Wait time management strategies at centralized intake system for hip and knee replacement surgery: A need for a blended evidence-based and patient-centered approach

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ABSTRACT
Objectives: Delays in access to specialty care and elective hip and knee total joint replacement (TJR) surgery remain a major concern among patients with osteoarthritis (OA) in Canada. Centralized intake systems as a wait time management strategy in the face of resource constraints can increase access and patient flow through the system but are not standard practice. We examine how wait time management strategies for the assessment and triaging referrals in a centralized intake system can inform quality improvement initiatives.

Design: We developed a discrete-event simulation model using all referrals to the Edmonton Bone and Joint Centre centralized intake system from 2012 to 2016 for the base case model. We assessed the combined effect of three wait time management strategies: improved prioritization, improved sorting through screening, and increased conservative management. Outcomes were measured in terms of patient flow and wait times.

Results: The screener sees more patient referrals (7094 compared to 6922), and the number of patients who proceed to surgery is reduced by 282 patients (4%) in the wait time management scenario compared to the base case model. Wait times from referral to surgery are reduced by 54 days for surgical patients. Furthermore, urgent surgical patients experienced lower wait times in all stages of care than non-urgent patients, with wait times from referral to surgery reduced by 86 days.

Conclusions: Triaging processes addressing prioritization, screening and conservative management of non-surgical patients can improve patient flow and significantly reduce patient wait times in a centralized intake process for TJR.

1. Introduction
Osteoarthritis affects more than 10% of Canadians aged 15 or older and is the main reason for joint replacement surgery [1,2]. Delays in access to specialty care and elective total joint replacement (TJR) surgery are major concerns for patients with advanced hip and knee osteoarthritis (OA) because of significant decreases in quality of life [3–5] and for the health care system because of increased healthcare costs [6–9]. With the ageing population and increasing rates of obesity, wait times will continue to rise without appropriate strategies to manage the waitlist.

To further motivate this study, we call attention to a 2019 report by
the Canadian Institute for Health Information [10] – approximately 30% of patients who needed a hip or knee replacement did not meet the recommended wait time benchmark of 182 days. The percentage of people receiving knee replacement surgery within the recommended wait time improved by only 5% since 2016 in only three provinces (Newfoundland and Labrador, Nova Scotia and British Columbia), while the percentage in Canada’s remaining provinces either decreased or remained stable. This poor performance is despite the investment of more than $41 billion by Canadian First Ministers through the 2004 Health Accord to provide benchmarks and measurable wait time reductions for priority procedures, including hip and knee replacements [11]. It is noteworthy that these national metrics only reflect the wait time between the date of surgeon consult and the date of surgery [12]. If the time from a referral is considered, the total wait time for patients is longer. In Alberta, for example, the wait time from referral to a surgeon to the date of surgery has also increased since 2012 - by about 14 weeks (from 13 weeks to 27 weeks).

Wait times worsened due to the COVID-19 crisis, with thousands of elective surgeries rescheduled or cancelled to make more capacity for the infected. Nearly 50,000 procedures have been delayed in Alberta, including 15,000 surgeries [13] during the first three waves. In a report published by the Canadian Medical Association (CMA) [14], approximately CAD 140 M is required by Alberta to return the wait times for hip and knee replacement surgery to pre-pandemic levels within one year, assuming that these procedures are performed at 90% of their historical capacity. All provinces across Canada face similar challenges to manage these growing wait times.

One way to improve patient flows is to increase the availability of resources, but this is not always feasible when resources are constrained. A single-entry model (SEM) or central intake system is a commonly-used wait time management strategy to increase access and flow through the system of care [15–19]. Nonetheless, SEMs are not currently commonplace in Canada, nor are they standard policy or practice [16]. Other process-focused strategies, when demand and supply strategies are not always feasible, have the potential to positively impact patient wait times [20]. Patient-level simulation models are powerful tools to evaluate the effect of changes to a system before implementation and to inform decisions [21–23]. In this paper, we develop a discrete-event simulation model to demonstrate how wait time management strategies for the assessment and triaging referrals in a centralized intake system can guide quality improvement initiatives to reduce wait times and can also improve access for patients referred for hip and knee joint replacement surgery.

2. Methods

2.1. Data sources and modeling assumptions

A centralized intake system for hip and knee joint replacement surgery was implemented in 2006 at the Edmonton Bone and Joint Centre in Alberta, Canada. This high-volume centre is the clinic base for 25 surgeons and receives approximately 11,000 patient referrals annually. We used administrative and clinical data for all patients referred to the Edmonton centralized intake system from fiscal year-end (FYE) 2012 to 2016, including the following information for each patient: referral date to the centralized intake system, priority (urgent/non-urgent) assigned by a triage team at the centralized intake system, subsequent routing, and elapsed times between appointments. The data also include the priority level of the referral based on information provided on the referral form and the accompanying radiograph. The referral is classified as normal or urgent.

