implementation, according to the principles of quality improvement. Adopting a continuous quality improvement approach to clinical pathway design, along with the incorporation of robust patient involvement in pathway design and implementation may provide an opportunity to refine clinical pathways for TKA patients such that outcomes and patient experience may be improved while costs are contained.
Chapter 3

3 Methods

3.1 Study context

3.1.1 Setting

SMH is a tertiary care academic hospital affiliated with the University of Toronto. A subset of the orthopaedic surgeons at SMH perform hip and knee arthroplasty, completing approximately 1000 of these procedures each year. Historically, each arthroplasty surgeon followed their own individual protocols with respect to the perioperative management of these patients, including dressings, post-operative mobilization and rehabilitation and even choice of venous thromboembolism prophylaxis. The differing protocols for each surgeon were a source of confusion for trainees (who had to remember the variations in practice and enter the post-operative orders accordingly) as well as for allied health professionals, who had to treat patients differently depending on staff surgeon preference. Furthermore, the individual protocols in place did not necessarily reflect best evidence, with some ongoing practices not being supported by current orthopaedic literature. Turnover in the staff orthopaedic surgeon group presented an opportunity to standardize protocols for all arthroplasty patients at SMH, thereby reducing confusion and frustration for patients and allied health professionals while also updating procedures to reflect current best practices. This also presented an opportunity to update protocols, ensuring that the new practices were based on best evidence.
While protocols varied between surgeons for both hip and knee arthroplasty patients, our initial focus was on standardizing and updating the post-operative inpatient rehabilitation protocol for TKA patients. This choice was driven mainly by the desire of the physiotherapy team to eliminate several historic practices that were not evidence-based and yet were highly labour-intensive. Since the physiotherapists are front-line team-members who are crucial to the ongoing success of any initiatives involving post-operative mobilization and rehabilitation of total hip and knee arthroplasty patients, it seemed prudent to address their stated priorities as a first step. The project therefore started as an initiative aimed at standardizing and improving post-operative inpatient mobilization and rehabilitation for TKA patients. Subsequently, as a result of the initial work on post-operative inpatient rehabilitation improvements, several other initiatives were developed and the project was broadened into the development of a standardized clinical pathway for management of TKA patients at SMH from the time of surgical consent until the 3-month post-operative follow-up visit.

From our previous experience at SMH, we had noted a steady decrease in hospital length of stay (LOS), while there had been no increase in Emergency Room (ER) visits or hospital readmission rates at SMH over the same time period. Figures 1-4 show the decreasing LOS between January 2011 and November 2016, percent of patients discharged to inpatient rehabilitation, 30-day ER visits and 30-day readmissions. Because of the relative rarity of readmissions, data for readmissions are presented as days between events. These data were obtained from the SMH Decision Support team, who routinely track these indicators for internal hospital purposes. The reductions in LOS and discharge to inpatient rehabilitation facilities noted over this time period were achieved with ad-hoc
interventions applied in response to changing targets set by the Ministry of Health and Long-term Care (MOHLTC) but without the application of a dedicated quality improvement program.

From these data, we can see that, at the outset of the study period for the quality improvement project described herein, the median length of stay for TKA patients at SMH was approximately 2.5 days. From 2014, the typical LOS had been 3 days, with a new 2-day target identified in July 2015. In the fall of 2015, work began on improving communication of the new 2-day LOS target. This likely accounts for the slight decrease in LOS observed between Jan-Oct 2016. The percent of TKA patients discharged to an inpatient rehabilitation facility was approximately 14% at the outset of the study period, higher than the MOHLTC target of 10%. Emergency department visits and readmissions at SMH (data were not available for any ER visits or readmissions that might have occurred elsewhere) had remained stable over time, with no special cause variation identified. This suggests that the decreased LOS that had occurred from 2011-2016 had not resulted in a greater number of patients visiting the emergency department or being readmitted to hospital within 30 days of surgery.
Note: For all SPC charts displayed, areas in blue denote common cause variation while red denotes special cause variation.

**Figure 1:** Median LOS for TKA at SMH (2011-2016).

**Figure 2:** Percent of TKA patients at SMH discharged to an inpatient rehabilitation facility (2011-2016).
Figure 3: Percent of TKA patients at SMH with an ER visit within 30 days (2011-2016).

Figure 4: Time between readmissions for TKA patients at SMH (2011-2016)
3.1.2 Study team

A study team was in place prior to the initiation of the present study, having begun some initial improvement work related to TKA in 2015. For the current study, the existing team was expanded to undertake further improvements with respect to early post-op mobilization and development of a standardized clinical pathway for TKA patients at SMH. Key members of the team included front-line staff responsible for various aspects of care delivery from the time of the initial surgical discussion until discharge home post-operatively, including orthopaedic surgeons, anaesthesiologists and members of the Acute Pain Service (APS), nursing staff, physiotherapists, and case managers. In addition, the team included the inpatient mobility unit clinical leader manager (CLM), who facilitated institutional support for the change initiatives, and a member of the SMH Quality and Performance Team, who acted as a consultant and quality improvement expert. Finally, a qualitative researcher was added to the study team to assist with the collection of qualitative data through patient interviews and shadowing. Other stakeholders who were consulted and engaged throughout the study but not included as permanent members of the study team included clinical assistants working on the inpatient mobility wards, nursing staff working in the surgical block room, pre-admission facility (PAF) and post-anaesthesia care unit (PACU), and surgical and anaesthesia trainees (resident physicians and clinical fellows). Patients were engaged through a qualitative co-design process. In addition, several patients, including two with medical backgrounds (one physician and one registered nurse) provided valuable feedback regarding the redesigned patient education materials that were developed to support the final clinical pathway.
3.1.2.1 Engaging staff

In addition to the staff who were actively involved in this project as formal members of the study team, a wide variety of other techniques were used to engage staff members more broadly. Early in the improvement process the study author reached out to front-line staff to informally discuss potential changes and to gauge existing levels of engagement. Some staff were found to have had previously negative interactions with surgeons and expressed significant appreciation for involvement in future decision-making surrounding the perioperative care of TKA patients. Subsequent techniques for engagement included providing formal “in-service” teaching sessions for nursing staff regarding current best-evidence on perioperative care for TKA patients and proposed changes to SMH protocols, attending the allied health team’s “unit-based council” where selected members of the nursing and allied health team discuss issues of importance to the entire unit. The author was invited to present at these sessions on two separate occasions and was the first surgeon to be invited to participate in this forum. On all occasions, nurses and allied health team members were encouraged to identify issues of concern to them regarding proposed changes. For those who were not comfortable providing feedback in a group setting, email correspondence was encouraged, or they were asked to anonymously provide feedback through one of the nursing leaders. Several staff members raised issues in these settings, allowing early identification of potential barriers to the improvement efforts. When such issues were identified, the team developed strategies to address the concerns and then circled back to the staff member who had raised the issue to ensure that the concern had been adequately addressed.
While these efforts were sometimes time-consuming, it was essential to gain the trust, respect and collaboration of all staff members. We found that ensuring accountability and respecting each team-member’s professionalism and clinical skills was essential to achieve these goals. The author also tried to listen to all concerns that were raised, even if they were outside of the scope of the current project. Some issues raised by nursing and allied health staff were able to be easily addressed by the surgical team, which reinforced the respectful relationship that developed between surgeons and other clinicians during the course of this improvement project. Improving communication and collaboration will help to ensure positive outcomes with future improvement work and was therefore viewed as worthwhile, even if it was not directly applicable to this project at all times.

3.1.3 Ongoing improvement work

Several corporate initiatives underway at SMH during the time that this project was being developed and implemented align with the objectives of the TKA pathway project. One such corporate initiative was a focus on “estimated date of discharge” or EDD. This was a corporate QI project that involved identifying the likely discharge date and making the patient and entire healthcare team aware of this date in order to focus efforts on timely discharges and thereby reduce LOS throughout the hospital. In orthopaedics, total hip and knee arthroplasty patients were identified as a target population for this intervention, as the study team believed that some of these patients could likely be discharged home sooner. The typical LOS for hip and knee arthroplasty patients at the beginning of this project was 3-4 days, but the team felt that some patients could safely go home on the second day after surgery. The EDD project coordinated nicely with efforts to decrease LOS in the arthroplasty population. As the project progressed, the discharge target
shortened even further, with the current target being discharge on the first or second postoperative day.

Another corporate initiative that impacted the orthopaedic surgery service during the course of this project was focused on discharge satisfaction and the development of “patient-oriented discharge summaries” (PODS). This project involved developing a plain language discharge summary as well as an enhanced discharge education protocol for patients, with the aim of improving patient satisfaction post-discharge. As the total knee pathway project broadened, patient education and incorporating patient-centred elements into the standardized clinical pathway design became priorities, which aligned with the corporate discharge satisfaction goal.

In addition to the ongoing corporate improvement work described above, some initial process changes related to total joint arthroplasty patients at SMH had also been initiated prior to the commencement of the current project. In September 2015, an improvement team had been assembled to begin work on improving communication of an expected two-day length of stay following total hip and knee arthroplasty. Prior to that time, the typical length of stay was three days and the team determined that patients’ expectation of a longer length of stay was a major barrier to reducing the LOS. Work on this priority continued for approximately one year and involved coordinating messaging so that all patients were educated to expect a two-day LOS. Messaging was initiated with the surgical consultation and reinforced at subsequent steps in the process, including at the pre-admission facility (PAF) visit, at the time of admission and during post-operative rounding. In January of 2016, additional changes were made based on a literature review and external scoping review that demonstrated that several existing practices were no
longer supported by best-evidence. The external scan was undertaken to review perioperative processes at several other local hospitals performing a high volume of TKAs. The physiotherapy group and case managers reached out to colleagues to obtain information on protocols in use at several other sites.

The use of continuous passive motion (CPM) machines was discontinued and the use of knee immobilizers was minimized. Through the external review performed by the study team, both practices had been found to be uncommon at other institutions performing high volumes of TKAs. To further reduce the use of knee immobilizers, the improvement team identified the use of femoral nerve blocks (FNBs) as a barrier, as these blocks can cause temporary quadriceps weakness and consequently knee buckling when patients mobilize. The historic practice at SMH had been that every TKA patient received an indwelling FNB. Through data collected by physiotherapists working on the improvement team, we found that 40% or more of patients experienced knee buckling while ambulating with a FNB in situ. As a result, the team worked with the Acute Pain Service (APS) and anaesthesia service to promote early discontinuation of these blocks whenever possible (this change commenced in April 2016). This had the effect of greatly reducing knee buckling. To support this change, the anaesthesia team began pre-medicating patients with celecoxib and acetaminophen in the block room prior to surgery, starting in March 2016. The goal was to improve multimodal pain management and prevent increased pain when the FNBs were discontinued earlier. Multimodal pain protocols have been demonstrated to permit earlier mobilization and reduce LOS following TKA.42
Finally, the patient education materials in use were found to be outdated and providing misinformation due to the numerous iterative changes that had been made. Therefore, in May 2016, the old patient education booklet was retired and a new one entered development.

The current project began in August 2016, with the goal of formalizing and building upon the many small changes and improvements to the perioperative management of TKA patients that had already been made prior to that date. The focus of improvement work in the current study was increasing day of surgery mobilization, increasing the number of patients discharged home on or prior to the second post-operative day, and developing a standardized clinical pathway incorporating patient co-creation.

Once the improvements had been implemented and the standardized clinical pathway was under development, a second external scan of current practices at other Canadian centres performing high volumes of TKAs was performed. Clinical pathways as well as patient educational materials used at these centres were reviewed to identify clinical pathway features and to identify best practices that could potentially be adopted at SMH.

3.1.4 Study period
While the improvement work conducted for this study must be placed in the context of ongoing quality improvement initiatives that had been commenced in July 2015, the study period for the work described herein spans the timeframe between August 2016 and December 2017. Several members of the study team that had been convened in 2015 continued work on the present improvement initiatives and improvements that had been initiated prior to the study period continued throughout the study period. The present
work is therefore the culmination of several years of improvement efforts around the management of TKA patients at SMH.

3.1.5 Study participants

This study included all primary and revision TKA patients having surgery during the study period (August 2016 – Dec 2017). Data were collected on a total of 665 consecutive TKA patients between January 2016 and Dec 2017. Data collected between January and August 2016 was used for ongoing improvement work and served as baseline data for the current study. Data collection regarding day of surgery mobilization began in October 2016 and included 486 TKA and 419 THA patients. Data regarding day of surgery mobilization were collected by staff surgeons and orthopaedic residents. Data regarding knee buckling, knee immobilizer use and knee range of motion were collected by the physiotherapy team.

All patients (regardless of age, comorbidities, complexity of the surgical procedure, etc.) were included to maximize the generalizability of our findings and to minimize the additional workload for clinicians. We hypothesized that all patients would benefit from the improvements introduced through this project, while recognizing that some patients would still be outliers in terms of LOS, ability to mobilize shortly after surgery, need for alternative pain management strategies, etc. Nonetheless, we decided to apply the improvements to all patients without pre-selecting which patients were expected to do best. For example, all patients were encouraged to mobilize on the day of surgery as this intervention has been demonstrated to be beneficial and no literature exists to suggest that any particular group should not mobilize on the day of surgery. This approach may have resulted in slightly lower rates of day of surgery mobilization of post-operative day 2
discharge, than would have been observed in patients had been pre-selected for a separate “fast-track” protocol. Universally applying the improvements gave every patient the chance to benefit and also reduced the burden on nursing and allied health team members, who would otherwise have had to identify which patients were on the “fast-track” protocol.

For the qualitative data collection portion of the study, 19 TKA patients and 8 family members were recruited. Historic baseline data for TKA and revision TKA patients having surgery prior to the study period were used where available (e.g. LOS and occurrence of falls) and data from ongoing improvement work were used as baseline data for several process and outcome measures (knee buckling, use of knee immobilizers, LOS, knee flexion).

3.1.6 Research ethics board approval

At SMH, ReQuIST is dedicated ethics review process designed to facilitate quality improvement projects. Through this mechanism, potential QI projects are submitted for ethics review and a decision is made regarding whether or not the project requires a full Research Ethics Board (REB) application and approval. Projects that represent true QI or knowledge translation initiatives generally receive a waiver stating that formal REB approval is not required. The two main components of this project: “Improving inpatient post-operative mobilization following total knee arthroplasty;” and, “Improving the standardization of clinical pathways in total knee arthroplasty through patient co-creation” were both assessed through the ReQuIST mechanism. The ReQuIST reviewers provided the following response:
“This initiative was formally reviewed by institutional authorities at St. Michael’s Hospital and deemed to neither require Research Ethics Board approval nor written informed consent from participants.”

3.2 Process map

In August 2016, in preparation for this project, the study team convened to prepare a process map. The team included a SMH corporate Quality and Performance specialist, who led the process map development by moderating the study team group sessions and compiling input from the various team members. The team elected to focus on flow and communication as patients travel through the perioperative process, once the decision has been made to proceed to surgery. The team felt that there were a number of opportunities for improvement at each step of the process and the mapping exercise was focused on identifying these opportunities. The team later prioritized areas for immediate improvement, based on an assessment of feasibility, readiness for change and potential for greatest impact. Figure 5 shows the high-level process map developed through this process.
Figure 5: High-level process map outlining patient journey and information flow for TKA at SMH
3.3 Root cause analysis

Root cause analysis was conducted primarily to understand the reasons that patients were not mobilizing on the day of surgery. Previous work had identified that deficits in team communication and lack of patient awareness were barriers to early discharge. Once the issue of clearly communicating the expected LOS to patients and team members had been addressed, the study team realized that further improvements to LOS required significant changes to the existing post-surgical process. The existing process was designed to facilitate discharge on post-operative day 3-4, which had been the historic LOS for TKA patients. To discharge patients earlier, the team realized that implementation of an “enhanced recovery” approach, including early mobilization would be essential. A review of the literature provided insight into “enhanced recovery,” “rapid recovery” and “fast-track” protocols in use at other institutions where LOS had successfully been decreased. The vast majority of these protocols included a provision for early post-operative mobilization, generally on the day of surgery. We therefore focused our efforts on understanding barriers to early mobilization within our existing processes, in order to identify the changes required to mobilize a majority of TKA patients on the day of surgery.

The study team assembled to perform the root cause analysis, with email correspondence in advance of team meetings to allow team members sufficient time to reflect on the issue in advance. The initial Ishikawa diagram developed as a result of the team meeting is shown in Figure 6.
**Figure 6:** Ishikawa diagram showing root causes for failure of TKA patients to mobilize on day of surgery

- **Provider**
  - Perceived increase in RN workload
  - Overnight staffing (fewer RNs, CAs 19:30-07:30)
  - RNs and CAs lack knowledge re: mobilizing patients on day of surgery

- **Policies**
  - Previous informal policy that patients do not move until POD#1
  - Tradition that CAs do not mobilize patients initially

- **Patients**
  - Patient refusal (pain, fear)
  - Patient unable (medically unstable, low BP, nausea/vomiting, etc.)

- **Equipment**
  - Bulky dressings
  - Nerve blocks - pumps awkward
  - Commode not at bedside
  - No bariatric equipment

- **Procedures**
  - Femoral nerve vs adductor canal block
  - Patients arrive to floor late after OR
  - Typical RN practice to avoid waking patients at night

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Failure to mobilize day of surgery
Through development of the Ishikawa diagram, the team identified a number of different barriers to patients mobilizing on the day of surgery. A driver diagram was then developed, categorizing the issues identified into primary and secondary drivers (Figure 7).

The first primary driver identified was lack of knowledge regarding the importance of mobilizing patients on the day of surgery and the need for education regarding the proposed new protocol. Root causes that related to this driver included lack of knowledge in patients as well as ward staff (specifically orthopaedic nurses and clinical assistants) and previous protocols that discouraged early mobilization and encouraged bedrest for 24 hours after surgery. One reason that early mobilization had previously been discouraged had been fear of dislocation in THA patients. With improved surgical techniques and evolving literature regarding the necessity of strict hip precautions to prevent dislocation following THA, the arthroplasty surgeons and study team were able to agree that there was no longer any reason to keep TKA or THA patients on bed rest for any length of time post-operatively. This facilitated re-education regarding the safety of early mobilization on the day of surgery and allowed the study team to encourage all members of the care team (not just physiotherapists) to mobilize patients.

The second primary driver was the workflow of ward nursing staff. There was a perception that mobilizing patients on the day of surgery would be very labour-intensive and that it would not be possible if patients arrived from the recovery room late in the day around the time of shift change or overnight, when staffing levels are reduced. The traditional post-operative dressing was also very bulky and made it difficult to move
patients, as most were unable to bend the operative leg on their own because of the large, heavy dressing. Finally, perioperative pain management was identified as a primary driver. Feeding into this were issues related to the practicality of mobilizing patients who were attached to multiple pumps and IV medications as well as limitations related to patients having significant post-operative pain and/or nausea. The existing pain management protocol involved the use of both IV patient-controlled analgesia (PCA) pumps as well as an indwelling femoral nerve catheter. This meant that each patient was attached to an IV in their arm as well as a nerve catheter in the operative leg (often on the opposite side to the arm having the IV). Negotiating all of these lines and tubes presented a logistical challenge to nursing staff if they were to mobilize patients.

There was also the need to overcome well-established routines and long-held beliefs held by some of the veteran nursing staff. The study team was faced with excellent nurses who had been working with the TKA patient population for many years and some required convincing that changing the established routines and processes would indeed represent an improvement, both to workflow and to patient care. On the other hand, we encountered some junior nurses who were eager to adopt progressive practices such as day of surgery mobilization. Some of the younger nurses and recent graduates had worked at other institutions where day of surgery mobilization was the norm and these nurses represented an opportunity to act as early adopters and champions for the proposed changes.
Figure 7: Driver diagram for day of surgery mobilization following TKA.
3.4 Qualitative data collection

When the study team performed root cause analysis and identified potential drivers of day of surgery mobilization, one potential driver identified was patient refusal or fear of mobilization. The team felt that this was likely due to lack of education regarding the benefits of early mobilization. Reviewing the existing patient education materials confirmed that they did not support the move to early mobilization and enhanced post-operative recovery. We therefore elected to rewrite our TKA patient education booklet. Previous versions of the booklet had been prepared solely by members of the healthcare team, with minimal or no input from patients. The study team determined that patient co-design of the new materials would be beneficial as this approach would ensure that patients received more of the information that they desired. We also felt that this approach was most likely to improve patient experience.

In order to further explore patient perceptions of the existing process, we undertook qualitative data collection spanning the time period from the decision to proceed with TKA surgery until 3-months post-operatively. We wanted to understand the current experience as well as to identify gaps in the information provided and opportunities to improve patient and caregiver experience.

Patients and caregivers were engaged through a series of semi-structured interviews as well as shadowing as they participated in various stages of the process (e.g. during the pre-op PAF visit). Patient interviews and shadowing were conducted between December 7, 2016 and February 17, 2017. These activities were led by a member of the study team with expertise in qualitative research. Patients and caregivers were recruited using
purposive sampling. We sampled different demographics (age, gender, race/ethnicity) as well as different stages in the clinical care pathway (initial consultation, pre-operative assessment, post-surgical hospital stay and post-operative follow-up visits at 4-6 weeks, 3 months and 1 year). Interviews were conducted in-person when possible (all except two interviews, which were conducted by phone) and recorded for later transcription (two patients refused recording so detailed notes were taken instead). Interview duration ranges from 5 – 47 minutes. Data collection was continued until saturation was reached. In total, 19 TKA patients and 8 family members were recruited for the qualitative data collection. Some individuals were interviewed multiple times, at different stages in the clinical path, therefore a total of 29 interviews were available for analysis. Interviews were based on an interview guide (Appendix I). Five patients were also asked to review and provide comments on the proposed revised patient education booklet (Appendix II). Once revisions had been made based on the initial feedback, an additional patient who was also a healthcare provider (RN) provided further feedback on the revised booklet.

All recorded interviews were transcribed, and the transcriptions were then analyzed for recurrent themes using an iterative and inductive coding and analysis process. The study team lead and the qualitative researcher responsible for undertaking the patient interviews met on several occasions to refine the coding and analysis process based on the study lead’s clinical knowledge and experience with the TKA perioperative processes and the qualitative researcher’s expertise in extracting qualitative data. The study lead also independently reviewed all transcriptions to confirm that all pertinent themes with clinical relevance had been extracted and summarized.
In addition to the formal patient engagement process described above, additional qualitative data was obtained from two different patients who offered to provide input on the redesigned patient education materials. Both patients also had medical backgrounds, one being a physician and the other an OR nurse. These patients provided valuable insight from the perspective of patients who also had a good understanding of the medical system. Informal feedback was also elicited from all of the arthroplasty surgeons as well as several members of the allied healthcare team.

3.5 Change theory

Education and standardization were the key change concepts identified to address root causes of failure to mobilize patients on the day of surgery. Standardization was used to address the availability of equipment, to ensure early mobilization was incorporated into the usual nursing workflow, and to improve anaesthesia protocols to facilitate easier early mobilization.

Education was used to address lack of knowledge regarding the importance of early mobilization for both clinical staff and patients. Education was also the starting point for reassuring staff that mobilization would not significantly increase workload. Hayes and Goldmann described a model for “highly adoptable improvement” whereby interventions are more likely to be adopted if they maintain or reduce staff workload, while maximizing perceived value.72 This model was considered when entertaining potential interventions, with the study team aiming to avoid increasing workload for front-line staff while also ensuring that staff perceived value in the proposed changes. According to the highly adoptable improvement model, all changes result in a brief increase in workload during the implementation phase. Some changes permanently increase workload, which
is generally unsustainable. Other changes result in no net change in workload, which can be acceptable, especially if the perceived value of the change is high. Finally, the most sustainable changes result in a permanently reduced workload. Changes implemented to improve the post-operative care of TKA patients prior to the study period included elimination of CPM and reduction in knee immobilizer use. Both changes were highly adoptable, as they resulted in decreased workload for staff (primarily physiotherapists, nursing staff and clinical assistants). These changes were also perceived as high value by the team. Early success with these changes was used during the study period to motivate the team to take on further changes such as early patient mobilization. Success with previous changes facilitated this process because the team was confident that improvements could be made and were not overly fearful of increased workload.

Education and standardization were also the prevailing change concepts addressed through development of the standardized clinical pathway for TKA patients at SMH. Development of the pathway allowed the identification of key steps in the process where standardization could be used to improve patient outcomes, increase efficiency and decrease costs and improve patient experience. Patient concerns identified through the qualitative data collection process related, in large part, to uncertainty regarding what to expect at different stages in the recovery process. Addressing this uncertainty through the provision of standardized education materials and standardized processes was therefore deemed to be appropriate.

3.5.1 Education
While low on the hierarchy of effectiveness, education was identified as an important component of the change strategy for several reasons. The previous approach had been
to actively discourage patients from mobilizing on the day of surgery. Given this history, it was important to educate all ward staff (nurses, clinical assistants, physiotherapists, etc.) about the new protocol and to ensure the team that all surgeons agreed and there would be no negative repercussions from the surgical team as a result of patients mobilizing early. Secondly, we had found through previous work improving communication of a shortened LOS, that educating patients themselves regarding what to expect was a very important step in implementing the process change. Patient expectations were identified as driving many aspects of care and preparing patients to mobilize on the day of surgery through improved pre-operative patient education was therefore essential. Educating patients regarding the importance of early mobilization and reassuring them that this was safe and desirable was a key change strategy to overcome patient refusal or fear of mobilization. We also ensured that this message was reinforced by all surgeons so that patients were aware that it was their surgeons who wanted them up and moving as soon as possible after surgery. To facilitate standard patient education, the study team stopped circulation of outdated patient education materials in May 2016 and embarked on a complete rewrite of these resources.

3.5.2 Standardization

Wherever possible, standardization was used to implement changes. While education was necessary to update dated clinical knowledge, we understood that this was not sufficient to create the desired change. The nurses on the study team developed standard workflows incorporating early mobilization into routine tasks such as admitting patients from the PACU and toileting. Changes to pain management protocols were standardized by working with the anaesthesia and APS team members.
In order to minimize confusion and facilitate the success of the project, a number of process changes implemented to improve care for TKA patients were also simultaneously introduced for total hip arthroplasty (THA) patients. THA patients are a similar patient population and post-operative management is very similar. Standardizing the approach to both groups was seen as the best way to ensure changes to the TKA protocols were adopted. Early mobilization was introduced at the same time for both patient populations and efforts to reduce LOS were also introduced simultaneously.

Standardization of several processes involved the negotiation of complex approvals processes within the hospital. For example, undertaking to standardize pain management protocols involved several steps. First, the team elected to begin pre-medication with acetaminophen and celecoxib on the day of surgery. The team started to give these medications to each total knee and total hip arthroplasty patient who did not have a contraindication in the block room prior to provision of the spinal anaesthetic and any peripheral nerve blocks. Providing this medication to all patients through a standard order set requires approval from a Pharmacy and Therapeutics Committee at our institution, as well as budgetary approval based on an assessment of the financial impact. Both processes can take many months and involve the preparation of extensive reports that must be presented to the various committees for review. As the study team did not want to delay implementation of clinical improvements, the decision was therefore made that the anesthesia team would order these medications on a case-by-case basis until such time as the standard order set had been developed and approved. More recently, the same concern arose with respect to discontinuation of IV PCA and implementation of an all-oral multimodal pain protocol. Standardization of this protocol through order sets
embedded within the SMH EMR will require many months of work and presentation to several committees for approval. Once again, to allow clinical improvement to continue while this process is underway, the study team has elected to implement the changes on a case-by-case basis initially. This approach has obvious shortcomings as there is a greater chance of variation in practice and inadvertent errors and omissions. However, standard pain protocols for the arthroplasty patient population at SMH did not previously exist so the individualized approach is not new. We anticipate that pain management will improve in future, once standard order sets have been approved and are in use.

Standardization of patient education materials also required negotiation of corporate approvals processes. All patient education materials provided at SMH are required to be reviewed by a plain language team to ensure readability for patients of varying educational and socioeconomic backgrounds. This process increased the number and complexity of revisions but hopefully will result in a superior product.

### 3.6 Family of Measures

Several outcome, process and balancing measures were identified and tracked through the course of the project. Table 1 provides an overview of the outcome, process and balancing measures used and how each relates to one or more of the study aims.
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<th>AIM</th>
<th>Process Measure(s)</th>
<th>Outcome Measure(s)</th>
<th>Balancing Measure(s)</th>
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<td>Improve Patient Outcomes</td>
<td>Decrease knee buckling</td>
<td>Increase knee flexion at discharge</td>
<td>Falls</td>
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<td></td>
<td>Decrease knee immobilizers</td>
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<td>Staff perception of workload (qualitative feedback)</td>
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<td>Increase early mobilization</td>
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<td>Increase adductor canal blocks</td>
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<td>Decrease Costs / Increase</td>
<td>Increase early mobilization</td>
<td>Decrease LOS</td>
<td>Falls</td>
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<td>Efficiency</td>
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<td>Early mobilization after THA</td>
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<td>Improve Patient Experience</td>
<td>Increase early mobilization</td>
<td>Qualitative data from patient and family member interviews</td>
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3.6.1 Outcome Measures

The main outcome measure was LOS, as measured by percent of TKA patients discharged on or before the second post-operative day. Percent of patients discharged by post-op day two was used rather than average LOS to avoid skewing of the data by outliers. Certain complex patients require longer LOS following TKA for a variety of medical reasons unrelated to the updated protocols and process improvements under investigation. For example, patients with haemophilia are often admitted for a week or more following TKA because of the need for continuous factor infusion perioperatively. Regardless of early mobilization and other process improvements, these patients will continue to have significantly longer LOS than the typical healthy TKA patient. Tracking percent of TKA patients discharged on or before post-operative day two therefore allowed us to recognize improvement more quickly than would have been evident solely by looking at average LOS. LOS was manually recorded for each patient from the EMR. While this data is available through the Decision Support group at SMH, the data were not available in a sufficiently timely fashion to inform rapid cycle change. LOS was therefore manually recorded on the master data record for each patient and then entered into a statistical process control (SPC) chart. P-charts were used as the data represent rates with a variable sample size. Shewart or SPC charts display data over time and can be used to differentiate between common cause and special cause variation. Common cause variation is inherent to the process being observed, affecting the entire system including everyone working in it and all outcomes. Special cause variation occurs because of specific circumstances and can indicate the result of changes and interventions introduced through QI work. All data were tracked in Excel spreadsheets and displayed in
SPC charts developed using QI Macros (KnowWare International Inc., Denver CO). Analysis was performed according to Healthcare rules for control charts based on those used by the IHI (Institute for Healthcare Improvement). The resulting SPC charts display upper and lower control limits and indicate areas of special cause variation in red. A new baseline was calculated on each SPC chart once the process was observed to be in control following implementation of a given change.

Degrees of knee flexion prior to discharge was also identified as an important clinical outcome, as stiffness following TKA can be a significant problem with long-term consequences for patients. The team hypothesized that earlier mobilization, elimination of CPM and reduction of knee immobilizer use would improve knee flexion. We also hypothesized that changes to the perioperative pain management protocol may further improve knee flexion. Knee ROM was not routinely available through pre-existing data sources. As a result, the physiotherapy team agreed to prospectively record knee ROM for each TKA patient during the study period. These data were regularly forwarded to the study lead for collation and input into the SPC charts (x-bar S for continuous variables).

3.6.2 Process Measures

The primary process measure tracked throughout this study was the percent of patients mobilizing on the day of surgery. This was defined as the patient at least sitting at the bedside and dangling the legs within 8 hours of arriving on the orthopaedic ward. The staff arthroplasty surgeons and their residents recorded these data prospectively (on a daily basis). Each patient was asked if they had sat at the bedside, stood or walked on the afternoon or evening following surgery. In instances where there was confusion or a language barrier, nursing staff were asked to confirm what type of mobilization had
occurred and when. Data were forwarded to the study lead on a weekly basis and tracked on SPC charts (P charts for rates with variable sample size). Interestingly, although this was not tracked specifically, it was noted that nursing documentation of day of surgery mobilization increased over the study period. Toward the end of the study period, it was possible to refer to nursing notes within the EMR for occasional missing data points and documentation of mobilization was usually easily found.

Other process measures included knee buckling and knee immobilizer use, both of which were tracked prospectively by the physiotherapy team for each TKA patient. These data were plotted on P charts.

Once specific changes were implemented, such as the switch from femoral nerve blocks to adductor canal blocks, or the switch from indwelling adductor canal blocks to single shot blocks, these metrics were then tracked to understand the fidelity of implementation. Data on block type is routinely collected in a dedicated anaesthesia database for all patients receiving regional anaesthesia and these data were made available to the study team. Rates of each block type were tracked on P charts.

3.6.3 Balancing Measures

The main balancing measure for the study was the occurrence of falls. This measure was chosen as it stands to reason that the earlier and more frequently patients are mobilized, the greater the number of opportunities there are for patients to fall. Furthermore, the occurrence of falls is measureable as falls are reliably reported within the hospital. All falls are documented in a corporate safety incident reporting database and these data were made available to the study team and tracked on an SPC chart. While it is possible that
some falls occurred that were not documented, the nursing staff tend to be very diligent about identifying and reporting falls because of other ongoing corporate quality improvement work regarding falls. In addition to data obtained through the existing mechanism, the physiotherapy team also noted any falls of which they were aware, as did the surgeons and residents (who are generally notified if one of their patients falls). Data were cross-referenced to maximize identification of any occurring falls. Fortunately, falls were rare events both before and during the study period. They were therefore tracked using a t chart for rare events.

An additional balancing measure was staff workload and/or staff perception of workload. The team considered formally measuring this using some type of standard survey or questionnaire but elected instead to simply elicit informal feedback on a regular basis, which then informed subsequent change cycles. It was decided not to formally assess workload or perception of workload because the initial feedback was strongly positive and we therefore felt that the workload required to administer a standard questionnaire was not warranted.

During some PDSA cycles, qualitative data regarding balancing measures such as pain, nausea and vomiting were also collected. Due to the complexity and intense workload that would have been required to collect quantitative data on these measures on an ongoing basis, the team elected not to do so. Instead, when specific changes were implemented (such as the trial of single shot adductor canal blocks), qualitative data were collected and used to inform further PDSA cycles. Members of the APS, for example, tracked pain scores during the single shot adductor canal block trial and qualitatively assessed whether or not patients were experiencing more than the expected amount of
post-operative pain. Pain and nausea/vomiting were also tracked during early mobilization, to ensure that these were not increasing or limiting mobilization.

Other potential balancing measures were simply not feasible to collect during the project. The rate of readmissions and ER visits would be excellent balancing measures for decreased LOS. However, while these data are collected by the MOHLTC, the availability of the data lags significantly, with timely data being inaccessible. With data on these measures lagging by one year or more, they are not currently useful for quality improvement work.

3.7 Iterative tests of change (PDSA cycles)

Iterative tests of change based on the Model for Improvement were used to implement changes. Plan-Do-Study-Act (PDSA) cycles were used to test hypotheses related to each change idea. Multiple PDSA cycles were implemented simultaneously, depending on logistics and readiness for change in individual domains. Table 2 shows the timeline of changes implemented during the course of this project. While overlapping PDSA cycles were undertaken, a key implementation strategy was that control over implementation of each change be delegated to the most affected stakeholder. For example, when early post-operative mobilization was initially implemented, changes were primarily in the nursing domain, as it had been determined that physiotherapy did not have sufficient resources to mobilize patients after hours on the day of surgery. Nursing therefore took charge of implementation in this area, with regular guidance and feedback from the entire study team. Additional iterative changes to pain protocols were lead by the surgeons and anaesthesiologists, with the goal of facilitating nursing workflow and minimizing barriers to mobilization resulting from either uncontrolled pain
or cumbersome equipment (e.g. nerve block catheters and pumps, IV PCA pain pumps, etc.). Team meetings were held regularly but were somewhat limited by clinical schedules, which meant the team could not meet at a regular time each week. Because control over implementation was left to front-line staff with the greatest familiarity with workflow, change ideas often deviated significantly with each subsequent PDSA cycle, based on real-world experience and feedback.
Table 2: Timeline of interventions implemented.
3.7.1 Nursing PDSAs

Nursing, led by the orthopaedic ward Resource Nurse, took charge of implementation of day of surgery mobilization. The study team held several initial meetings, during which a root cause analysis was performed to identify potential reasons that patients were not mobilizing on the day of surgery. Change ideas developed as a result included educating nurses (pre-admission, day surgery, PACU and ward nurses) and clinical assistants, educating patients, and ensuring that commodes were readily available for toileting. The nursing team felt that toileting presented an opportunity to incorporate day of surgery mobilization and that access to commodes at patients’ bedsides was a potential barrier to implementation.

The orthopaedic surgeon on the study team facilitated several education sessions through November and December of 2016, ensuring that all nurses working in the mobility ward, PAF, day surgery (where nurses are responsible for admitting patients pre-operatively and also work in the regional anaesthesia unit), and PACU received education regarding the process improvements and study aims (day of surgery mobilization to at least dangling at the bedside within 8 hours of admission to the ward post-operatively). The official launch date for the new protocol was January 1, 2017, although some early adopter nurses began mobilizing patients on the day of surgery prior to that date. The Resource Nurse for the mobility inpatient units designed a poster titled “What’s Hot and What’s Not,” which described various protocol updates including the importance of day of surgery mobilization. This poster was posted in both inpatient mobility units as well as nursing break rooms and work areas in December 2016, in preparation for the official project launch in January 2017.
Once the project had been launched, the Resource Nurse taking the lead in this area undertook several independent PDSAs based on her own insight as well as nursing feedback. It became apparent that despite the team’s initial concerns, commode availability was not a major issue. Workflow and the integration of day of surgery mobilization into usual nursing duties arose as a larger issue. Based on her understanding of nursing culture and the specifics of the inpatient mobility ward at SMH, our Resource Nurse then implemented a series of targeted interventions. Between January and February, she performed regular ward rounds and discussed day of surgery mobilization with both post-operative patients and ward nurses. She also introduced a discussion of patient mobilization into the daily 9am mobility unit “bullet rounds.” These are multidisciplinary rounds attended by nurses, allied health professionals, and case managers. Inclusion of a discussion of mobilization during these rounds served as a reminder of its importance and also facilitated daily discussion of barriers to implementation. Nurses also indicated that they were motivated to mobilize their patients to avoid having to “explain” to their colleagues at bullet rounds why this had not been done. This was an unexpected motivational benefit to inclusion of mobilization status at bullet rounds, which was increasingly useful later in the project, once most patients were being mobilized on the day of surgery. Once it had become the norm, feedback from nurses indicated that bullet rounds were increasingly motivational, as nurses did not want to appear to be singled out as not having mobilized a patient when their colleagues had done so.

The final intervention implemented by the Resource Nurse was a “buddy system” where she would attend shifts and shadow a nurse undertaking their usual duties, particularly
when admitting post-operative TKA patients to the ward. The Resource Nurse would then model ways to incorporate patient mobilization into usual work. Nurses had identified evening shifts and admissions at or near the time of shift change as a barrier to mobilizing patients. The Resource Nurse therefore targeted evenings and shift changes for this intervention, altering her usual working hours on days when a high volume of TKA patients were expected in the ward. She found multiple ways to incorporate early post-operative mobilization, including dangling patients at the bedside during the initial assessment that is conducted by ward nurses when admitting a post-operative patient to the ward and incorporating dangling and/or standing and walking into toileting patients. The team, including surgeons and surgical residents, began discouraging the use of bedpans, advising patients and nurses that it was preferable to transfer patients to a bedside commode or to the washroom for toileting. As toileting is a usual occurrence that often happens naturally within 8 hours of ward admission following surgery, this represented an ideal opportunity to incorporate early mobilization into the usual workflow.

3.7.2 Anaesthesia and APS PDSAs

Changes to the perioperative pain management protocol were ongoing simultaneously, led by anaesthesia and the APS. Prior to implementation of early post-operative mobilization, several changes had been made to facilitate this, including pre-medication with acetaminophen and celecoxib and early post-operative discontinuation of femoral nerve blocks. These changes were based on feedback from the physiotherapy team when CPM was eliminated, and knee immobilizer use reduced in early 2016. The physiotherapy team noted that many patients could not safely mobilize without a knee
immobilizer while the femoral nerve block was *in situ*, as the operative leg buckled due to quadriceps inhibition. Approximately 43% of patients exhibited knee buckling on the first post-operative day with a continuous femoral nerve block in place. The team had therefore taken these data to the anaesthesiology group and requested to have the femoral nerve blocks discontinued early on the first post-operative day, to facilitate physiotherapy and ambulation.

Following from this previous work, the first PDSA in the current project related to pain management was the switch to adductor canal blocks. Adductor canal blocks are a more distal nerve block that maintains the benefits of a femoral nerve block for pain control but avoids the motor block affecting the quadriceps muscles. Implementing this change involved leadership from the anaesthesiology team and the APS. Data regarding knee buckling was instrumental in demonstrating that there was a clinical problem related to the existing strategy (use of continuous femoral nerve blocks). The anaesthesiologists made use of clinical fellows with experience conducting adductor canal blocks (some of whom had trained with this technique at other institutions). These individuals, along with experienced staff anaesthesiologists helped to train other anaesthesiology team members in performing adductor canal blocks and this became the standard for TKA patients. Once improvement was noted from this change, another PDSA was implemented to test the feasibility of changing from a continuous nerve block (involving the use of a nerve catheter attached to a pump to provide a continuous flow of local anaesthetic to the nerve) to a single shot adductor canal block. It was hypothesized that the single shot block might not be as effective as the continuous nerve catheter, but the benefit would be the elimination of the tubing for the catheter, which was attached to a pump and therefore
needed to be either capped off and temporarily removed or carried with the patient when they mobilized. The overall goal with all changes being made was to eliminate unnecessary tubes and pumps and to make mobilization easier for patients and nurses, therefore the team felt that eliminating the continuous nerve catheters would have a net benefit with respect to early post-op mobilization. To facilitate the change to a single shot nerve block and to reduce the possibility of higher pain levels, the surgeons began infiltrating a local anaesthesia mixture directly into the soft tissues around the knee at the end of surgery (with a focus on the posterior capsule, which is not anaesthetized by either femoral or adductor nerve blocks). Local infiltration analgesia (LIA) has considerable support in the literature\textsuperscript{75-79}, which allowed the study team to gain the approval of the SMH Pharmacy and Therapeutics Committee and begin LIA in January 2017. Following this, a trial of single shot adductor canal blocks was begun in June 2017. Initially, single shot blocks were performed for patients having TKA as the first or second case of the day, with patients having surgery later in the day having continuous nerve block catheters placed. This was chosen as the first implementation step to address concerns from anaesthesia regarding the possibility of excessive pain overnight in patients receiving only the single shot block. The team did not want multiple overnight calls to the on-call APS team members and decided it was best to trial single shot blocks in such a way that the block would wear off before the overnight period. Once this concern had been alleviated, a full switch to single shot adductor canal blocks along with LIA performed by the surgeon at the end of the case was made in February 2018. While these changes were implemented, the APS service monitored for excessive pain and for increased calls to the APS team overnight.
Currently, the team is in the process of obtaining final approval for a new post-operative pain protocol, which will focus primarily on oral pain medications. Targeted at opioid-naïve patients undergoing simple primary TKA surgeries, the goal is to eliminate IV patient-controlled analgesia (PCA) to further facilitate early post-op mobilization and earlier discharge. Feedback from nursing and physiotherapy staff and observation by the surgical team has indicated that many patients have significant nausea and vomiting while taking IV opioids. To minimize this problem and also to eliminate a further physical barrier (attachment to an IV PCA machine via IV tubing), patients will be started on an oral-only multimodal pain protocol and will only receive IV medications for break-through if they have excessive pain on the oral medications. Similar protocols are widely used with good success at other institutions currently performing TKA, both locally and internationally.\textsuperscript{42,80} An external scan was performed to determine the appropriate combination of medications and this was then tailored to SMH based on anaesthesia and APS preferences, formulary availability, etc. The new protocol is expected to be implemented in the next 1-2 months. Data regarding pain scores and opioid usage will be tracked by the APS team.

**3.7.3 Orthopaedic Surgeon PDSAs**

Finally, a number of iterative tests of change were undertaken by the surgical team. Prior to the initiation of the early mobilization project, surgeons has already identified a 2-day LOS as a target and had begun educating patients and staff regarding this target. CPM machines were eliminated, and knee immobilizers reduced (i.e. only used when required for safe mobilization rather than as a standard protocol) in January 2016. In May 2016, the pre-existing patient education booklet was pulled from circulation as it was outdated.
and still referred to a 3-4 day LOS as well as the need for CPM and knee immobilizers. The team felt that misinformation was confusing patients and negatively impacting the ability of staff to discharge patients earlier than 3-4 days post-operatively. In preparation to launch the early post-operative mobilization project, the surgical team switched from a bulky and restrictive post-op knee dressing to a much lighter and more mobile dressing. This change was made with the surgical project lead and a resident physician using multiple small PDSA cycles over several weeks in August 2016. New lighter dressings were trialed, and the resident provided feedback regarding dressing performance until an ideal alternative dressing had been identified. Criteria for an acceptable dressing were: ease of movement for patients, ease of dressing changes for residents and nursing staff, and performance with respect to containing early post-operative wound drainage. In January 2017, the surgical team made two changes aimed at improving early post-op mobilization. The first was universal implementation of LIA for TKA cases, as discussed above. The second change was the elimination of hip precautions following total hip arthroplasty (THA). While this change might appear to be unrelated to post-op mobilization following TKA, the team received feedback from nursing staff that patients were sometimes being restricted from mobilizing because staff-members were concerned about whether or not the patient had any mobility restrictions. Clinical assistants did not always have the clinical expertise to determine if a TKA patient could be helped to the washroom or to dangle at the bedside when a THA patient could not. Traditionally, patients at SMH followed hip precautions following THA surgery. These precautions involve limiting the degree of hip flexion as well as certain other motions that might provoke a hip dislocation after surgery. The study team felt that early mobilization would
be most effective if applied to both hip and knee arthroplasty patients simultaneously (evidence supports early mobilization for both populations) and quickly realized that hip precautions were a barrier to this. A review of the literature was conducted as was an informal survey of arthroplasty staff. The prevailing opinion was that hip precautions were of mostly historic significant, with little evidence that modern surgical techniques benefitted from prolonged use of post-op hip precautions. The team therefore elected to discontinue hip precautions in January 2017, in order to facilitate early mobilization of both TKA and THA patients.
Chapter 4

4 Results

4.1 Qualitative data

4.1.1 Existing process

Overall, patients were generally positive about their experiences, particularly regarding the information provided at the time of the initial surgical consultation and during preparatory visits prior to surgery. Patients also expressed appreciation that the surgeons and other members of the healthcare team made themselves available to answer questions and explain details of the proposed procedure.

“She explained the whole procedure. Because the way I thought of it, it was completely different than what she told me. I thought they took your whole knee out and they replace it. They just make a little bit of a groove, and then put metal plates in. I guess I never really looked it up, but from what everybody told me, I thought it was more complicated.” (TKA-11)

“At the orientation we got a lot of information, and they clarified some things.” (TKA-07)

Patients’ positive experiences seemed to be influenced by the trust they developed in their surgeon at the time of the surgical consultation, with patients commenting on the surgeon’s amount of experience as well as their demeanor.

“High energy type of person” (TKA-08)
“Comforting” (TKA-18)

“Kind, informative, patient” (TKA-18)

The opportunity to ask questions was also positively received by patients, as was the opportunity to contact the surgeon in future if further questions arose.

“He answered most of the questions to begin with. I didn't have many after to ask.” (TKA-18) “I asked a zillion. Probably too many.” (TKA-11)

Patients were reassured when provided with close follow-up, such as visits from their surgeon during their inpatient stay.

“The surgeon herself visited me yesterday afternoon. She met my daughter and said everything was fine. You just have to move forward on the processes that I have to go through, like physio.” (TKA-07)

Patients also expressed positive reactions to the wait-times at SMH, which are currently among the lowest in the Toronto Central LHIN (Local Health Integration Network) for both the time to surgical consultation as well as time to surgery.

“I went to see my rheumatologist and he had to try my knee and realized that my knee was in a condition where I needed quicker help because I've already been scheduled with another surgeon, but only within four months of seeing him. And so he heard of this surgeon, as a well-recommended surgeon, and got me in for a visit.” (TKA-18)
4.1.1.1 Opportunities for improvement

Several themes emerged representing opportunities for improvement of existing processes. Major themes included patient expectations, concerns around pain management and medications, physiotherapy, and the need for support from family and peers.

4.1.1.1.1 Patient Expectations

Throughout the journey from the decision to pursue surgery to the post-operative recovery, patients highlighted the importance of adequately addressing their expectations. Patients make assumptions about what to expect following surgery based on their previous experiences and those of their friends and family members.

“I just hope that everything will go as last time, everything was okay and that I trust the doctor very much. It was very easy. I walked away from the operation. I walked without nothing. I just walked out, no pain, nothing. Thank you very much.” (TKA-16)

“I met few people who did the surgery. They say it is good to do it. They say it’s better to do before, not too late.” (TKA-17)

Some patients’ expectations were also shaped by their own previous experiences with surgery. For example, one patient expected that the recovery process would be similar to what they had experienced following a different surgery several years earlier.

“I thought that I would probably go to a rehab place and not go home. Why did I think that? When I broke my hip, I was down here, 10, 15 years ago, and they sent me to a rehab hospital for a week. So, I just thought with my age and everything else. I mean, I
was thinking of the past, and it was always implied that maybe you're going to go to a rehab hospital, but maybe you won't.” (TKA-10)

Uncertainty about what to expect following surgery was a common theme. As with the patient above, who expressed uncertainty about discharge disposition, several patients expressed varying concerns about what to expect following surgery.

Actually, I forgot to ask how long it will take, the recovery. What is the time period? I did not ask that question, but I need to know that so mentally I will be ready, for my mental satisfaction. So, mentally, I will be ready for that time. This is the time for recovery.” (TKA-17)

Despite the general desire for more information regarding what to expect, one patient also expressed fear about searching for such information on their own. When asked about using the internet, the patient stated:

“No, I didn't. Could I have gone on the Internet? I could have. In fact, today for the first time, I went on and looked at knee replacement exercises. Actually, from what I learned today, everything looks fine, what I did. Unfortunately, I am a bit of an anxious person, and I specifically didn't go on the Internet. Because I'm an anxious person, I was afraid. Because very often you find a whole bunch of awful stuff.” (TKA-13)

Expectations around what to expect following surgery, particularly after discharge from hospital, were also frequently mentioned. Patients expressed uncertainty about how long recovery would take and how they would feel. After surgery, several patients expressed surprise at how they felt and what recovery at home was like.
“Well, I didn't realize it was going to be so - not debilitating, but so constraining. Like in other words, I thought I'll have the surgery and shortly after I will be able to do many more things than I can do. I'm a high energy person but I'm really surprised about how little energy I have. Even just getting up and having a shower and getting dressed and stuff, things like that, and not taking medication. So, I really do feel the pain.” (TKA-05)

“But you know, I didn't really know, because I was told... Here's the thing. I was told recovery was six weeks to three months. And in my mind, recovery meant I'm going to be back to feeling like myself. So, that's an interesting word, recovery. For me, that's not a good word to use, because recovery to me means I'm going to feel kind of normal again. That's of course not true.” (TKA-13)

Some patients were surprised about how difficult they found their recovery, feeling that they had not been adequately prepared for the experience. Family members expressed similar concerns about their loved-ones, finding the effect of surgery unexpected. Patients also stated that knowing what was considered “normal” would have been helpful following surgery.

“People said it would be difficult, and I didn't know what difficult meant.” (TKA-12)

“They give you that package and you read it, but you have no idea.” (TKA-05)

“Family member: I think that's the most surprising for us is that she's a very fit and active person, and she's now very reluctant. It's been a struggle to actually get her to do the exercises at home. She's doing better now though.

Patient: It's just not feeling good. Just because of the pain I think.” (TKA-05)
Patients also noted that inconsistencies in the information that was provided to them created distress and confusion. Sometimes they felt they had received different messages from different members of the care team and other times they simply felt that the information received would have been more useful had it been provided earlier.

“In that first month, the community physiotherapist said to me that he thought I was experiencing more pain than his usual knee clients. When I went to see the physiotherapist at the hospital, I told her that, and her response to me was, "You’re not crazy. It’s really, really painful." So, I’m not really sure... You know, the physiotherapist I went to, and I’m still going to him... I’m not 100 percent... They were kind of two different messages.” (TKA-13)

“Well, I was told... I specifically asked. This is what I was told. When I was first assessed, that was the physiotherapist at the hospital. They said recovery was six weeks to three months. When I went back, it was the same physiotherapist and the doctor. I remember the doctor saying three months. When I went for pre-op, the person who oriented me, I said to her, ‘What should I be telling work, when I can come back to work?’ I said, ‘I need to give them a guideline.’ She said six weeks.” (TKA-13)

“Now when I met the surgeon the other day, or last week, she said it will be a year or a year and a half before you’re feeling back to... And that would have been good for me to know at the beginning, too.” (TKA-13)

“Last week I was really reassured when I realized it would have been really good to have the surgeon have that conversation at an earlier point, because you don’t know what’s happening. You don’t know what your recovery is like. You want someone who has real
experience in the specific procedure to comment on it rather than the generic response from nursing or physio staff. Much of the need along the way is assurance that what is happening is normal and not a problem.” (TKA-12)

4.1.1.1.2 Pain management and medications

Many patients expressed concerns regarding pain management and pain medications, both during the inpatient stay and following discharge home. Patients experienced pain, which was distressing, but also experienced side-effects from the pain medications (such as nausea, vomiting, headache, hallucinations). Several patients expressed uncertainty about how to best manage their pain following discharge.

“The pain was so intense that I think that's what caused the nausea.” (TKA-03)

“I think I went into it a little naive about how painful it was going to be. It was very painful. I think that was the part I was surprised about.” (TKA-13)

“Because I know after the surgery, I had a blue button where I can push for painkillers, which I think I only used twice, because it did bring on a raging headache. I don't know which was worse, the pain or the headache.” (TKA-13)

“Because I had pain, and I really didn't know I was supposed to have pain. I had pain in places where I didn't think I should have pain. I was also on hydromorphone, because I have some issues with other drugs, some reactions. That also created a reaction for me. So, I think some better consultation on my pain management after I left the hospital would have been helpful to me. I didn't know what to expect. With the limitations of what I could take, it created a lot of problems for us here.” (TKA-12)
Some patients expressed uncertainty about how to take their medications after discharge, being uncertain if it was safe to take over-the-counter medications such as acetaminophen along with the prescription medications provided at the time of discharge.

“It would have been really good for me to know that I could take a hydromorphone along with extra-strength Tylenol. Logistically, you could think that I might have been able to figure that out, if I was allowed to take two hydromorphines. Obviously taking extra would be okay. But I didn't think about that at the time. So then I was a little worried about mixing medications. And I suppose, if I think about it logically, maybe I should have picked up the phone and called someone, but I didn't even know who to call. And actually, because I was in pain, I was just trying to get through each four-hour period. That's how I lived. It was just like, when can I take the next one that won't give me a raging headache, and then I can deal with the pain.” (TKA-13)

Patients were also uncertain about who to contact regarding pain control issues once they were at home. This may relate to the fact that pain is generally managed by the APS team (lead by anaesthesia) during the inpatient stay, but patients are expected to contact their surgeon or family physician regarding issues that occur after discharge.

*I suppose, if I think about it logically, maybe I should have picked up the phone and called someone, but I didn't even know who to call. And actually, because I was in pain, I was just trying to get through each four-hour period. That's how I lived. It was just like, when can I take the next one that won't give me a raging headache, and then I can deal with the pain.” (TKA-13)*
4.1.1.1.3 Physiotherapy

Physiotherapy was another common theme identified through the patient interviews. Patients did not always clearly understand the role of the physiotherapists during their inpatient stay and often expected more one-on-one therapy than was actually provided. Patients did not necessarily recognize that performing exercises independently, mobilizing to and from the bathroom or performing other ADLs constituted part of their therapy while recovering from surgery.

“The only thing I was a little surprised at was early this morning, the young fellow came in about the physio. He said, ‘We’re going to get you all set up for physio. We’re going to do this, and this, and this.’ I didn’t see anybody until lunchtime. Then my physio consisted of getting up and sitting in that chair. That was it. I thought somebody would be here doing exercises with me, but that didn’t happen.” (TKA-08)

Patients discussed barriers to participation in physiotherapy following surgery, including pain, side-effects from medications, IV lines, and persistent numbness from nerve blocks.

“The physio, she came in about the second day, and she had me up and going up and down stairs with the crutches. Maybe it wouldn't have made any difference. Our head's not straight. I think I could've done with just a bit more. I couldn't feel my leg because the freezing didn't go out from one leg. It didn't go out, and it lingered, and they were concerned about it because it stayed and stayed.” (TKA-10)

Physiotherapists had a positive influence when they explained what patients should expect and encouraged persistence with exercises despite post-operative pain.
“I said to the physiotherapist at that point, ‘Okay, I’m doing these ones, but these two hurt so badly, I’m not doing as many repetitions.’ At which he said to me, ‘You need to do that. You need to work through that pain, or the scar tissue is going to build up, and then you won't get the motion.’ I think that scared me, so I started working... That was really good for him to come back and say that to me.” (TKA-13)

Outpatient physiotherapists also provided information that was helpful to patients, allowing them to gauge if their recovery was on track and if what they were experiencing was normal.

“When I went to see the physiotherapist at the hospital, I told her about the pain, and her response to me was, ‘You're not crazy. It's really, really painful.’” (TKA-13)

“Rehab is doing okay. You have to push. I know that, so I’ve been pushing. The thing she says to me right now is - work on leg straightening. She goes, my bending is really good. She goes, my straightening should be better. I'm going to have to work on that, she said.” (TKA-11)

Patient expectations overlapped with concerns about physiotherapy, with several patients wanting to know more about what to expect with respect to physiotherapy itself. Some patients sought out additional information from sources on the internet.

“That's something I guess I didn’t ask about the therapy - will I be doing it here? Or would I be doing therapies beside where I live?” (TKA-11)

“It’s hard to really say because I did a lot of research before I had this done anyway. I kind of started doing exercises before the surgery and stuff like that. Well, they said to go
to physiotherapy, but up our way, it’s not as readily available. There’s just not the
openings. So, you go on the computer, and you look at them, and all the exercises that
are here are on the computer. I had it on my phone, so if I was sitting, I looked at my
phone. I would do some of the exercises there. I think - I’m hoping that it’s going to be
beneficial to me.” (TKA-08)

4.1.1.1.4 Family and peer support

Many patients expressed surprise at how much they relied on family and friends for
information and support during their recovery. Some patients and family members were
surprised by the amount of support patients required during recovery, although this varied
substantially from patient to patient.

“I know people vary on their individual differences, but for me, this has been an
incredibly difficult few months. My wife, for other reasons and for my health, took time
off work to stay with me. Otherwise we would have had to hire somebody. I was largely
not functional for at least two months.” (TKA-12)

So, I’m coming to work by Wheel-Trans now. I have met people on the Wheel-Trans, and
I have met at physiotherapy now a couple of people with knee replacements. That has
been the most helpful thing for me. Just to be able to see and talk to them about what
they’ve been experiencing. It puts my recovery into perspective.” (TKA-13)

4.1.2 Proposed patient education booklet

Patients praised the draft booklet for being clearly laid-out with a logical flow.
Suggestions for improvement often focused on the provision of clear expectations about
surgery and recovery, including more information on post-operative pain management.
“But I have to admit, ‘Will I have pain after surgery?’ is a question, and it is not answered in that paragraph. It is implied, but not answered. You know, I think everything was pretty well covered. I mean, the only thing that wasn't, to me, clear enough, was pain.” (TKA-13)

“Well, I think it would be helpful just to know that you might have a reaction to these heavy duty meds they're going to give you when they do the surgery and afterwards if you're not a person who takes medication all the time. I don't think it's going to change anything for you, but it might help you understand.” (TKA-05)

Some patients had very specific suggestions, such as providing copies of educational materials on the internet, informing patients that clicking can occur after TKA surgery, and providing opportunities for peer-to-peer support.

“So, that would be a recommendation, like for people who may not remember stuff or have an inability to carry things, like just having it available on the web. I could have printed it off rather than calling in, you know what I mean? Have it on the knee surgery program website. Here's all the handouts, but in case you lose them there is a website.” (TKA-05)

“Other than maybe the clicking might be about the only thing. I'm trying to think of what else. I think that was about it.” (TKA-11)
4.2 Quantitative data

4.2.1 Patient outcomes

Table 2 summarizes the improvements achieved as part of this quality improvement project. Baseline data represent historic rates (prior to the implementation of any interventions) for measures including knee buckling, knee immobilizer use, early (day of surgery) mobilization, adductor canal blocks, LOS and falls. Data for some measures (early mobilization, knee buckling, knee immobilizer use) were not routinely collected prior to January 2016. The baseline rate is listed as NA for knee buckling, as it is unknown what the rate was prior to the initiation of data collection. Anecdotal evidence from the physiotherapy team indicated that knee buckling was frequent, but the exact baseline rate is unknown. For measures such as knee immobilizer use and early mobilization, estimated rates are given, based on the protocols in place at the time. The vast majority of patients routinely received a knee immobilizer (therefore the historic rate is presented as ~100%) and patients were actively discouraged from mobilizing on the day of surgery, giving a baseline rate of ~0%. It is possible that a small number of patients were historically discharged without a knee immobilizer or mobilized for some reason on the day of surgery, but these would have been exceptions and not in keeping with the existing protocols at the time.

Knee buckling and knee immobilizer use were both decreased during work conducted between January and September 2016, prior to the initiation of the early mobilization phase of the improvement project. Early mobilization following TKA and THA and increased use of adductor canal blocks all took place during the early mobilization project study period (September 2016 – December 2017. Concurrent with the increased use of
adductor canal blocks, was a decreased use of femoral nerve blocks (data not shown), which was the previous block of choice for TKA patients at SMH.

The frequency of falls was recorded historically and also tracked through the early mobilization study period. LOS data were also available both historically and through the early mobilization project study period. LOS decreased steadily, starting with the improvement work conducted prior to the early mobilization project and continuing through the study period, this is reflected in an increased percentage of patients discharged on or before post-operative day two.
<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline Rate</th>
<th>Pre-Intervention Rate</th>
<th>Post-Intervention Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee buckling</td>
<td>NA</td>
<td>45.21%</td>
<td>4.78%</td>
</tr>
<tr>
<td>Knee immobilizer use</td>
<td>~100%</td>
<td>7.19%</td>
<td>0.41%</td>
</tr>
<tr>
<td>Early mobilization (TKA)</td>
<td>~0%</td>
<td>21.43%</td>
<td>70.59%</td>
</tr>
<tr>
<td>Early mobilization (THA)</td>
<td>~0%</td>
<td>40.00%</td>
<td>74.31%</td>
</tr>
<tr>
<td>Adductor canal block usage for TKA</td>
<td>0%</td>
<td>0%</td>
<td>90.11%</td>
</tr>
<tr>
<td>LOS (Percent patients discharged by POD #2)</td>
<td>16.52%</td>
<td>49.77%</td>
<td>71.31%</td>
</tr>
<tr>
<td>Falls (TKA)*</td>
<td>16.61</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Falls (THA)*</td>
<td>20.93</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Falls are a rare event, data shown as days between events. No special cause variation was observed throughout the study period for falls in TKA or THA patients, so only the baseline rate is displayed.

**Table 3:** Summary of key measures during baseline period as well as pre and post-intervention
4.2.1.1 Knee buckling

Knee buckling decreased substantially prior to implementation of the early mobilization project (Figure 8). The main change that appeared to be responsible for the decrease in knee buckling during mobilization was the switch from femoral nerve blocks to adductor canal blocks, which took place in September 2016. In addition to this change, we had also implemented the use of premedication with acetaminophen and celecoxib on the day of surgery. Both medications were ordered by the anaesthesiologist and administered by the nursing team in the surgical block area. The theory behind this change was to improve early postoperative pain relief, which would be required to implement planned changes such as day of surgery mobilization.

By October 2016, the occurrence of knee buckling, as reported by the inpatient physiotherapy team during their first post-operative sessions with each TKA patient, had decreased from 44% to less than 5% of patients. To ensure that the decrease was sustained, we continued to monitor knee buckling until the end of 2017, with the rate remaining consistently below 5% of TKA patients despite subsequent changes including the implementation of early post-operative mobilization.

To facilitate the planned implementation of early mobilization, the team also wished to discontinue indwelling nerve catheters (based on feedback from nursing and physiotherapy that the catheters limited patient mobilization). A trial of single shot adductor canal blocks was therefore implemented in June 2017. Based on discussions with anaesthesia and APS, the trial involved providing single shot blocks for TKA patients having surgery as either the first or second case of the day. TKA patients having
surgery later in the day were given continuous nerve blocks. This strategy was adopted based on a concern from anaesthesia and APS that single shot blocks might wear off over night, resulting in patients having severe pain during the overnight hours and consequently leading to a high number of calls to APS to manage such pain. Single shot blocks given to the first and second patient of the day should have worn off during daytime hours, allowing APS staff to manage any problems before leaving for the day. After several months, it became evident that patients were not having severe pain once the single shot block had worn off. APS nurse practitioners monitored pain scores as well as calls to APS for uncontrolled pain following TKA and found no increase in either. We theorize that the combination of LIA provided by the surgeon intraoperatively as well as the single shot block was sufficient to minimize post-operative pain throughout the first 24 hour period for the vast majority of TKA patients. Ongoing improvement work is continuing and we have recently switched entirely to single-shot adductor canal blocks, with some exceptions for patients with a history of severe chronic pain or with other special considerations.
Figure 8: Reduction in knee buckling (limiting post-op mobilization) following TKA over time.
4.2.1.2 Knee immobilizer use

The decrease in the use of knee immobilizers (Figure 9) was closely related to the occurrence of knee buckling. Historically, all patients had received a knee immobilizer and had been instructed to use it whenever they were mobilizing after TKA surgery. However, many patients found the knee immobilizers difficult to put on and difficult to remove and many consequently left the device on at all times, except when doing physiotherapy. Believing that this had a detrimental effect on knee flexion, efforts were made to minimize knee immobilizer use beginning in January 2016. Simply by allowing the physiotherapy team to assess which patients actually required a knee immobilizer, the rate of use immediately dropped from 100% to less than 5%. The physiotherapy team reported that many patients experienced knee buckling with femoral nerve blocks in situ but that these patients could often be mobilized safely without use of a knee immobilizer, with extra support from the team. After the implementation of premedication and the change from femoral nerve blocks to adductor canal blocks in September 2016, the rate of knee immobilizer use dropped precipitously. The use of knee immobilizers was effectively eliminated and remained at zero until the end of the study period (December 2017). The elimination of knee immobilizers was positively received by nursing staff and the physiotherapy team, as it decreased workload (putting on and taking off the knee immobilizers and adjusting them when they slipped or were applied incorrectly by patients). The change was also positively received by patients, who were often confused by the correct use of the device. Furthermore, patients were required to purchase the knee immobilizers, which represented a significant cost to some patients with limited means.
Eliminating the use of this unnecessary device therefore also improved efficiency for staff and improved patient experience.

Following the reduction in knee immobilizer use, the devices remained available and were very occasionally used for specific indications, generally in the case of revision procedures (e.g. in the setting of extensor mechanism disruption) or for patients with neurologic deficits, etc.
Figure 9: Reduction in knee immobilizer use during post-op mobilization following TKA over time.
4.2.1.3 Knee flexion

Historical data collected for over 200 TKA patients treated at SMH prior to the implementation of the perioperative management process changes started in 2015 showed that average knee flexion at hospital discharge was ~49 degrees. When data regarding knee flexion began to be collected prospectively at the time of discontinuation of CPM and knee immobilizers, it was found to average 73 degrees, representing a significant improvement as a result of these changes alone (Figure 10). Knee flexion remained stable at approximately 73 degrees until October 2017, when it increased slightly to approximately 79 degrees, with this amount of knee flexion at discharge persisting until the end of the study period (December 2017). The rate achieved was slightly less than the project aim of 90 degrees of knee flexion at hospital discharge.

Important PDSAs related to knee flexion included the elimination of CPM and reduction in knee immobilizer use that occurred in January 2016 and subsequent improvements in post-operative pain management (premedication, switch to adductor canal blocks etc.). It is unclear why special cause variation is noted from Oct-Dec 2017, when knee flexion at discharge began to increase slightly from the established baseline of ~73 degrees. It may be that the combination of improvements, including single shot adductor canal blocks, the intra-operative use of LIA and the widespread uptake of day of surgery mobilization were combining to result in improved flexion. However, no single intervention is clearly temporally related to this observed improvement.
4.2.1.4 Day of surgery mobilization

Day of surgery mobilization was fully implemented in January 2017, although some nurses had begun mobilizing patients on the day of surgery leading up to this date, based on education sessions and one-on-one discussions with highly motivated champions and early adopters. Data were collected on a biweekly basis, as the number of TKA patients varies considerably from week to week (Figure 11). Between October and December 2016, baseline rates of day of surgery mobilization averaged 25%. Following full implementation of the change strategy, the rate of day of surgery mobilization increased to 79%, a rate that remained stable from January to December 2017.

PDSAs which related to improved mobilization on the day of surgery included the switch to adductor canal blocks, several nursing education interventions (“in-service” sessions, an update to the Mobility nursing council, the placement of posters on the wards and one-on-one sessions lead by an experienced ward nurse on the study team), the elimination of hip precautions for THA patients and the implementation of LIA by surgeons.

Further PDSAs which had occurred earlier (elimination of CPM, reduction in knee immobilizers, premedication in the block area, early discontinuation of FNBs and switch to a lighter post-op dressing) likely also contributed to this improvement. These interventions had been implemented in preparation for early mobilization, as the study team felt that pain control, quadriceps function (knee buckling) and the presence of bulky dressings and equipment were all potential barriers to mobilization. However, these interventions were undertaken prior to the study period and before data collection regarding day of surgery mobilization had commenced. Therefore, temporal relationships between these changes and the improvement in day of surgery mobilization cannot be
confirmed. It should be noted, however, that day of surgery mobilization was a rarity prior to the implementation of improvements to the TKA perioperative management process that began on 2015. Historically, all patients at SMH were on 24 hours of bedrest following either TKA or THA and many were actively discouraged from mobilizing until they had been seen by a physiotherapist on the first post-operative day. It can therefore be surmised that some of the improvement noted in day of surgery mobilization can be attributed to the earlier changes (occurring prior to October 2016), as the baseline rate of day of surgery mobilization at the time that data collection began for this process measure was 25% for TKA patients and 40% for THA patients. THA patients typically have less post-operative pain that TKA patients, which likely accounted for the greater baseline rate of THA mobilization. Furthermore, while hip precautions had not yet been formally discontinued, staff had been informally made aware that hip precautions should not be a reason to avoid mobilizing THA patients and that RNs and CAs were permitted to mobilize patients without waiting for a physiotherapy assessment.
Figure 10: Mean knee flexion (degrees) prior to hospital discharge over time
Figure 11: Increase in day of surgery mobilization following TKA over time.
**Figure 12:** Increase in day of surgery mobilization following THA over time
Day of surgery mobilization for THA patients was also collected, to determine if there were significant differences in rates between these populations and to establish if the strategy of applying the change to both populations simultaneously in order to avoid confusion was effective. Figure 12 shows day of surgery mobilization rates for THA patients. Interestingly, THA patients mobilized more frequently (40%) than TKA patients during the baseline data collection period. Nonetheless, THA patients experienced a significant increase in day of surgery mobilization following implementation of the changes in January 2017, with ~74% of THA patients mobilizing on the day of surgery between January and December 2017.

4.2.1.4.1 Adductor Canal Blocks

The switch to adductor canal blocks from femoral nerve blocks and the subsequent change favouring single shot blocks over continuous blocks were seen by the study team as instrumental in facilitating and sustaining early (day of surgery) mobilization following TKA. Prior to September 2016, TKA patients at SMH universally received femoral nerve blocks with a continuous nerve catheter placed for post-operative pain control. Rare exceptions included cases where the nerve block could not be performed, or the continuous catheter not placed for technical reasons. Beginning in September 2016, anaesthesiologists began placing adductor canal catheters instead of femoral nerve blocks, with a rapid uptake in the new procedure, such that an average of 90% of patients received the new adductor canal block by January 2017. Several months were required for this change to take hold, as anaesthesiologists and anaesthesia trainees needed to become familiarized with the new technique. Members of the anaesthesia team with experience placing adductor canal blocks and catheters (staff as well as some fellows
with previous experience at other institutions) disseminated the new technique and trained other team members who were more familiar with femoral nerve blocks. Figure 13 shows the increase in adductor canal blocks along with the decrease in femoral nerve blocks over time throughout the study period. Special cause variation is noted at the time of the process change (September 2016), with a significant increase in use of adductor canal blocks following the intervention. Following the study period, the uptake of adductor canal blocks continued to increase and is currently 100% for TKA patients at our institution.
Figure 13: Increase in percentage of adductor canal blocks in TKA patients over time.
Figure 14 shows the increase in use of single shot blocks toward the end of the study period. The baseline rate of single shot blocks was \(~2\%\), with single shot blocks being used only for technical reasons initially (e.g. inability to place a continuous catheter due to patient anatomy). The increase began in June 2017 when a trial of single shot blocks was implemented and, by the end of the study period, approximately 40\% of TKA patients were receiving single shot blocks instead of continuous catheters. After the study period, continued uptake of single shot blocks occurred. Since February 2018, single shot blocks have been almost exclusively used in uncomplicated primary TKA patients, with only the occasional continuous block being used only on a case-by-case basis for patients with special requirements (e.g. chronic pain patients or patients with an intolerance to opioids, etc.). The current regimen is a combination of single shot adductor canal block and surgeon-administered LIA at the time of surgery.
Figure 14: Increase in single shot nerve blocks in TKA patients over time.
4.2.1.5 Falls

Falls were tracked as a balancing measure, to ensure that earlier and more frequent mobilization was not resulting in unsafe mobilization, as measured by the occurrence of falls. The t-chart showing the occurrence of falls in TKA and THA patients, respectively, during the baseline period and following implementation of day of surgery mobilization is shown in Figures 15 and 16. No increase in frequency of falls was noted during the study period.

We hypothesized that falls could potentially increase as day of surgery mobilization increased and patients began mobilizing independently at an earlier stage. However, no increase in the frequency of falls was identified over the study period. In fact, falls appear to have started to become less frequent toward the end of the study period, although this change was not significant.
Figure 15: Days between falls during inpatient stay following TKA over time
Figure 16: Days between falls during inpatient stay following THA over time
4.2.2 Cost / efficiency of care

4.2.2.1 Length of stay

Discharge on the second post-operative day had been a target at SMH prior to implementation of the day of surgery mobilization project. Work on this priority began in 2015 and a significant increase was noted in the percent of TKA patients being discharged on post-operative day 2 by early 2016, following implementation of improvements to communication of the discharge target, elimination of CPMs and knee immobilizers, and some early improvements to the peri-operative pain protocols (Figure 17). The baseline rate of discharge on the second post-operative day for TKA patients was ~16%. After implementation of the changes described, this rate had increased to ~50% by early 2016 and this represented the baseline rate for the early mobilization project. Following implementation of early post-operative mobilization, the rate of discharge of TKA patients on the second post-operative day increased further to ~71% and remained stable. This rate was just below the stated aim of 75%.

Interventions implemented to reduce LOS included work done in 2015 that included identifying a 2-day LOS target and communicating this new target broadly to all stakeholders (including patients, through improved communication in clinic and at the PAF appointment). Elimination of CPM and knee immobilizers and implementation of early (day of surgery) mobilization along with improved pain management techniques such as the use of adductor canal blocks and LIA were the subsequent PDSAs used to increase the percent of patients discharged on post-op day 2 or earlier following TKA.
Figure 17: Increase in percent of TKA patients discharged home on or before second post-operative day over time
Following the study period, LOS has continued to decrease, with the percent of patients discharged on post-operative day two continuing to increase. With the current protocol including the use of single shot adductor canal blocks, surgeon-administered LIA, an oral multimodal pain protocol, and early (day of surgery) mobilization, many TKA patients are being discharged home safely on the first post-operative day and some patients are even discharged on the same day as surgery.

4.3 Evidence-based clinical pathway components

Based on the review of literature (including published guidelines related to the care of TKA patients), an external scan of practices at several other Canadian institutions (Sunnybrook Health Sciences Centre, Mount Sinai Hospital, Toronto Western Hospital, Alberta Bone and Joint Health, Vancouver Coastal Health and North Bay Regional Health Centre), and patient feedback obtained through semi-structured interviews, we identified potential components of a clinical pathway for the perioperative management of TKA patients. As each information source described the pathway components or features slightly differently, they were grouped into similar “buckets” based on the judgment of the principal investigator. For example, pathway features involving pre-operative patient education or attendance at a pre-op group teaching session or pre-admission facility session geared to patients undergoing TKA were all considered as a single clinical pathway feature. All potential clinical pathway features were then compiled into a table (Appendix 3) and prioritized. Pathway features were prioritized based on:

- Frequency of occurrence;
• Importance to clinicians;
• Importance to patients; and,
• Feasibility

Importance to clinicians was determined based on the frequency of the intervention within the existing literature as well as the assessment of the study team (composed of a group of multidisciplinary clinicians all having expertise in the management of TKA patients). Importance to patients was determined by matching the intervention to patient concerns identified within the qualitative interview process. Patient education materials and the pre-op teaching sessions were explicitly commented upon by patients and therefore determined to be important to patients. While this methodology has limitations (patients may not have commented on interventions about which they were unaware, for example), it nonetheless allowed the study team to consider the patient perspective while evaluating each intervention and to make some assessment of whether or not that intervention was likely to resonate with patients or was more relevant to clinicians and the hospital administration.

For example, incorporating pre-operative patient education through a mechanism such as a group session during the PAF visit was identified as a key pathway feature from 12 different sources and was also noted as being important by both clinicians and patients. This is therefore a highly prioritized feature of the standardized clinical pathway.

Conversely, the use of pulsed electromagnetic fields to reduce post-operative pain and swelling was identified in only one source and was not viewed as important by either clinicians or patients. This was therefore determined to be a low priority pathway feature that was not incorporated into the final standardized clinical pathway. Pathway
components that had already been successfully implemented at SMH were also prioritized. For example, through the study team’s work on early post-operative mobilization, we had already realized significant benefits in terms of patient outcomes and LOS by mobilizing patients routinely on the day of surgery. This was therefore determined to be a highly prioritized feature to maintain in the final standardized clinical pathway.

Based on the review and prioritization of clinical pathway features, the finalized standard clinical pathway for TKA patients at SMH is shown in Table 3. Formal implementation of the pathway is currently ongoing. While many discrete aspects of the pathway were implemented through the iterative quality improvement process described here, full implementation of the pathway will be realized once all of the associated standard order sets are available and in use. We anticipate that full implementation of electronic order sets to support the practices developed through this improvement project will take an additional 4-6 months.

Notably, implementation of the changes that have been made to date has resulted in an overall improvement in patient flow and a reduction in workload for many members of the clinical team, including physiotherapists, clinical assistants, nursing staff and anaesthesia/APS. These changes have been very well received within the clinical team, in keeping with Hayes’ model of highly adoptable improvement, reinforcing that high-value changes that either maintain or reduce workload tend to be sustainable.\textsuperscript{72}
<table>
<thead>
<tr>
<th>Surgeon’s Office</th>
<th>Pre-work (Before PAF visit)</th>
<th>Pre-admission Facility Visit</th>
<th>Pre-work (pre-op)</th>
<th>Pre-op / Block Room</th>
<th>Intra-op</th>
<th>Post-op / PACU</th>
<th>Ward</th>
<th>Post-operative Day 1-2</th>
<th>Discharge Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient</strong></td>
<td>Understands diagnosis, treatment options, and decision process.</td>
<td>Pre-operative education and counseling materials.</td>
<td>Understands pre-operative risks and benefits.</td>
<td>Undergoes physical examination and laboratory tests (bloodwork, imaging).</td>
<td>Pre-operative medication administration.</td>
<td>Intra-operative monitoring.</td>
<td>Mobilizes as tolerated.</td>
<td>Mehmet as tolerated.</td>
<td>Discharge planning - target 0-2 day discharge if possible or day 2 transfer to inpatient rehab.</td>
</tr>
<tr>
<td><strong>Family / Friend</strong></td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
<td>Supports patient, provides support and guidance.</td>
</tr>
<tr>
<td><strong>Physiotherapy</strong></td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
</tr>
<tr>
<td><strong>Pharmacy</strong></td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
<td>Provides pre-op medication administration, prophylaxis.</td>
</tr>
<tr>
<td><strong>Physiotherapy</strong></td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
<td>Provides pre-op exercise program.</td>
</tr>
<tr>
<td><strong>Case Manager</strong></td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
<td>Tends to the needs of the patient, ensuring smooth transitions.</td>
</tr>
</tbody>
</table>

**Table 4: Proposed clinical pathway for TKA at SMH.**
Chapter 5

5 Discussion

5.1 Patient Outcomes

Significant improvements in patient outcomes occurred as a result of the quality improvement interventions implemented between September 2016 and December 2017. While the target related to knee flexion at discharge from hospital (average of 90 degrees flexion) was not achieved, the improvement that resulted from previous work (increasing average discharge flexion from 50 to 73 degrees) was maintained and there is evidence of further improvement from October to December 2017, when average knee flexion increased to 79 degrees. The exact cause of the special cause variation in knee flexion occurring between October and December 2017 is unclear, but this may be the cumulative result of iterative changes to the perioperative pathway that had been completed by that point in time. Qualitative feedback from APS and the physiotherapy team indicated that patients were achieving excellent pain control with the combination of an adductor canal block and LIA. It is possible that this subsequently allowed the physiotherapists to feel confident encouraging more aggressive range of motion, thereby achieving greater discharge knee flexion several months after this change had been implemented.

The use of adductor canal blocks began in September 2016. However, this change took time to be fully adopted, with some anaesthesia staff preferring to continue using femoral nerve blocks after this time. Ongoing feedback regarding improved mobilization and reduced knee buckling in patients receiving adductor canal blocks, as well as reassurance from the APS nurses that pain control remained excellent, gradually led to increased uptake of this change.
Knee buckling during in-hospital mobilization decreased from a baseline rate of 45% to less than 5% (achieving the stated aim of <10% knee buckling by 1 May 2017). This decrease coincided with the switch from femoral nerve to adductor canal blocks, implemented in September 2016. The rate of knee buckling that interfered with post-operative mobilization then remained quite constant at less than 5% until the end of the study period. While a rate of knee buckling <5% is excellent, occasional patients still experience this problem. Avoidance of intra-operative tourniquet use may be explored in future to determine if the rate of knee buckling can be further reduced. There is some evidence that quadriceps weakness in the early post-operative period may be lessened when tourniquets are not used, with no detrimental effects on blood loss or other important outcomes.\textsuperscript{81-84}

Coincident with the reduction in knee buckling was the almost complete elimination of knee immobilizer usage post-operatively. Knee immobilizer use had already decreased from close to 100% to less than 10% at the beginning of the study period, as a result of a decision to use knee immobilizers on an as-needed basis instead of as part of a routine protocol. However, the rate further decreased following the change to adductor canal blocks, likely because knee buckling (which had previously been the main indication for knee immobilizer use) was significantly reduced. The use of knee immobilizers decreased from 7% to less than 0.5% over the study period. Knee immobilizers have now been essentially eliminated from our post-operative protocol, being used only occasionally for special circumstances. We believe that decreased use of knee immobilizers has contributed directly to increased knee flexion at hospital discharge, allowing patients to range their knees more frequently and more easily during the early post-operative period. Furthermore, eliminating knee immobilizers was well-received by both patients and allied health professionals. Patients found the immobilizers difficult to put on and take off and often wore them incorrectly positioned. Allied health professionals provided feedback to the
study team indicating that the knee immobilizers often discouraged patients from actively mobilizing or undertaking knee range of motion exercises except when being assisted and encouraged by nursing or physiotherapy staff.

Day of surgery mobilization (to at least dangling at the bedside) increased from a baseline rate of 25% between Oct-Dec 2016 to 79% from January to December 2017. This exceeded the stated aim of 75% of TKA patients mobilizing on the day of surgery by 1 December 2017. The rate of mobilization was not available prior to October 2016, as this data was not previously tracked. However, patients had historically been kept on bedrest until the first post-operative day, when the physiotherapy team mobilized them for the first time. The fact that the baseline rate of day of surgery mobilization was 25% in October 2016 likely reflects preliminary discussions with the study team and the efforts of early adopting RNs to begin moving their patients during the baseline data collection period.

The relatively rapid improvement that occurred between December 2016 and January 2017 likely reflects the intense effort that was dedicated to this specific change during that time period. Multiple education sessions were held with the PAF, day surgery, PACU and ward nurses explaining the change and encouraging uptake. The leadership of nurse champions and the orthopaedic resource nurse were essential to the success of this change. Leading up to the change, nursing and allied health discussed the new protocol at their “Unit Based Council” and brain-stormed ways of encouraging participation from both patients and other nurses. Nurse champions created and distributed posters encouraging day of surgery mobilization, which were posted in break areas as well as around the orthopaedic in-patient wards where they could be seen by both staff and patients. Surgeons and surgical trainees encouraged patients to ask their nursing team to get them up out of bed on the day of surgery and to avoid using bedpans. Finally,
the resource nurse (a member of the study team) decided to work shifts alongside front-line nurses over several weeks in January and February to help nurses see when and how early mobilization could be incorporated into the usual workflow.

Study data regarding mobilization indicates that the most common time that patients were mobilized was for toileting. Nursing feedback indicated that this routine task required effort on their part at baseline and dangling patients or transferring them to a bedside commode did not constitute a significant increase in work, when compared to providing a bedpan, changing bedding, etc. Allowing an experienced nurse to take the lead on working with front-line staff to incorporate day of surgery mobilization was likely instrumental to the rapid success of this intervention. Targeting toileting for the intervention allowed nursing staff and clinical assistants to mobilize patients without disrupting their workflow or adding any significant additional work. Some nurses provided qualitative feedback to the study team indicating that their workload actually decreased when patients gained autonomy earlier, often achieving independent transfers for toileting on the day of surgery. This finding helped to explain the success of the study team in rapidly increasing rates of early mobilization for TKA and THA patients. Once educated on the benefits to patients of early mobilization, most front-line staff perceived this intervention as having high value. The experience of staff that early mobilization actually decreased workload then made the intervention highly adoptable. The physiotherapy team provided feedback indicating that patients were much more prepared for their first mobilization on the day following surgery, as they had often already been up several times. Previously, they had noted that some patients felt faint or otherwise unwell when they first mobilized with the physiotherapy team, but this issue was greatly reduced once patients were mobilizing first on the day of surgery. In this way, Hayes’ model also applied to the work of the physiotherapy team, who also perceived high value in early mobilization and benefitted from reduced workload.
The occurrence of falls was tracked as a balancing measure. Falls represent a rare event at baseline but no increased frequency was noted over the study period, suggesting that earlier and more frequent post-operative mobilization does not increase risk for falls. The other balancing measure related to patient outcomes was staff and patient perception of the change. While this was not formally evaluated as part of the study, qualitative feedback indicated that the majority of staff and patients were happy with the protocol, which seemed to enhance patient autonomy.

5.2 Cost/efficiency

The main outcome measure related to decreasing costs and increasing efficiency is LOS. The percent of TKA patients discharged on the second post-operative day increased significantly over the study period. In 2015, the baseline rate of POD2 discharges had been approximately 17%. With efforts to improve communication of a 2-day LOS target, this rate was increased to 50% by early 2016. However, the rate did not increase further until several further interventions, including day of surgery mobilization, were implemented. Following elimination of an old patient education booklet (that quoted a 3-4 day LOS), introduction of a new lighter dressing (designed to facilitate early mobilization), the switch to adductor canal blocks, and early improvements in day of surgery mobilization, the percent of TKA patients discharged on POD2 increased to 71%. Special cause variation in LOS was first noted in October 2016, after the first three of these changes had been implemented and during a time period when some early adopting RNs were already beginning to mobilize their patients on the day of surgery (a change from historic practices at SMH).

A balancing measure related to cost and efficiency was the rate of day of surgery mobilization in THA patients. While the target study group was TKA patients, the study team elected to implement as many changes as possible for both groups simultaneously to reduce confusion and
simplify processes for staff. To facilitate this change for THA patients, a simultaneous quality improvement initiative was implemented, involving the elimination of post-operative hip precautions. Evidence suggests that hip precautions do little to reduce the risk of hip dislocation but can be functionally limiting for patients.\textsuperscript{85-88} We therefore eliminated hip precautions in January 2017 and encouraged staff to mobilize both TKA and THA patients on the day of surgery. Our data show that THA patients mobilized as much or more than TKA patients, from a rate of 40% during the baseline data collection period (Oct-Dec 2016) to 74% from January to December 2017. Pain control following THA is often easier, which may account for the fact that more THA patients mobilized on the day of surgery than did TKA patients. In any case, this evidence suggests that the efforts put into encouraging early mobilization to improve outcomes for TKA patients also benefitted THA patients, with no evidence that it detracted from the care of this patient population.

5.3 Patient experience

Through the patient and family member interviews and subsequent review and revision of the draft patient education booklet, we identified several areas for improvement. First, we sought to provide clear and realistic expectations regarding the expected course of recovery and the usual timeline. Sections regarding common post-operative concerns such as pain and swelling were expanded with additional information. The section on post-operative pain management was significantly expanded and information on using acetaminophen to help control post-op pain was added.

Instructions about exactly who to contact with concerns following discharge were clarified and patients were provided with guidelines about what they should consider a normal part of recovery and when they should be concerned. We also added a “frequently asked questions”
section to address a number of specific patient concerns (e.g. the occurrence of “clicking” after TKA surgery).

Another major theme identified by patients was physiotherapy. The booklet was revised to incorporate greater emphasis on the importance of moving and starting exercises immediately following surgery. We also included information explaining that performing exercises independently and resuming ADLs constitutes an important part of post-op therapy. Our goal was to dispel the notion that post-op physiotherapy only consists of performing exercises with a therapist. The goal is to have patients performing exercises and activities independently as soon as possible after surgery, with the role of the therapist being to guide the exercise program and ensure patients are progressing as expected.

The need for family and peer support was a final theme uncovered through the patient interviews. While we are not currently in a position to provide a formal peer support network for TKA patients at SMH, several patients expressed an interest in speaking with other patients about surgery and recovery. This is something we will pursue further in future as it would appear to have potential for further improving patient experience. Another mechanism for this may be the provision of electronic resources. One patient suggested that we provide our patient education materials in electronic format on our website, which we intend to do with the finalized patient education booklet. There is also the opportunity to provide links to other helpful resources, including online forums for patients who have undergone TKA surgery.

In addition to the formal patient interviews, we also gathered informal qualitative feedback regarding patient experience throughout the study period and used this to inform our PDSA cycles. The increase in day of surgery mobilization was received favourably by patients, many of whom expressed a preference for toileting on a commode or in the bathroom as opposed to using
a bedpan (the historic practice until POD1 prior to implementation of this QI project). Several patients provided feedback based on their experience of having one knee replaced prior to the study period and the second during the study period. These patients generally expressed satisfaction with the process changes, preferring the lighter dressings and not using bedpans and also feeling that their pain control was better and that they had more control over the operative leg (which one patient had described as feeling like a “pool noodle” during the period when continuous femoral nerve blocks were still in use).

We expect that patient experience will be positively affected by the provision of information identified by patients as being important to their preparation for a recovery from surgery. Patients who have reviewed the updated materials have provided positive feedback and indicated that they feel they would benefit from the information provided.

5.4 Standardized clinical pathway

The final proposed standard clinical pathway for TKA patients at SMH incorporates improvements to our current processes that were identified review of the relevant literature pertaining to clinical pathways for the management of TKA patients, review of clinical pathways in use at other similar institutions, patient and caregiver input gathered through semi-structured interviews and the clinical judgment of the arthroplasty staff surgeons. The final pathway also represents the culmination of iterative improvements to our processes that have been undertaken using PDSA methodology over the past 3 years.

Key additions and improvements to existing practices at SMH have been incorporated into the final clinical pathway. While many aspects of the pathway were previously well-established within our existing processes, formalizing the clinical pathway should allow for better communication with patients and between team members and should also facilitate future
Improvement work. Improvements to existing processes that are included in the newly developed pathway include identifying a patient-specific outcome goal and identifying an expected LOS at the time of the surgical consultation (i.e. when the decision to proceed to surgery is made). Early discussion of patient goals and realistic goal setting may be important for improving patient satisfaction with TKA, as several studies have identified failure to meet patients’ expectations as affecting patient satisfaction following TKA. We hope that formally including a discussion of realistic outcome goals for TKA may help to address this issue.

Based on the qualitative data collected through patient interviews, we also incorporated specific improvements into our patient education materials as part of the new standardized clinical pathway. Additional information about pain management after discharge as well as new sections about what to expect as part of the normal post-operative recovery were added to our existing educational materials. We also incorporated a “frequently asked questions” section, based on patients feedback as well as surgeons’ experience with patient phone calls and post-operative concerns. In future, we hope to further improve these materials and to add resources in other formats such as web-based materials and a mobile app. We will engage patients when designing new resources and conduct usability testing to ensure patients are able to navigate the resources easily and make use of the information provided.

Identifying the expected LOS early and reinforcing it consistently at each step in the patient’s journey has been integral to our success in reducing LOS following TKA. Improvement work prior to the early mobilization study period demonstrated that improved communication of LOS to the patient and between team members had the effect of actually decreasing LOS (by improving adherence to a new target LOS). We have therefore formalized the discussion of LOS throughout the clinical pathway. Ongoing work is underway at SMH, in collaboration with
computer scientists, to use data collected electronically to predict LOS. We are currently
developing an algorithm that should allow us to accurately predict LOS based on a variety of
patient factors. Currently, this work is done by experienced clinicians, but the accuracy is
affected by clinical experience. The algorithm under development should help to address this
uncertainty and help us to accurately predict which patients will be able to be discharged home
either same day or 1-2 days post-op, which patients will require a longer hospital stay, and which
patients will require in-patient rehabilitation prior to discharge home.

5.5 Other opportunities

Smoking and obesity are known to be correlated with poorer outcomes and increased rates of
complications following TKA.92-95 The inclusion of routine counselling regarding these risk
factors therefore represents an opportunity to intervene and improve outcomes for high-risk
patients. Future QI work may include implementing interventions to reduce risk in patients with
modifiable risk factors such as smokers, obese patients, patients with poorly controlled diabetes,
etc.

Anemia is another risk factor for complications, with anemic patients being more likely to
require blood transfusion post-operatively.96-99 Transfusion following TKA has also been found
to be associated with increased risk of surgical site infection, which can be a devastating
complication.100 At SMH we have a well-established blood management team who screen
patients and intervene with various measures to maximize pre-operative haemoglobin (Hb).
However, interventions generally require several weeks to months to be effective and surgical
wait-times have been decreasing. Ironically, the improvement in wait-times has made it more
challenging to intervene in a timely fashion for anemic patients wishing to undergo total joint
arthroplasty. Currently, patients are usually identified as anemic at the time of the PAF
appointment, which is often only ~4 weeks prior to surgery. Future work will involve changing our processes such that we identify anemic patients earlier in the process, offering a greater opportunity to optimize Hb levels pre-operatively.

Much of the work in this study involved optimizing pain management protocols and improving early mobilization. Successful interventions that have been formalized within the clinical pathway include pre-medication in the block room on the day of surgery, use of single shot adductor canal blocks plus surgeon-administered LIA, the elimination of continuous nerve catheters and IV PCA (except in the case of patients with special needs such as chronic pain patients) and the use of an oral multimodal pain regimen post-operatively (once again, except in the case of patients with special considerations, who will continue to be managed on a case-by-case basis).

Mobilization, beginning on the day of surgery and continuing several times per day until and following discharge is also highlighted in the clinical pathway. We found that early mobilization was instrumental in preparing patients for earlier discharge following TKA, consistent with the work of many other groups.\textsuperscript{2,3,36,38,40} This strategy is therefore highlighted and reinforced throughout the proposed clinical care pathway. Future strategies to maximize early mobility, now that patients are no longer hindered by IV PCA and continuous nerve catheters, will be to have patients dress in their usual clothing as soon as possible after surgery and to sit up in a chair for all meals. We hope to continue working to normalize recovery and eliminate aspects of care that support a mentality of dependence or infirmity while patients are recovering from TKA.

Finally, we hope to standardize discharge criteria at several steps along the proposed clinical pathway. Currently, while there is a generally accepted concept of when patients are ready to be discharged from the PACU to the nursing ward or from the ward to home, there is no
documented set of criteria. To improve predictability and encourage better communication of goals between the healthcare team and patients as well as between different members of the healthcare team, we plan to implement specific criteria for advancing along the pathway. Criteria for discharge from the PACU to the ward are in development and will involve discussions between the surgical team, anaesthesiologists and PACU nurses. Criteria for discharge home are included in the proposed pathway, including the ability to walk 50m on flat ground, safely navigate stairs (if necessary), safely get out of bed and transfer to the bathroom and to dress and perform ADLs. Patients must also have stable vitals, be voiding and have adequate pain management.

Implementation and tracking of specific interventions within the proposed clinical pathway has been piecemeal to date. We anticipate a future state that will allow electronic tracking of all important measures related to progress along the pathway. Ideally, full implementation of the standardized clinical pathway would involve integration of all pathway components into the electronic medical record, including documentation of patient-specific surgical goals as well as milestones such as the time of first mobilization, readiness for discharge, etc. Unfortunately, the EMR currently in use at SMH does not easily support incorporation of milestone documentation or electronic identification of patients requiring special consideration (such as post-op inpatient rehabilitation). The existing EMR is primarily designed for order entry, medication administration, etc. Furthermore, there are currently multiple large corporate changes underway at SMH, including implementation of a new peri-operative management software program, which has necessitated the commitment of significant resources that might otherwise have been available to pursue electronic implementation of the standardized TKA clinical pathway. As a result, changes to the management of TKA patients made through this project have been implemented iteratively and without dedicated support within the EMR. While a coordinated
implementation with EMR support would be ideal, this project nonetheless demonstrates that significant process improvements can be made and implemented even without EMR coordination or sophisticated IT support. In fact, this may provide a roadmap for institutions with limited IT resources for the implementation of process improvements.

Within the limitations of our EMR, we were able to update existing electronic order sets to correspond to changes in our management protocols. For example, we eliminated standard orders for CPM and knee immobilizers and added an order to mobilize patients as tolerated beginning the day of surgery. While the changes to electronic order sets were likely not instrumental in achieving improvements in these areas, we hope they will support the sustainability of the changes that have been implemented. As an academic teaching institution, resident surgeons rotate through our service every several months and standard order sets are instrumental in ensuring that protocols are correctly followed.

Despite lacking the ability to fully integrate the clinical pathway into our EMR, through this improvement project we were nonetheless able to realize significant improvements in patient outcomes (increased early mobilization, decreased knee buckling, increased knee flexion at hospital discharge), cost and efficiency (decreased LOS) and patient experience (through co-design of a new patient education booklet designed to address patient concerns).

Finally, we would like to further investigate the role of patient and family peer support. Through the qualitative work done as part of this study, we found that patients currently find support by discussing their concerns and experiences with other patients, for example during Wheel-Trans rides to and from appointments or in group physiotherapy sessions. Several patients have volunteered to members of the study team to become peer support resources for future patients. Such support networks have been shown to be beneficial in other patient populations, such as
patients with diabetes, renal disease and cancer.\textsuperscript{101-103} We hypothesize, based on the success of such programs in other patient populations and the expressed desires of arthroplasty patients, that such support networks may be beneficial to TKA patients, perhaps lessening anxiety about the unknown and thereby improving patient experience.

Table 5 summarizes the key implementation strategies that were instrumental in achieving the improvements described.
<table>
<thead>
<tr>
<th>Implementation strategy</th>
<th>Example</th>
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<tr>
<td><strong>Start small, gain early wins</strong></td>
<td>Early change was elimination of CPM, simple to do (just had to get surgeons to all agree) and very well-received by physiotherapists and nursing.</td>
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<td><strong>Engaging front-line staff</strong></td>
<td>Key changes were led by the most-involved front-line staff. Physiotherapists collected data and led elimination of CPM and knee immobilizers. Anaesthesia led work on switching from femoral to adductor canal blocks (occurred more slowly than surgeons may have wished but gained buy-in from key players and convinced those who were initially hesitant). Nurses led implementation of early mobilization, finding their own strategies to increase uptake. Surgical team provided support and encouragement.</td>
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<td><strong>Identifying local champions</strong></td>
<td>A resource nurse joined the study team and was instrumental in finding ways that her colleagues would accept day of surgery mobilization. An anaesthesiology fellow with prior experience and interest in adductor canal blocks helped to train his colleagues along with a staff anaesthesia champion. A case manager kept the focus on avoiding un-necessarily long LOS by keeping the team focused on discharge criteria.</td>
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<td><strong>Using data to overcome resistance</strong></td>
<td>An early hurdle was resistance from some anaesthesiologists about switching to adductor canal blocks. They believed the femoral block in use was sufficiently low-dose to not cause quadriceps inhibition. Data collected by the physiotherapy team showed that ~45% of patients’ knees buckled enough to interfere with mobilization. This fact led to a trial of adductor canal blocks, and an immediate reduction in the rate of knee buckling.</td>
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<td><strong>Standard work</strong></td>
<td>Standardization was used to avoid unintentional variation. Instead of picking patients who might go home a day early, the 2-day target was set for ALL patients, with the understanding that some might not meet the target (and this would be ok). Every patient was given the opportunity to exceed expectations. Standard orders and discharge summaries were used to sustain changes (some of this work is ongoing).</td>
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<td><strong>Making “highly adoptable” improvements</strong></td>
<td>Interventions that maintained or reduced workload and addressed problems perceived as having high value were prioritized. Early mobilization is supported as best practice by orthopaedic, physiotherapy and nursing literature and was found to decrease workload for the nursing team.</td>
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<td><strong>Aligning project with institutional goals</strong></td>
<td>SMH administration was working on a project to reduce LOS by improving identification of the estimated date of discharge (&quot;EDD&quot;). Identifying and promoting a 2-day LOS was therefore easily sold as a valuable project, gaining executive support. Other interventions, such as early mobilization, were seen as means to achieve the overall goal of reducing LOS.</td>
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<tr>
<td><strong>Engaging patients and families</strong></td>
<td>Patients and families were instrumental in ensuring the changes remained focused on improving patient outcomes and experience. Patients and families were able to guide the team toward improvements in patient education and communication that may not have otherwise occurred.</td>
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<tr>
<td><strong>Surgeon champion</strong></td>
<td>Leadership from a surgeon-champion was essential. Roles included celebration and recognition of improvements achieved, liaising with both front-line staff and hospital leadership to achieve project goals and, perhaps most importantly, fostering a positive culture encouraging collaboration and joy in work for all team members.</td>
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Table 5: Summary of key intervention strategies with examples.
5.6 Study limitations

This study had several limitations, including the fact that the study period was selected from within an ongoing longer-term quality improvement project that both started before and extended beyond the study period defined for this thesis. This fact compounded a difficulty inherent to many quality improvement studies, whereby it can be difficult to separate the effects of multiple interventions. Many of the interventions implemented through this study constituted small bundles of interventions, making assessment of the individual effects of each intervention difficult. However, where bundles of related interventions were supported by the literature, we felt it was most prudent to implement all interventions rather than implementing only one intervention at a time and thereby greatly extending the length of time required to achieve improvement.

In addition to difficulty separating the impact of individual interventions, it is also difficult to separate the effect of interventions implemented through our quality improvement work from outside trends and larger system interventions unrelated to the specific work described herein. However, the use of SPC charts and the assessment of the temporal relationship between interventions and changes noted in the process and outcome measures provides strong evidence that our interventions were largely responsible for the improvements that were observed.

Finally, this study was limited by the ability of high-quality and timely data on a number of measures. System-level data such as the occurrence of ER visits and readmissions (outside of SMH) were not available in an accessible and timely fashion and therefore could not be used during the course of this project. Such measures may have added important information that would have informed this project. For example, if an increase in ER visits has been observed with the reduction in LOS achieved during this study, that may have been an important balancing
measure. For this reason, we are currently looking at data available through ICES to further investigate this question.

Additionally, detailed patient-level data regarding demographics, comorbidities and other factors that may have impacted measures such as day of surgery mobilization and LOS were not available due to the workload that would have been required to collect such data on the large number of patients tracked through this study.
Chapter 6

6 Future study and ongoing improvement work

Based on the improvement work described herein, next steps will include developing new standardized order sets to formalize the new multimodal pain management protocols that have been developed. We are also working on developing standard discharge prescriptions, to ensure that medications such as acetaminophen are prescribed upon discharge for all patients without a contraindication. Patient feedback suggested that pain management was a significant issue following discharge and patients were not necessarily aware that they could combine acetaminophen with a narcotic pain medication. After the study period, a new oral multimodal pain protocol was introduced, with significant improvements in post-operative pain management observed, as well as a further decrease in LOS, with many patients now being discharged home on or before the first post-operative day. As part of our continuing effort to improve early mobilization, we also switched entirely to single shot adductor canal blocks in February 2018. In combination with the change to an oral pain protocol (hence the elimination of IV PCA pumps) and with the added benefit of intra-operative LIA, we observed excellent pain relief and further enhanced early mobilization, with many patients beginning to mobilize independently on the day of surgery. These further improvements have also allowed us to further increase the percent of patients being discharged on the first and second post-operative day. We plan to continue to minimize the duration of the inpatient stay while striving to provide greater support to patients following discharge to avoid potential increases in either ER visits or readmissions). Current work is ongoing using ICES data to evaluate rates of ER visits and readmissions over time, as LOS has decreased following TKA within Ontario over the last decade.
While our study applied interventions to all TKA and THA patients rather than identifying those who may have been at greater likelihood of achieving early mobilization or a shortened LOS, future work will include a detailed examination of the characteristics of those patients who may not have benefitted significantly from our improved clinical pathway. It is possible that a small number of complex patients continue to experience delays in post-operative mobilization or prolonged LOS. While our data demonstrate significant overall improvements, a small subset of patients may continue to struggle. Further analysis to look at outliers under our current protocol may identify opportunities for further improvements specifically related to certain subpopulations of patients.

This work has increasing relevance with the recent implementation of a bundled payment model for hip and knee arthroplasty in Ontario. Based on the framework for improvement developed during the study period, the study team intends to periodically review our processes and undertake further improvement work if new opportunities are identified to improve outcomes, increase cost and efficiency or improve patient experience. Areas where there may be opportunity for further improvement include greater pre-operative optimization of patients with high-risk conditions such as obesity and poorly controlled diabetes, improved identification of patients requiring inpatient rehabilitation post-operatively (and improved communication between team members regarding patients flagged for inpatient rehab), greater standardization of outpatient physiotherapy (both in terms of content and duration) and better early post-operative follow-up.

Based on the qualitative work performed as part of this study, it was evident that most concerns arose early in the recovery process, shortly after patients had been discharged home. Patients had significant concerns about pain and pain management and many described their recovery
trajectory as unexpected, finding that they needed more support from family and friends than they had anticipated. A recent qualitative study by Kennedy et al closely mirrors our findings. In this study, conducted at an academic Hospital in Toronto similar to St. Michael’s, participants also emphasized the need for greater information about pain management post-discharge, suggesting that this is a common concern of arthroplasty patients. Participants in the Kennedy study also endorsed using printed patient education materials, while some indicated they would prefer other sources of information such as websites and mobile apps. Peer support was also identified as something that participants would find helpful, something that was also noted by our patients. Given that the informational needs of total joint patients in Toronto seem to be quite consistent, we elected to include more extensive information about post-operative pain and pain management in our revised patient education materials. We also incorporated more information on what to expect and what is “normal” during a typical post-operative recovery. Participants in our qualitative data collection as well as the findings of Kennedy et al will inform future work, as we plan to develop additional patient education resources, including web-based and mobile applications.

Improved early post-op monitoring is an opportunity that the study team has identified for future study. Other researchers have demonstrated that the use of remote patient monitoring apps can provide additional support following hospital discharge, reducing the need for clinic visits and potentially allowing early identification and management of post-operative complications. The development and implementation of such an app, as well as additional web-based resources may allow greater support for patients during the early post-operative period, thereby improving patient experience while also potentially reducing costs by avoiding unnecessary emergency department and clinic visits. With patient feedback suggesting that many patients struggle to manage their pain and have concerns regarding what constitutes a “normal” recovery following
discharge from hospital, the provision of additional supports during the transition period following hospital discharge is essential. The literature supports that a shortened LOS following TKA is safe and also suggests that discharge to home (as opposed to an inpatient rehabilitation facility) confers a lower risk of complications and/or readmission.\textsuperscript{110-115} Recent literature suggests that even patients living alone may be safely discharged directly home following total joint arthroplasty.\textsuperscript{116} However, patients seem to still experience significant anxiety following discharge from hospital, as evidenced by our qualitative research. In order to contain costs and ensure good outcomes, patients should be recovering in their own homes, but healthcare providers must also provide the support necessary to ensure that this process is experienced favourably by the patient.\textsuperscript{116} We are currently pursuing options to develop a mobile app to provide additional support and monitoring of patients following discharge from hospital. The app we envision will both provide ongoing patient education and support, in keeping with the standardized clinical pathway, but will also allow for interaction with patients who may be having difficulties. Other researchers have demonstrated that such apps can reduce the need for ER visits and in-person clinic visits, potentially providing additional support while also containing costs.\textsuperscript{104-106,108,117} We anticipate that such an app could also be used to improve and standardize the provision of post-operative physiotherapy by ensuring that patients are aware of and achieving appropriate milestones.

Another way to ease anxiety following hospital discharge and ensure that patients feel supported at home is to implement some form of peer support network. This was suggested by several patients and has been found to be beneficial in other patient populations.\textsuperscript{101-103} The implementation of peer support for TKA (and THA) patients therefore represents an opportunity for future research.
This quality improvement project demonstrates that length of stay can be significantly decreased following TKA, while maintaining or improving patient outcomes, by reorganizing the processes of care during the acute-care hospital stay. By eliminating interventions conferring a heavy work-load that were not evidence-based and instead adopting evidence-based interventions aimed at promoting rapid recovery following joint replacement surgery, we were able to increase the proportion of patients mobilizing on the day of surgery as well as the proportion of patients able to be discharged on or before the second post-operative day. In doing so, we found it was essential to engage both front-line nursing staff as well as other members of the interdisciplinary team (physiotherapists, anaesthesiologists, case managers) and patients. Using an iterative approach whereby successive changes were introduced, studied and then fully adopted once it was evident that improvements were being made, allowed the team to undertake large improvements and significant changes to the existing care protocol over a relatively short period of time, while experiencing limited resistance. Resistance that was experienced early in the process was eliminated by engaging stakeholders and demonstrating improvements through ongoing data collection. This model should be applicable to other similar institutions looking to update and improve existing and potentially outdated protocols for the care of total joint arthroplasty patients. Of note, while our study was focused on improving care for TKA patients, we also successfully implemented improvements in care for total hip arthroplasty patients by standardizing some of the interventions adopted for all arthroplasty patients (e.g. day of surgery mobilization). This “halo” effect has been described elsewhere, with improvements and simplification in care processes for TKA patients also resulting in better care for THA patients.\textsuperscript{118}

While we were able to improve care during the acute-care stay following TKA and THA surgery, work remains to be done once patients are discharged home. We identified several opportunities
to continue our improvement work into the post-acute care phase of recovery. Work in this area is particularly timely, as our hospital has recently become a pilot site for a new bundled-care model being adopted by the Ontario MOHLTC. Under this new model, we will be responsible, through a bundled payment model, for both the acute-care and post-acute phase of rehabilitation. Ensuring that post-acute care is high-quality and evidence-based will allow us to continue to contain costs while ensuring the best outcomes for our patients.
<table>
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<tr>
<th><strong>Glossary of Terms</strong></th>
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<tr>
<td><strong>Adductor canal block</strong></td>
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<td><strong>Arthroplasty</strong></td>
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<td><strong>Bundled payment model</strong></td>
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<td><strong>Continuous passive motion</strong></td>
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<td><strong>Clinical assistant</strong></td>
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<td><strong>Femoral nerve block</strong></td>
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<td><strong>Indwelling nerve catheter</strong></td>
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<td><strong>Knee buckling</strong></td>
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<td><strong>Knee immobilizer</strong></td>
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<td><strong>Local infiltration analgesia</strong></td>
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<td><strong>NSAID (non-steroidal anti-inflammatory drug)</strong></td>
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<td><strong>Oral multimodal pain protocol</strong></td>
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<td><strong>Patient-controlled analgesia</strong></td>
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<td><strong>Peripheral nerve block</strong></td>
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<td><strong>Single-shot nerve block</strong></td>
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<td><strong>Total knee arthroplasty</strong></td>
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<td><strong>VTE prophylaxis</strong></td>
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References


24. Duncan CM, Moeschler SM, Horlocker TT, Hanssen AD, Hebl JR. A self-paired comparison of perioperative outcomes before and after implementation of a clinical


Appendices
Appendix I: Patient and Caregiver Interview Guide

Oral consent script

We are interested in finding out more about patients’ and caregivers’ experiences before and after total knee replacement so that we can improve our processes and support patients and caregivers in managing their expectations throughout the process. Therefore, we would like to ask you a few questions and/or follow you to your clinic/PAF/follow-up visits and during your post-surgery hospital stay. Answering the questions will only take 15 minutes and the length of shadowing will depend on the length of your visits.

The information collected is for quality improvement purposes only and will remain strictly confidential. I would like to audio-record our conversation/take notes during observations. Any recordings or transcripts made from interviews and observations will not contain any identifying information. Only the QI lead and I will be allowed to look at these records.

Your participation is voluntary. You can stop the recording or withdraw your participation at any time during our interview or shadowing. Please let me know whether you agree to participate or not.

Brief interview guide

This is a guide, so these questions will be tailored to the particular stage that the patient or caregiver is at when approached in SMH’s Division of Orthopaedic Surgery.
Appendix I: Patient and Caregiver Interview Guide

1) Could you talk about what brought you to the clinic/hospital?
   a. On clinic visit:

2) How did your clinic visit help you today?
3) Can you recall the information they provided you that was important for you?
4) Was this new to you, or have you heard/read this elsewhere before? If so, when or what sources have you used?
5) Was there anything that you didn’t understand and/or wanted to ask but you could not? If so, what was it?
6) Could you voice some of your concerns?
7) What information are you looking for to prepare for surgery and what comes after?
8) What do you expect and fear as you go through your surgery and what comes after?
9) Do you have any suggestions how clinicians could be more helpful to patients and their caregivers?

On PAF visit:

1) How did your PAF visit help you as a patient undergoing TKA most so far at St. Michael’s Hospital?
2) Do you feel prepared for your PAF visit? How so? How have the handouts you received at clinic help you prepare? Was there anything you were missing from them?
3) Can you recall some of the information they provided you now that seems important for you to prepare for the surgery and what comes after? Do you plan reading all the documents that you got today?
4) Was this new to you, or have you heard/read this elsewhere before? If so, when or what sources have you used? What was new today?
5) Was there anything that you didn’t understand and/or wanted to ask but you could not? If so, what was it?
6) Could you voice some of your concerns?
7) What do you expect and fear as you go through your surgery and what comes after?
8) Do you have any suggestions how clinicians could be more helpful to patients with TKA at St. Michael’s Hospital?

On post-surgery:

1) How did your surgery go and how do you feel now?
Appendix I: Patient and Caregiver Interview Guide

2) What has been helpful or important for you since you have been in the hospital? How?
3) Is there something that you wished you knew in advance but you didn’t?
4) Can you recall some of the things clinicians said or did that seemed really important for you to prepare for the surgery and what comes after?
5) Was there anything that you didn’t understand and/or wanted to ask but you could not at any one moment? If so, what was it and when?
6) Looking back, do you think something was missing from what clinicians told you or how they did so?
7) Can you recall whether you had a chance to read the many information sheets you received at your clinic and PAF visits? If so, how did they help you prepare for what’s coming?
8) Have you used other resources to find out more about surgery and what comes after? If so, when, what led to it, and what sources have you used?
9) Do you have any suggestions how clinicians could be more helpful to patients with TKA and their families at St. Michael’s Hospital? Any suggestions about how to support families while they are waiting?

On follow up appointments:

1) How has your recovery been?
2) What do you expect from your appointment today? How was your follow up helpful to you today?
3) Can you recall some of the things the clinician said or did that you found really important or helpful?
4) Was there anything that you didn’t understand and/or wanted to ask but you could not today? If so, what was it and when?
5) Today you had a meeting with the advanced practice physiotherapist, not the surgeon. How do you feel about it?
6) Looking back, do you think something was missing from what clinicians told you before or right after surgery, or is there something that you wished you knew in advance?
7) While at home/rehab post-surgery, have you used other resources to find out more about your experiences and what to do? If so, when, what led to it, and what sources have you used? And how helpful have you found them?
8) Have you reached out to other help? If so, to whom and why? How helpful have you found them?
9) Do you have any suggestions what or how clinicians could be more helpful to patients with TKA at St. Michael’s Hospital?
Appendix I: Patient and Caregiver Interview Guide

Final question:

Is there anything else you would like to add?

Patient and Family feedback on TKA booklet interview guide

We are updating our TKA Surgery Booklet. Before we finalize it, we would like to gather the feedback of patients and families. On the basis of your feedback and suggestions, we hope to improve the booklet. So, I wonder whether you would be willing to have a look at this new version and comment on it. It is quite lengthy but may be useful for you, so I wonder if you could take it home, review it, and when you come in for your surgery I could meet you to discuss your feedback during your hospital stay.

1) How do you like the booklet?
2) What is it that you like and don’t like about it?
3) Is the purpose of the booklet clearly stated?
4) What do you think about the presentation, the look? (Are the pictures and cues used help you understand the text?)
5) How do you find navigating the booklet? Is the information organized in a logical, easy to follow manner?
6) Are the headings and sections used helpful? Do the titles clearly tell you about the topic or content?
7) Is the text easy to read? Are simple sentences used? Are medical or technical words and abbreviations defined?
8) Does it help you understand what you are going through and what you can expect down your path?
9) Is there any additional content that you’d like to see on the pages? Is any information missing?
10) Does it help you understand who the doctors and other health care providers are that take care of you and how you can communicate with them if you have any questions and problems?
Appendix I: Patient and Caregiver Interview Guide

11) Are there any other suggestions you have about how we can improve the booklet?

Thank you!
Appendix II: Draft Patient Education Booklet
Knee Replacement Surgery

Information for patients and families

Please bring this booklet with you at each hospital visit, and on the day of your surgery.
### Important dates

#### Your Pre-Admission Facility Visit and Teaching Date
- **Date:** ___________________
- **Time:** ___________________
- **Location:** ___________________

#### Your Surgery Date
- **Date:** ___________________
- **Time:** ___________________
- **Location:** Sullivan Lounge on the 5th floor of the Cardinal Carter Wing
  - **Note:** No eating or drinking after midnight on the night before your surgery

#### Your Family Doctor Appointment (to remove your staples)
- **Date:** ___________________ (10-14 days after your surgery date)
- **Time:** ___________________
  - **Note:** Bring the staple remover given to you at discharge

#### Your Surgeon or Advanced Practice Physiotherapist Follow-Up Appointment in the Martin Family Centre
- **Date:** ___________________
- **Time:** ___________________

#### Your Follow-up Physiotherapy treatment will be at:
- **Clinic:** ___________________
- **Date:** ___________________
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Your knee surgery

This booklet is designed to help you prepare for your upcoming knee replacement surgery. Please read this booklet carefully and bring it to each hospital visit.

There are many things to prepare before your surgery. Being prepared will help ensure you are ready for your return home. It will also help you recover faster.

If you have any questions, please write them down in the notes section at the end of the book. Then ask a member of your Orthopaedic Team.

Why do I need knee replacement surgery?

Damage can happen in the knee joint for many reasons. It can be caused by injuries to the bones of the knee joint, or by some diseases like arthritis. Some forms of arthritis may damage only the knee joint. In others, the knee may be just one of many joints with arthritis.

These conditions can lead to increasing pain, both at rest and when placing weight through the leg. Over time, the knee cannot move as much. Movement may become difficult, often with a grating sound or feeling. When your knee joint is damaged, you may lose the ability to do normal activities comfortably.

Joint replacement surgery is only for those people with very damaged joints that cannot be treated in other ways, such as with medicines, exercises or therapy. It is done for the following reasons:

- to relieve pain and improve knee movement
- to improve function (for example, walking, sitting)
What will my new knee be made of?

Your new knee replacement unit consists of 3 to 4 parts called components:

1. The **femoral component** is metal and is fitted to the end of your femur (the long thigh bone).

2. The **tibial component** is also metal and is attached to the top of your tibia (the shin bone).

3. A plastic insert is fitted between the two metal components. This insert is made of polyethylene, a type of plastic. The insert acts like a shock absorber and helps with knee movement, much like your natural cartilage used to act.

4. A plastic **patellar component** may be fitted to your patella (knee cap).

The metal components are usually attached to your own bone using bone cement. The bond between the artificial knee and your bone is very strong. You can put your full weight on your new knee right away.

What results can I expect?

Most people experience good or excellent results after a total knee replacement. They get pain relief and have good functional movement and strength. After knee surgery, you can expect to be able to walk, sit and participate in activities of daily living with little
or no difficulty. You shouldn’t participate in high-impact activities such as running with an artificial knee joint, as this may cause it to wear out early.

In most cases, the new joint will last for many years. However, some people may develop problems. These problems can include:

- Infection
- Stiffness
- Loosening of the joint from wear or due to mechanical failure

If you develop an infection in your artificial knee, you will need more surgery as well as treatment with antibiotics. You may even need your entire knee replaced a second time, in what is called a revision surgery. A knee revision usually involves having another major surgical procedure to put in new components and another period of rehabilitation. The results of a revision might not be as good as the results of the first knee replacement surgery.

If your new knee wears out or becomes loose, you may also need a revision surgery.

**How do I prevent my new joint from getting an infection?**

After having a joint replacement, you may need antibiotics when you get infections. This will prevent the infection from spreading to your joint. The following are times that you may need antibiotics.

1. In the future if you have an infected tooth or need dental work (including cleaning), please tell your dentist that you have an artificial joint. You will need to take antibiotics.
2. If you have a bladder infection or need a cystoscopy (a test to check your bladder function), tell your Doctor that you have an artificial joint. You will need to take antibiotics.
3. If you have an infection anywhere with redness, swelling inflammation, or pus, call your doctor immediately. Tell them you have an artificial joint and you may need antibiotics.
Before your surgery

What do I need to organize before my surgery?

Today, almost all patients who have knee replacement surgery go home 2 days after surgery. You can have a big impact on the success of your surgery if you plan and are well-prepared before surgery.

It is important to prepare for your return home after surgery. Please be ready and arrange:

1. Someone to help you after surgery

   Arrange for someone to help you at home for the first few days after surgery. The following is a list of things they will need to help you with:
   - Pick you up from the hospital 2 days after your surgery. Make sure the vehicle is not low to the ground like a sports car.
   - You will need to make arrangements for transportation to/from appointments eg rides, taxis etc.
   - Help you with heavy housework such as laundry, cleaning, cooking, and shopping.

2. Special equipment

   During your Pre-Admission Facility education session we will recommend equipment based on the layout of your home. You will have to find a medical supply company to rent it from or buy it before your surgery. This is very important. (*Ensure you have your crutches or walker at the hospital or in your car on the day of discharge)

3. Prepare your home

   You will need to prepare your home the week before you come in for your surgery. The following is a list of some things you can do to prepare your home:
   - Get rid of clutter, especially in hallways.
   - Remove small rugs. Remove any tripping hazards you see.
- Make sure all railings are secure. Consider installing handrails to provide support on stairs if you do not have them.
- Check to see that you have a chair that is high with a firm seat, backrest and armrests. This will make it easier to sit or stand.

4. Prepare your kitchen and meals

- Stock up! Cook meals in advance and freeze them. You can buy groceries and healthy frozen dinners or arrange for help from friends and family.

5. Prepare your bathroom

You may need to rent or buy the following items from a medical supply store:

   a) **Raised toilet seat with armrests and**
   b) Equipment for your bath or shower. If you have a walk-in shower - you will need a **shower chair**. If you have a bathtub you may need a **bath transfer bench**.

Use rubber bath-mats, in the bathtub and on the floor outside the bathtub.

6. Book an appointment with your family doctor 10-14 days after your surgery to remove your staples/sutures. If you do not have a family doctor, find a local walk-in clinic. Call to see if you can book an appointment or if you can walk in to have this done. The hospital will give you the staple remover on the morning you leave the hospital.

**What if I get sick the week before my surgery?**

In the week before surgery, if you have any illness or health issue that you believe may interfere with your surgery, please contact your surgeon's office immediately to let them know. Your surgery may need to be re-scheduled to another day.
Your hospital stay

How long will I be in the hospital?

Planning your discharge begins before you have your surgery. When you visit our Pre-Admission Facility (PAF) teaching session, your discharge plan will be explained to you. Most patients are discharged directly to their home after 2 days in hospital.

You do not have the option to choose if you are going home or to a rehabilitation unit after your surgery. This will be decided by the therapy and discharge team based on a number of factors, including your strength and function.

Your length of stay in the hospital depends on the surgery you had, your overall health and your recovery in hospital. Most patients are ready to return home 2 days after knee surgery.

What should I bring with me on the day of my surgery?

The hospital is a public building so it is important to leave any valuables at home for safe keeping.

Medicines:

- Bring the phone number and address of your pharmacy with you
- Bring all your medicines with you to the hospital

Clothing and Personal Care Products:

- Socks and supportive walking shoes (for example, running shoes)
- Loose fitting clothes for the trip home
- Underwear
- Your CPAP device, if you have one for treatment of sleep apnea
- Toiletries (for example: toothbrush, toothpaste)
- Optional: House coat and slippers (slippers must have a rubber sole and a back around the heel)

Equipment:

- Two-wheeled walker/crutches
Will I feel pain during surgery?

Anaesthesiologists are specialist medical doctors. They are trained to provide sedation, pain control, and treatment for serious medical emergencies during your surgery. You will meet with an anaesthesiologist before your surgery to discuss the best pain and sedation options for you. This meeting may be during your pre-admission visit if you have other medical issues or on the day of surgery if you are generally in good health.

There are 2 ways to feel no pain during surgery:

1. Spinal Anaesthetic:

   Most patients having knee replacement surgery have spinal anaesthetic. This is done with the injection of local anaesthetic and pain medicine given in the back. The lower part of your body will be ‘frozen’ for a few hours and you will not feel any pain during the surgery. You may also receive intravenous (IV) sedation that will make you very sleepy and relaxed during the knee surgery. Speak to your anaesthesiologist if you still feel anxious and want more sedation. The dose of sedation medicine can be adjusted to make sure you are relaxed and safe during your surgery.

2. General Anaesthetic:

   General anaesthetic is medicine that puts you asleep. It is given by injecting medicine and/or by breathing in anaesthetic gases. This is only used in about 1 out of 10 patients having knee replacement surgery.

You can find more information in the pamphlet “Do you have questions about your anaesthetic and pain control” available in the Preadmission Facility (PAF).

Where will I get this anaesthetic?

The Regional Room is next to the operating room where patients receive spinal anaesthetic. The anaesthesiologist and nurses who work there are specially trained to give patients spinal anaesthetic for their surgery and for pain control afterwards.
If you decide to receive a spinal anaesthetic for your knee surgery, you might receive IV sedation before the injection. After the injection, you will be monitored in the Regional Room before the anaesthesiologist and nurses transfer you to the operating room for your surgery.

In the Operating Room, the anaesthesiologist will give you medicine for sedation to make you sleepy and relaxed if you are already ‘frozen’ with a spinal anaesthetic.

**What happens during my surgery?**

In the operating room, a cut is made over the front of your knee. The damaged bone and cartilage in your knee is removed and replaced with the artificial knee joint. The cut is closed with staples/sutures and covered with a dressing. After this, you will be moved to the recovery room.

**What happens when my surgery is over?**

You will wake up from your surgery in the Post Anesthetic Care Unit (PACU), sometimes called the “recovery room”. Here the nurses will check your vital signs (heart rate, blood pressure, breathing rate, and temperature) regularly and treat your pain and other issues until you are ready to be moved to your room. You will be wearing an oxygen mask for your safety. You will stay in the recovery room for several hours. Next you will be moved to your room on the orthopaedic floor. Here a nurse will do a complete assessment of you.

**Will I have pain after surgery?**

It is important to get out of bed and start moving as soon as possible after your surgery. This will help with your pain and will help to reduce side-effects such as constipation, nausea and vomiting. Some of the strong narcotic pain medications that you may need after your surgery can cause constipation, nausea, vomiting, drowsiness and difficulty urinating. The team taking care of you will try to minimize these strong medications and will get you up and moving around quickly after surgery to reduce the chance that you have these problems.
What can I expect each day I am in hospital?

**CLINICAL PATHWAY FOR TOTAL KNEE REPLACEMENTS**

<table>
<thead>
<tr>
<th>Post-Op Day 0</th>
<th>Post-Op Day 1</th>
<th>Post-Op Day 2</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intravenous Pain Medication</strong></td>
<td><strong>Oral Pain Medications</strong></td>
<td><strong>Checklist</strong></td>
<td></td>
</tr>
</tbody>
</table>

### After your surgery
- You will have an IV (intravenous)
- You will receive pain medication
- You may have clear fluids for food (juice, broth, jello), and/or solid foods, as tolerated
- You will start moving with help
  - for example sitting at the edge of the bed or getting up to the commode or bathroom
- You will have help to bathe yourself
- You will eat solid foods
- You will sit up in a chair for 1-2 meals with help
- You will walk in the hallway with help from your Physiotherapist or Nurse
- You may be changed to oral pain medication
- Your discharge plan will be reviewed
- You will be able to move and walk on your own with a walker or crutches
- You will be able to use the bathroom on your own
- Your Physiotherapist will teach you how to climb stairs if applicable
- Your Nurse will teach you how to change your dressing and care for your wound

Before leaving the hospital, ensure you have your
- Prescription
- Copy of your home exercise program
- Referral for outpatient physiotherapy if needed
- Dressing supplies
- Follow-up appointment time with your Surgeon or Advanced Practice Physiotherapist (APP)

The health care team will ensure the best care plan with each patient

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St. Michael’s
Inspired Care. Inspiring Science.
What problems can occur after Surgery?

Your health care team will do everything they can to help you achieve the best possible results after surgery. However, problems sometimes happen. These problems may include blood clots in the leg veins, pulmonary embolism, breathing problems, nausea and vomiting, inability to pass urine, constipation, dizziness, skin irritation/bed sores and confusion/delirium. The good news is that you can prevent most of these problems from happening. Some people will develop stiffness in the operated knee, especially if they aren’t able to do the post-operative exercises. It is very important to move your knee right away after surgery and to keep moving it more and more each day in order to avoid stiffness.

To prevent problems, be as active as you can and participate in your own care and recovery.

It is common to have some swelling in your knee or operated leg after surgery. Ensure to elevate the leg occasionally during the day and apply ice as needed (not directly to the skin) x 10-15 minutes on, followed by 1-2 hours off.

Discharge instructions and follow-up

What is my discharge plan?

Your discharge plan will be to go home on the second day after your knee surgery. Before you return home, you will be able to walk and generally be able to look after yourself. Rehabilitation continues while you are at home with a home exercise program that is provided to you by your physiotherapist during your hospital stay. It is very important to:

- continue with this exercise program in your home (3 to 5 times/day)
- walk every day using the equipment your physiotherapist recommended (for example, walker or crutches)
- take lots of sitting breaks when you walk
- ensure you have a date for outpatient Physiotherapy before you come for surgery.

4-6 weeks after your surgery you will have a follow-up appointment with either an Advanced Practice Physiotherapist or your surgeon.

During your stay, your discharge plan may change. The team will monitor your progress and ensure that the best plans for you are in place for your discharge.

**Will I need physiotherapy after surgery?**

You will need further physiotherapy once you leave the hospital. You will go to an outpatient physiotherapy clinic at a rehab centre, private physiotherapy or an OHIP-funded clinic. You should start your physiotherapy within 1 week after discharge from hospital. You will have to ensure you are able to get to and from the appointments, either by public transportation, or by a friend or family member.

**Note:** Transportation is not organized by St. Michael’s Hospital.

<table>
<thead>
<tr>
<th>The discharge time from the hospital is 11:00 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please make sure you arrange transportation to your home.</td>
</tr>
<tr>
<td>If someone will be helping you at home, we encourage them to come and participate in the discharge instructions by the physiotherapist and nurse from about 09:00 – 11:00 a.m.</td>
</tr>
</tbody>
</table>

**What do I need to have before I leave the hospital?**

Before you leave the hospital make sure you have all of the following things with you:

- The necessary equipment in place at home, with a prescription for them if required (for example, a walker, crutches, raised toilet seat, bath chair)
- Prescriptions for medicines
Your follow-up appointments
- Dressing changing supplies
- Staple remover
- Exercise instructions
- All of your belongings

You will need to know how to do these things safely before you are discharged home:
- Walk with the recommended aid device (for example, crutches or walker)
- Transfer into and out of bed and chair
- Transfer into and out of a car
- Climb stairs (if you have them)
- Be aware of the activities you can and cannot do
- Change your dressing

What medicines will I need to take at home?
On the day of your discharge, you will receive prescriptions for pain medicine to help you manage your pain, blood thinners to prevent blood clots, and stool softeners to prevent constipation. Take the stool softeners for the length of time that you are on pain medicines. Once you go home, if you have any questions about your medicines, please contact your surgeon’s office or your family doctor.

What symptoms should I watch out for?
Call your doctor right away if you have any of these problems:
- Increasing redness, swelling or fluid draining from your incision site
- A bad smell or green, pus-like drainage at the incision site
- An unexplained fever (temperature over 100 degrees Fahrenheit or 38 degrees Celsius) or chills that last more than 1 day
- Severe knee pain that does not get better when you take your pain medicine
- Numbness or tingling that does not improve when you put your leg up

Visit your nearest Emergency Department if you have any of these problems:
- Shortness of breath or difficulty breathing
- Chest pain, tightness or pressure
- A sudden swelling, pain or redness in your thigh or calf
- A sudden and severe increase in pain in your new knee

How do I care for my incision at home?

It is important to take care of your incision until it is completely healed. It is important to look at your incision daily to ensure there are no signs of infection.

Keep your incision clean and dry and do not soak in a bath, pool or hot-tub until your sutures have been removed and your incision is completely healed. Do not rub or scratch your incision.

Unless your healthcare team gives you different instructions it is okay to shower or take a sponge bath 48 hours after surgery. Wash yourself with soap and water, allowing the water to run over the surgical incision and then gently pat the area dry. Do not rub or scrub your incision. Do not apply anything on your incision including creams, lotions or oils.

How to remove your staples/sutures:

Staples can be removed 10 to 14 days after your surgery. They can be taken out by a community health care provider (for example, your family doctor). You will be provided with a staple remover before you are discharged from hospital, because your family doctor may not have one.

Tips for climbing stairs and getting into/out of a car

How to climb stairs

- Going upstairs
  1. Step up onto the first step with your non-operated leg.
  2. Step onto the step with the operated leg.
  3. Follow with your cane/crutch(es).
  4. Repeat steps 1 to 3.

- Going downstairs
1. Lower the cane/crutch(es) to the step below.
2. Step down with your operated leg.
3. Step down with the non-operated leg.
4. Repeat steps 1 to 3.

Note: Use a railing, if present, to improve safety. When going up and down stairs with a railing hold onto the railing with one hand and hold the cane/crutch in the other hand.

How to get in and out of your car

- To get into the passenger seat of a car
  1. Have the driver recline the car seat back.
  2. Push the seat as far back as possible to allow for enough leg room.
  3. Put 1 to 2 pillows on the seat to raise the height of the seat.
  4. Back up to the car using your walking aid until you feel the car frame touch the back of your legs.
  5. Grab onto the back of the car seat while you lower yourself to the seat.
  6. Use your arms on the seat and your non-operated leg to push yourself backward across the seat.
  7. Then bring your legs into the car one at a time (you may require assistance to swing your legs into the car). Your body will face the front window.
To get out of your car
1. Slide your legs out one at a time. You may need help with your operated leg. Your family member/friend could help by supporting your operated leg by the knee and ankle. Slowly move until both legs are out of the car and touching the ground.
2. Slide yourself to the edge of the seat using your arms and non-operated leg. Keep the operated leg straight in front of you.
3. Grab onto two stable surfaces (the side of the car and your crutches/walker) and stand up pushing with your arms and your non-operated leg.

Tips for a comfortable car ride home:
- For long car trips, stop every 2 hours or as needed. Get out and walk around to prevent discomfort, stiffness and potential blood clots.
- While in the car, move your ankles up and down to help with circulation and prevent stiffness.

When can I resume my sports and driving?

Usually people can resume most activities by 3 months after surgery. If unsure, ask your surgeon. Things to avoid include high impact activities eg. running, squash, moguls skiing, kickboxing.

Driving a car

Do not drive any vehicle or heavy machinery for at least 6 weeks after surgery. This is because car insurance companies will generally not cover you in the event of an accident until you have recovered from your surgery. Also, your driving may be impaired if you are taking pain medicines.

Speak to your surgeon or advanced practice physiotherapist at your 4-6 week appointment for further directions as to when you can start driving.
Where can I get more information?

The following websites are extra sources of information. They are not associated with St. Michael’s Hospital. Use the information in this booklet as your guide as it is developed for people having joint replacements at St. Michael’s Hospital.

‘My Joint Replacement’ website provides easy to understand information on every step of joint replacement surgery and rehabilitation. It tells you what you can expect and how you can prepare. It was developed with surgeons and other health professionals.  
http://arthritis.ca/manage-arthritis/living-well-with-arthritis/surgery

The Canadian Orthopaedic Foundation has helpful Patient Information Resources.  
http://whenithurtstomove.org/

The Ontario Physiotherapy Association has information to help you find a physiotherapy clinic or a physiotherapist in your community.  
https://opa.on.ca/about-physiotherapy/find-a-physiotherapist/ or call (416) 322-6866
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### Appendix III: Summary of Clinical Pathway Features

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<th>LIT REVIEW: Pathway Features</th>
<th>Program coordinator identified; oversees communication, care delivery</th>
<th>Standardized communication</th>
<th>Realistic patient-specific goal setting</th>
<th>Connect patients with experienced patients</th>
<th>PAF course/session</th>
<th>Encourage family involvement in pre-op teaching</th>
<th>Pre-op counselling re: smoking, nutrition/weight loss, exercise</th>
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Appendix IV: Revised Patient Education Booklet
Knee replacement surgery
Information for patients and families

Please bring this booklet with you for each hospital visit, and on the day of your surgery.
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Contact your surgeon if you have any questions after reading this booklet or if you have any concerns after you leave hospital after your surgery.

**Surgeon**

Name: ___________________________  Telephone: _______________________

Address: _______________________________________________________________________

As soon as you know your surgery date, you should arrange post-op physiotherapy to begin within 1 week of leaving hospital.

**Post-op physiotherapy clinic**

Name: ___________________________  Telephone: _______________________

Address: _______________________________________________________________________

We recommend that you have a family member or close friend agree to be your coach or supporter for this surgery.

**Coach:** _______________________  Telephone: _______________________

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4
Knee replacement surgery
My knee surgery

This booklet is designed to help you prepare for your upcoming knee replacement surgery. Please read this booklet carefully and bring it each time you visit the hospital. Remember to bring it on the day of your surgery.

There are many things to prepare before your surgery, such as finding a physiotherapy clinic to attend after surgery. You will also need to prepare your home for when you get home from the hospital. Being ready will help you recover faster.

If you have any questions, please write them down on the notes page at the end of the booklet. Then ask a member of your health-care team.

My goal after knee surgery

What are you hoping to be able to do after surgery that you cannot do now? Maybe you want to be able to walk a certain distance without pain, or return to work or go on a special vacation. Pick a goal and write it in the space below.

Be sure to discuss your goal with your surgeon and with the rest of your hospital team. Discussing your goal will help you to know if it is realistic after knee replacement surgery. Once the team knows what your goal is, they can also help you work toward achieving it.

My goal after knee surgery is: __________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
Why do I need knee replacement surgery?

Knee replacement surgery is for people with badly damaged joints that cannot be treated with medicine, exercises or therapy. Your knee might have been damaged by an injury or by a disease such as arthritis. When your knee joint is damaged, you may find it hard to do your normal activities. Over time, you may feel pain or find it difficult to move. You may feel or hear grinding in your knee.

Knee replacement is done to:

- Help relieve pain and improve how your knee moves
- Make it easier to walk, sit or do other things

A healthy knee joint looks like this:

Used from *Your New Knee* © 2015 with permission from Hamilton Health Sciences, Hamilton ON Canada
What results can I expect after knee replacement?

After knee replacement, you can expect to be able to do your normal activities more easily and with less pain.

Some people still have some pain or discomfort even after a knee replacement. They usually have much less pain than before the surgery. Many people feel or hear clicking after knee replacement surgery. This is normal and does not mean there is a problem.

After knee replacement surgery, you should keep active. Being active is good for your overall health and helps keep your knee working well. The best activities are low impact sports and activities such as walking, swimming and cycling. Do not do high-impact exercises that involve running and jumping. These activities may cause your knee replacement to wear out early.
**What can I do to help make the surgery a success?**

What you do before surgery affects how well you recover from knee replacement surgery.

If you smoke, you are more likely to get an infection in your new knee joint. If you get an infection you could need more surgery. To prevent this, you should quit smoking before your surgery. Talk to your surgeon or your family doctor about how they can help you quit smoking.

Being very overweight (obese) also increases your risk of getting an infection or having other problems after surgery. If you are very overweight, the best thing you can do is work with your family doctor or a dietitian to reduce your weight to a safer level before surgery. This will make it less likely that you will have complications during and after surgery. It may also make your new knee last longer.

**How long will my recovery take?**

Knee replacement is major surgery and recovery takes at least 3 months. Most patients will continue to improve for up to 2 or 3 years after surgery. Their operated leg will keep getting stronger and they will be able to do more without getting tired.

Remember that everyone recovers at a different pace after knee surgery. If you have concerns at any point during your recovery, check with your surgeon.
How long will my new knee last?

It is common for knee replacements to last 20 years or longer. To make sure that your new joint lasts as long as possible, follow the instructions we give you. You can also take care of your new knee by staying active and healthy. Doing these things will help to make sure that you will not need to have it replaced again.

A small number of people can develop problems after surgery, including:

- Infections
- Stiffness in the joint
- A loose joint, if the joint wears out or gets damaged because of something like a bad accident

If you get an infection in your knee replacement, you will need antibiotics and more surgery. You may even need to have your entire knee replaced a second time. This is called a revision surgery. You could also need a revision surgery if your new knee wears out or becomes loose.

If a knee replacement starts to wear out, it is usually a very gradual process that takes many years after surgery. Your surgeon will check you regularly and will take x-rays every few years to look for early signs of wear in your joint. If you notice any new pain, swelling or difficulties with your artificial knee you should contact your surgeon to be checked.
What will my new knee be made of?

Your knee replacement has 3 or 4 parts called components.

1. The **femoral component** is metal, usually a cobalt-chromium alloy. It is fitted to the end of your femur (the long bone in your thigh).

2. The **tibial component** is also metal, usually a titanium alloy. It is attached to the top of your tibia (your shin bone).

3. A **plastic insert** (polyethylene) is put between the two metal components. This spacer acts like a shock absorber. It helps your knee move like it used to.

4. A plastic (polyethylene) patellar component may also be fitted to the back of your patella (knee cap). Your surgeon will decide whether or not to resurface your knee cap.
The metal components are usually attached to your bones using bone cement. The bond between the artificial knee and your bone is very strong. **You can stand on and move your new knee right away.** Standing right away will not cause any damage. The sooner you start moving and standing on your new knee, the better you will feel and the easier your recovery will be.
What happens next?

The following table shows what to expect now that you have decided to have knee replacement surgery.

Your full recovery can take 2 years or longer but you should be back to most of your usual activities within 3 months.

To learn more about how to prepare for surgery and make sure you have the best possible recovery, read the next sections carefully. Ask a member of your health-care team if you have any questions.

<table>
<thead>
<tr>
<th>When</th>
<th>Pre-admission appointment</th>
<th>Get moving</th>
<th>Start physiotherapy</th>
<th>Wound check</th>
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<tbody>
<tr>
<td><strong>When</strong></td>
<td>1 month before surgery</td>
<td>Day of surgery</td>
<td>1 week after surgery</td>
<td>2 weeks after surgery</td>
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<tr>
<td><strong>Details</strong></td>
<td>Attend clinic for medical check-up before surgery</td>
<td>You will be getting out of bed on the day of surgery</td>
<td>Start within 1 week of going home from hospital</td>
<td>Have family doctor check your surgical wound</td>
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<td>Attend a session to learn about the surgery</td>
<td>Start your post-op exercises</td>
<td>Do exercises at home every day</td>
<td>Have your staples or stitches taken out 10 to 14 days after surgery</td>
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<td></td>
<td>Get instructions for how to prepare for surgery</td>
<td>Most patients go home 1 or 2 days after surgery. Some patients may go home the same day</td>
<td>Keep moving and gradually increase your activity</td>
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<td>Make a plan for physiotherapy after surgery</td>
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<td>First follow-up</td>
<td>Return to work</td>
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<td><strong>When</strong></td>
<td>4 to 6 weeks after surgery</td>
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| **Details**       | Meet with surgical team. They will check your healing and how your knee is moving | You may be able to go back to work 6 to 8 weeks after surgery  
If you have a physical job, go back to work after 3 months  
Wait at least 6 weeks to travel or drive | Your knee will continue to improve for 2 to 3 years  
Your strength and endurance will improve slowly |
Getting ready for surgery
Checklist: What to bring to my pre-admission appointment

During your pre-admission appointment our team will make sure you are medically fit and prepared for your upcoming surgery. You will be assessed by a nurse and you will attend an education session about knee replacement surgery. You will learn about what to expect during your hospital stay and what you should do to prepare for a successful surgery. A member of the team will talk to you about arranging your post-op physiotherapy. You may also be assessed by an anesthesiologist or other medical doctors, depending on your general health.

Here is a checklist of what you should bring with you:

- Your health card
- Information about your private insurance, if you have insurance
- All of your medicines in their original containers. Bring all of your prescription and non-prescription medications, including any herbal products you are taking.
- Up-to-date letters and reports if you are seeing a specialist for any health problems. For example if you have a heart condition, bring a report from your cardiologist. If you have kidney disease bring a letter from your kidney specialist.
- A friend or family member. They can help you to remember important information.
- Any questions you have about your upcoming surgery. During your pre-admission visit, be sure to ask us these questions.
- This booklet.
Checklist: Before my surgery

Be as healthy as you can be before surgery. Make sure to drink lots of fluid, eat healthy foods and get plenty of rest and exercise. Stay active and try to do your regular activities.

Almost everyone who has knee replacement surgery can go home 1 or 2 days after the surgery. Before your surgery, make sure your home is ready for you. This will make it easier when you return home.

These checklists show what you need to do to be ready to return home. There is space for you to write the name of the person who will help with each task.

☐ The person who will drive me home from the hospital is:

_______________________________________________________________

☐ The person who will stay with me for a few days or check on me regularly once I go home is:

_______________________________________________________________

If you do not have transportation and need to use WheelTrans, make sure to arrange this a long time before the day of your surgery.

For more information about WheelTrans, ask a member of your health-care team.

Here is a link to the website where you can apply for Wheel-Trans: https://www.ttc.ca/WheelTrans/How_to_apply/index.jsp
I may need help with other tasks for a few weeks after surgery

☐ The person who will help me get to physiotherapy and other appointments is: ________________________________

☐ The person who will help me with heavy housework such as laundry, cleaning, cooking and shopping is: ______________

☐ The person who will look after my pets is: ______________

I have made changes at home

☐ I have arranged to rent, buy or borrow the equipment that I need

☐ Crutches or a walker

☐ A raised toilet seat with armrests

☐ A shower chair or bath transfer bench

☐ I have put away rugs and anything else I could trip over

☐ There are handrails where I need them

☐ I have a chair with a high, firm seat, a backrest and armrests

☐ I have rubber bathmats in the tub and on the floor outside the shower

☐ I have food to eat, including groceries and frozen prepared meals

I am ready for follow-up appointments

☐ I have found a physiotherapy clinic and booked an appointment for physiotherapy. The appointment is within 1 week after my surgery.

☐ I have an appointment with my family doctor 10 to 14 days after surgery to check my cut and take out my staples or stitches (if necessary).

Please check that you have done these things before your surgery.
Surgery and hospital stay
CHECKLIST: The day of my surgery

Remember to bring this booklet with you when you come to the hospital.

Here is a checklist of other things you will need:

☐ My health card
☐ The phone number and address of my pharmacy
☐ All of my medicines. This includes all of my prescription and non-prescription medications including any herbal products I am taking.

Make sure you have the clothes and personal care products you need. These include:

☐ Socks and supportive walking shoes (for example, running shoes)
☐ Loose clothes to wear in hospital and for the trip home
☐ Underwear for 2 or 3 days
☐ If I want, I can bring a robe or housecoat. I can also bring slippers, but only if they have a rubber sole and are closed behind the heel
☐ Toiletries such as a toothbrush and toothpaste
☐ My CPAP device (if I use one at home)
Do not eat solid foods after midnight the night before your surgery. You can have clear fluids up to 3 hours before your surgery. This includes water, apple juice, a sports drink and tea or coffee without milk or cream.

Leave your valuables at home!
Where do I go on the day of surgery?

Go to the Sullivan Lounge on the 5th floor of the hospital. To get there take the North elevators in the Cardinal Carter Wing and follow the signs.

- Register at the desk.
- Staff will take you to change your clothes. You can leave these clothes with your family.
- After you are wearing a hospital gown, a nurse will put in an IV line.
- Your family or friends can wait in the Sullivan Lounge.

What if I get sick a few days before my surgery?

Contact your surgeon’s office immediately if you get sick. We may need to re-schedule your surgery to another day.

Here are some health issues that could affect your surgery:

- Infections of any kind such as a cough, cold or flu, a bladder infection and any infections in your teeth or gums
- Open wounds or sores on your legs
- Any newly-diagnosed medical problems such as heart or lung problems
Will I feel pain during surgery?

Before your surgery you will meet with a doctor who will talk to you about the best ways to keep you comfortable and control your pain during surgery. If your health is good, you will meet them on the day of your surgery. If you have other health problems you will meet them at your pre-admission visit.

Here is how the doctor will control your pain during surgery.

**Regional Anesthetic:**

Most patients who have knee replacement surgery are **not** completely asleep for surgery. They have a regional anesthetic. This means that part of your body will feel ‘frozen.’ Here is how regional anesthetics work:

- You may get an injection in your back. This is called a **spinal** because it is put into your spine. Medicine in the spinal will make the lower part of your body feel ‘frozen’ for a few hours. With a spinal you will not feel any pain during the surgery.

- You may get an injection in your leg to block the nerves in your leg. With a **nerve block** your leg will feel ‘frozen’ longer than with a spinal. A nerve block helps take away a lot of the pain in your knee after surgery. This will make you more comfortable and make it possible to do your exercises with less pain.

- You may get medicine through your IV tube that will make you feel very sleepy and relaxed during your knee surgery.

Once you have the injections, you will wait in the Regional Room until you are ready for surgery. Then you will be taken to the operating room.
General Anesthetic:

A few patients will be completely asleep during their knee replacement surgery. These patients are given medicine called a general anesthetic. If you have general anesthetic you will get an injection or you will breathe in the medicine through a mask. Once you are asleep the doctor will put a tube in your throat, which is attached to a breathing machine to help you breathe during the surgery. Only about 1 out of 10 patients having knee replacement surgery are given a general anesthetic.

Do you want more information?

If you want more information, read the pamphlet called “Do you have questions about your anesthetic and pain control.” There are copies in the Preadmission Facility (PAF).
What happens during surgery?

In the operating room, a cut is made over the front of your knee. This cut is called an incision.

The surgeon will remove the damaged bone and cartilage in your knee and replace it with the artificial knee joint.

When the surgeon has fitted all of the components of your knee replacement they will close the cut with glue, stitches or staples.

Next they may cover the glue, stitches or staples with bandages. When the surgeon is finished, you will be moved to the Post-Anesthetic Care Unit (PACU).

What will happen when my surgery is over?

You will wake up from your surgery in the Post Anesthetic Care Unit (PACU). This is also called the recovery room. You will be wearing an oxygen mask. You will still have the IV.

You will stay in the recovery room for several hours. Nurses will check your vital signs. They will check your heart rate, blood pressure, breathing rate and temperature. The nurses will treat your pain until you are ready to be moved to your room.

Next you will be moved to your room on the orthopedic floor. When you are in your room a nurse will do a complete assessment of you. You may also meet a Clinical Assistant (CA) who can help with non-medical needs.
Will I have pain after surgery?

You should expect some pain, swelling and bruising after surgery. We will use several different medicines and strategies to manage your pain so that you can get up, move around and do your exercises.

Pain medicine is a part of your recovery and is safe and effective when used properly and as prescribed. Pain medicine cannot get rid of all your pain. Over time, a combination of pain medicine, time and returning to your normal activities will reduce pain.

To manage your pain while you are in hospital we use a combination of medicines (acetaminophen or Tylenol and NSAIDs like Advil as well as strong pain pills called opioids). We recommend that you continue taking acetaminophen regularly for 2 weeks after surgery. You should also take an NSAID medicine for 2 weeks after surgery, if it is recommended by your surgeon. Taking these medicines will help control pain. With these medicines you will need fewer opioids which can have side effects such as nausea and vomiting, dizziness, drowsiness and constipation.

It is normal to have some pain and swelling in your leg after surgery. Take pain medication when you need it and take rest breaks during the day.
Here are other things you can do so that you will not need as much of the strong opioid medicines:

- Get up and move soon after your surgery
- Apply ice packs to your knee
- Elevate your leg several times each day

Getting up and moving around regularly after surgery will reduce the chance of complications from the surgery and from the pain medication. You should gradually take less and less opioid pain medicine. Taking opioids for more than 2 weeks, or taking too many opioids, can lead to serious problems, including addiction.
What problems can happen after surgery?

Even though we do our best, problems sometimes happen. You may stay longer in hospital if you develop medical problems after your surgery. These problems may include:

- Infections
- Blood clots in the leg or lung
- Breathing problems
- Being unable to pass urine (pee)
- Dizziness
- Nausea and vomiting
- Confusion or delirium

You can help reduce the chance of some of these problems if you move and return to your normal activities as soon as possible after surgery. Moving will also help prevent your knee from getting stiff. It is very important to move your knee right after surgery.

To prevent problems, be as active as you can and participate in your own care and recovery.
Will I have swelling in my leg after surgery?

After surgery, your leg may be bruised and swollen. Swelling and bruising may get worse after you go home. It is usually worst in the first few weeks, but some swelling can last for several months.

To help your leg heal, you should be up and walking as much as you can after surgery. You should also increase the amount you do each day.

Make sure to rest often in the first few weeks after your surgery. A few times every day, lie down for 20 to 30 minutes with your leg raised above the level of your heart. This is especially important if you have a lot of swelling in your leg.

You can also apply ice to help with pain and swelling. Apply ice for 10 to 15 minutes at a time, then wait 1 or 2 hours before you ice your leg again. Never put ice onto your skin. Wrap the ice in a towel before you put it on your leg. If you wish, you may use an ice machine such as a cryocuff or a game ready device, but this is not necessary.

Some patients may find that wearing compression stockings after surgery helps to reduce swelling in their legs. If your leg is less swollen it will be less painful.
What will happen each day on the Orthopedic floor?

It is very important to get moving right away after your surgery. The staff on the floor will help you get up to walk around, get to the bathroom and sit in a chair. This is part of your therapy while you are in the hospital.

Try to take an active part in your own recovery. The more you can do, the more successful your knee replacement will be. There are no restrictions on how much you should walk or move your knee after surgery. Do as much as you can each day and try to bend your knee a little more each time you do your exercises.

The table on the next page shows you what to expect each day.
<table>
<thead>
<tr>
<th></th>
<th>Surgery day</th>
<th>1 or 2 days after surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Staying comfortable</strong></td>
<td>You will be given medicines by mouth or through an IV to reduce pain and control nausea. You can use ice and other techniques to help manage pain.</td>
<td>You will take medicines by mouth to stay comfortable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will start a medicine to prevent blood clots.</td>
</tr>
<tr>
<td><strong>Getting moving</strong></td>
<td>You will sit on the edge of the bed. You will get out of bed (with help) to use the bathroom.</td>
<td>You will get out of bed and walk on your own</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will do your exercises at least 3 times each day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will sit up in a chair for all of your meals</td>
</tr>
<tr>
<td><strong>Eating and drinking</strong></td>
<td>You will start drinking clear fluids and eating foods such as jello or broth. You may also start eating solid foods when you feel ready.</td>
<td>You will eat regular food and drink plenty of water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will take a medicine to prevent constipation</td>
</tr>
<tr>
<td><strong>Physiotherapy and exercises</strong></td>
<td>You can put your full weight on your operated leg. You will start moving (bending and straightening your leg) as soon as the freezing wears off.</td>
<td>The team will teach you how to move around safely (using a walker or crutches) and how to do your exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will learn how to climb stairs (if you have them at home)</td>
</tr>
<tr>
<td><strong>Looking after your new knee</strong></td>
<td>You will start to learn how to look after your cut and how to move around safely.</td>
<td>Your nurse will teach you how to look after your cut</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You will learn what to watch for when you go home</td>
</tr>
</tbody>
</table>
Going home
**When will I be ready to go home?**

Going home from hospital is called being discharged. If you are moving well and not having any problems, you will be discharged on the first or second day after your surgery.

Before you are discharged we will check that you can walk safely and look after yourself.

Here are the things you **must** be able to do:

- Walk with your crutches or walker
- Move into and out of bed
- Move into and out of a chair
- Move into and out of a car
- Climb stairs, if you have them at home
- Know what you can and cannot do
- Change your bandages, if necessary
- Manage your pain
How to climb stairs

If there is a railing, use it. Hold onto the railing with one hand. Hold your crutch or cane in the other hand. If there is no railing, use 2 crutches.

To go up stairs

1. Step up onto the first step with your non-operated leg.
2. Step onto the step with the operated leg.
3. Follow with your cane or crutch(es).
4. Repeat steps 1 to 3.

To go down stairs

1. Lower your cane or crutch(es) to the step below.
2. Step down with your operated leg.
3. Step down with the non-operated leg.
4. Repeat steps 1 to 3.
Checklist: Going home

You will be discharged before 11 a.m.
Please make sure you have a ride home.

Your physiotherapist and nurse will meet with you between 9 and 11 a.m. They will make sure you have everything you need to go home. If someone will be helping you at home, they should come to your room between 9 and 9:30 a.m.

Before you leave the hospital, make sure you have:

☐ The equipment you need at home, such as a walker with two wheels, crutches, raised toilet seat and bath chair. If you do not have the equipment, make sure you have a list of equipment you need and a list of places where you can buy or rent the equipment.

☐ Prescriptions for your medicines

☐ Dates for your follow-up appointments. You will also get papers that explain your stay in hospital and list what you need to do next

☐ Bandages for your knee, if necessary

☐ A staple remover if you have staples in your cut

☐ Exercise instructions and a blue physiotherapy referral form (blue sheet). You will need to take the referral form to your physiotherapy clinic when you go for your first appointment.

☐ All of your belongings
What medicines will I need to take at home?

On the day you are discharged, you will receive prescriptions for:

- Medicine to help you manage your pain
- Medicine to prevent blood clots in your leg or lung
- Laxatives to prevent constipation

Take the laxatives as long as you are on pain medicines.

Before you go home, ask the pharmacist or your doctor if you have any questions about your medicines. Once you go home, if you have any questions about your medicines, please call your surgeon’s office or your family doctor.

You will be discharged **before 11 a.m.**

**Make sure you have a ride home.**

If someone will be helping you at home, please ask them to be at your room between 9 and 9:30 a.m. They can help you remember what the nurse tells you.
How can I stay comfortable on the ride home?

In the car, move your feet up and down. This will keep your blood flowing.

For long car trips, stop every 2 hours. Stop sooner if you need to. Get out and walk around. This will help prevent discomfort, stiffness and potential blood clots.

How to get in and out of a car

To get into the passenger seat of a car

1. Ask the driver to recline the seat back.
2. Make sure the seat is pushed back as far as it will go. This will give you more leg room.
3. Put 1 or 2 pillows on the seat. This will raise the seat up.
4. Using your crutches or walker, back up to the car. Stop when you feel the car touch the back of your legs. Slide your operated leg forward.
5. Grab onto the back of the car seat while you lower yourself to the seat.
6. Use your arms on the seat and your stronger leg to push yourself backward across the seat.
7. Then bring your legs into the car one at a time. You may need help to swing your legs into the car. Turn to face the front window.
To get out of your car

1. Slide your legs out one at a time. You may need help with the leg that is healing. Your family member or friend could help by supporting your knee and ankle. Slowly move until both legs are out of the car and touching the ground.

2. Slide yourself to the edge of the seat.

3. Grab onto the side of the car and your crutches or walker. To stand up, push with your arms and your stronger leg.
After I get home
What happens after I leave the hospital?

When you are home, your knee will continue to heal. There are four things you must do to take care of your knee:

1. Keep your cut clean and dry. Change your bandages as often as necessary (if they get wet or soiled).
2. Walk and do your exercises 3 to 5 times a day
3. Go to physiotherapy. Your first appointment should be within 1 week of leaving hospital
4. Come to your follow-up appointments
How do I look after my cut?

It is important to take care of your knee until it is completely healed.

Here is how to take care of your knee:

- Look at the cut in your knee every day. Check to make sure it is not infected. If it is infected it will be very red or there will be pus around the cut or a lot of liquid leaking from the cut.
- Keep the cut clean and dry. Do not rub or scratch your staples or stitches.
- You can take a shower or sponge bath. Take off the bandage before you bathe. Wash yourself with soap and water. Let water run over the cut. Do not rub or scrub your staples or stitches.
- When you are clean, pat the cut dry with a clean towel. Do not put any cream, lotion or oil on your cut. Do not put a new bandage on until your knee is totally dry.
- Do not soak in a bath, pool or hot tub until your staples or stitches have been removed, your cut is completely healed and there is no scab.

How will my staples or stitches be taken out?

If you have staples or stitches, they should be removed 10 to 14 days after your surgery.

Make an appointment with your family doctor. If you do not have a family doctor, make an appointment at a walk-in clinic. The doctor may not have a staple remover. We will give you one before you are discharged from hospital.
When should I call my doctor?

Call your surgeon right away if you:

- See a lot of redness or fluid draining from your cut
- Smell a bad smell or see green pus draining from the cut
- Have a fever or chills that last more than 1 day (a fever is a temperature over 38 degrees Celsius or 100 degrees Fahrenheit)
- Feel a lot of pain in your knee which does not get better when you take your pain medicine
- Have any other problems that you are not sure about

When should I go to the emergency department?

Go to the emergency department if you feel:

- Short of breath or you have difficulty breathing
- Pain, tightness or pressure in your chest
- A sudden swelling, pain or redness in your thigh or calf
- A sudden and severe increase in pain in your new knee that does not improve when you rest and put your leg up or take your pain medicine
What should I do if I have concerns after I get home?

Contact your surgeon if you have any concerns about your surgery, recovery, or the medicines that were prescribed when you left hospital.

You must let your surgeon know if:

- You think you might have an infection
- You have gone to the emergency department for a problem related to your surgery
- You have visited a walk-in clinic or your family doctor for a problem related to your surgery

Contact your family doctor if you have concerns but can’t reach your surgeon.

Go to the emergency department if you have concerns but can’t reach your surgeon or your family doctor or if you think the situation is urgent.
How often should I walk and exercise after I go home?

At home, continue to do the exercises you learned in the hospital.

Remember to:

- Do your exercises 3 to 5 times every day.

- Walk every day. Use your walker or crutches. Start with short walks a few times each day. Walk a little farther each day, a little at a time.

- Take lots of breaks during the day.

Both rest and exercise are very important for your recovery. In the first few weeks after surgery you will probably get tired quickly. Rest when you feel tired and try and do shorter activities during the day.

When do I go to physiotherapy?

You will need physiotherapy after you leave the hospital. You should start physiotherapy within 1 week after you go home.

You can go to an outpatient physiotherapy clinic at a rehabilitation centre, to a private physiotherapy clinic or to an OHIP-funded clinic.

Do not drive yourself to physiotherapy. Take public transportation or ask a friend or family member to drive you. You should not drive for 6 weeks after surgery.
**How can I find a physiotherapy clinic or physiotherapist?**

The person leading your pre-admission visit will discuss where you can go for physiotherapy in the community.

The Ontario Physiotherapy Association has information to help you find a physiotherapist in your community as well. Visit their website at:

https://opa.on.ca/about-physiotherapy/find-a-physiotherapist/

To help you find a clinic you could call the Physiotherapy Association at (416) 322-6866

**When will I have my follow-up appointment?**

You will have a follow-up appointment **4 to 6 weeks after your surgery.** The appointment will be with your surgeon or an advanced practice physiotherapist.

At this appointment, we will check how your knee is moving and make sure you are recovering well.
Frequently Asked Questions
Frequently Asked Questions

When can I stop using my walker or crutches?

Keep using your walker or crutches until your physiotherapist says that you no longer need them. This may take 2 to 4 weeks but it could take longer. Each person’s recovery is different.

When can I begin having sex again?

Most people who have knee replacement surgery can have sex when it does not cause pain or discomfort. Sexual activity is safe for your new knee as long as you are comfortable.

When can I start to drive again?

Do not drive anything for at least 6 weeks after surgery. Also, strong pain medicines might affect your driving. Do not drive while you are taking these medicines.

Ask your health-care team when you can start driving.

When can I start to do sports again?

Most people can return to their usual activities by 3 months after surgery.

After you’ve recovered from your surgery, you can enjoy a variety of activities including walking, swimming, golfing and biking. Do not swim until your incision has healed completely.

Some activities are harder on the knees than others. You should avoid activities that involve running or jumping such as squash, moguls skiing, soccer and basketball. It is safe to kneel down if it is comfortable.

Ask your surgeon if you have any questions about specific activities.
**When can I return to work?**

When you return to work depends on the kind of work you do and how quickly you heal after surgery. Most people can return to work by 3 months after surgery. Talk to your surgeon about when it is safe for you to go back to work.

**Is it normal to feel a clicking in my new knee?**

Your new knee is made of metal and plastic and it is normal to sometimes hear or feel a clicking or feel clunking. This is because the artificial knee is a mechanical device. Clicking and clunking is not dangerous and does not mean that anything is wrong with your new knee.

**Is it normal to feel numb around my knee?**

After surgery, most people have some numbness on the front of their knee. The numbness usually goes away but this can take several months. It is not dangerous and does not mean that anything is wrong.

**Will my new knee set off metal detectors in the airport when I travel?**

It is very likely that your knee replacement will set off the metal detectors at the airport. Just let the security staff know you have a knee replacement before you walk through the detector. You do not need any special paperwork to travel.

**How soon can I fly after surgery?**

Most surgeons recommend that you don’t fly for at least 6 weeks after surgery. If possible, you should put off travelling for 3 months to make sure you are fully recovered from surgery and can enjoy your trip.
How do I make sure infections do not spread to my new joint?

With your new knee, you may need antibiotics when you get infections in other parts of your body. This will keep the infection from spreading to your joint. Make sure that your doctors and dentist know you have had a knee replacement.
Where can I get more information?

Use the information in this booklet as your guide. This booklet was developed for people having knee replacement surgery at St. Michael’s Hospital.

More information about orthopedic surgery at St. Michael’s Hospital is available on the following website:

[www.orthosurgery.ca](http://www.orthosurgery.ca)

The following websites are extra sources of information. They have nothing to do with St. Michael’s Hospital.

- The Arthritis Society has a lot of easy to understand information about knee replacement surgery. They offer information about what to expect and about recovering from surgery and getting back to normal. They also have information for your family and friends
  

- The Canadian Orthopaedic Foundation has three videos about knee and hip replacement surgery.
  
  [https://whenithurtstomove.org/about-orthopaedics/watch-video](https://whenithurtstomove.org/about-orthopaedics/watch-video)

  They also offer information about how to prepare for your surgery, and how to get moving again after surgery.

  [https://whenithurtstomove.org/ways-to-give-get-involved/patient-information-resources/](https://whenithurtstomove.org/ways-to-give-get-involved/patient-information-resources/)