2.2. Description of patient flow through the central intake system

Fig. 1 depicts the patient flow through the centralized intake system described elsewhere [24]. Patients are initially scheduled by intake staff

![Fig. 1. Patient flow and wait times in the centralized intake system T represents the average wait time; T_{IM} = time (in days) from receipt of complete referral (I) to initial appointment with MSK screener (M); T_{IC} = time (in days) from receipt of complete referral (I) to initial consult with surgeon (C); T_{MC} = time (in days) from final appointment with MSK screener (M) to initial consult with surgeon (C); T_{CS} = time (in days) from final appointment with surgeon (C) to scheduled date of surgery (S); T_{TS} = the time from receipt of complete referral (I) to scheduled date of surgery (S).](image-url)
In the initial simulation model (base case model), patients are scheduled for appointments and moved through the system on a first-come, first-served basis. For referrals that are scheduled with the MSK screener, a new consult with a surgeon, or surgery, the model finds an appointment date on or after the simulated day that the referral is scheduled, plus a reasonable processing lag of two days [27]. The available appointments on that day are then reduced accordingly. The pattern of appointments for 2016 was repeated to project into the future for 2017 through 2023. This was done to extend the availability of appointments (system capacity) so that the entire cohort of OA patients could proceed through the simulation. Wait time statistics were collected and reported from the simulation model stratified by priority (urgent/non-urgent) and by whether the patient received surgery or not. It was assumed that the number of available surgeries remained fixed – no additional operating room capacity was added to the system.

2.4. Scenario assessing the effect of wait time management strategies

The base case model was then used to test a scenario to determine the effect of implementing a combination of three wait time management strategies. The combined strategies improve the triaging and assessment processes for referrals at intake.

**Strategy 1. Prioritization based on urgency:** This strategy aims to improve the scheduling of patients for assessment through changes in triaging policies for prioritizing referrals based on urgency. We simulated the effect of a scenario in which urgent patients referred to the centralized intake system receive the next available appointment with a screener or a surgeon according to the observed data for each patient. For non-urgent patients, we allowed 30 days to elapse before scheduling an appointment to maintain sufficient slack for appointments needed for urgent referrals [27]. There are no data on the accuracy of prioritization at triage. We assume that the prioritization is accurate and valid, demonstrating the impact of reliable adherence to prioritization guidelines.

**Strategy 2. Sorting patients based on assessment for surgery:** This strategy aims to improve the determination of patients as surgical or non-surgical through increased use of the MSK screener. We simulated an increase in the proportion of patients sent to the MSK screener (by 10%) and correspondingly decreased the proportion of patients sent directly to the surgeon (by 10%). The change in the referral pathway for 10% of the patients may result from changes in guidelines for referral criteria or changes in the details or completion of the referral forms that assist the central intake staff in deciding which referrals to send to an MSK and increase the proportion of appropriate referrals [28].

The choice of strategies 1 and 2 was motivated by current operational practices at the Edmonton Bone and Joint Centre in Alberta, Canada and the effects of changes in guidelines.

**Strategy 3. Management of patients based on the assessed need for surgery:** This strategy aims to increase the proportion of patients who complete a trial of non-surgical management as per international guidelines [25,29–32] instead of proceeding to surgery. In this strategy, we diverted 10% of surgical patients to a non-surgical management program instead of scheduling surgery.

The choice of strategy three was motivated by clinical guidelines for non-surgical management [25].

2.5. Statistical analysis

The output from the base case and the alternative scenario consisted of the simulated patient wait times (see Fig. 1) of each patient referred to the Edmonton centralized intake system based on the observed arrivals of referrals and wait times from 2012 to 2016 FYE. Wait time statistics were collected and reported from the simulation model stratified by priority (urgent/non-urgent) and by whether the patient received surgery or not. The report includes the count of patients and the average, median and 90th percentile across all the patients for each of the wait times defined by the Alberta wait times rules for hip and knee replacements [12], as shown in Fig. 1.

3. Results

3.1. Base case model

A total of 11,090 referrals were received in 2014/15, out of which 62% of patients were directed to visit the MSK screener (n = 6,922, mean wait time = 43 days), and 38% directly went to see the orthopedic surgeon for their new consult (n = 4,168, mean wait time = 96 days). After the initial screener visit, 39% (n = 2687) were deemed non-surgical and 61% were directed to see the surgeon for a surgical consult (n = 4,235, mean wait time = 100 days). Of all patients referred to orthopedic surgeons, 82% were deemed surgical (n = 6,887, mean wait time = 100 days until surgery) and 18% were deemed non-surgical (n = 1516). The overall patient journey from referral to surgery (TIS) was 205 days on average.

3.2. Scenarios assessing wait time management strategies

The scenario assessing the combined wait time management strategies (prioritization based on urgency, improved sorting and increased non-surgical management) resulted in the referral of 64% of patients to the MSK screener (n = 7,094, mean wait time = 78 days), and 36% going to the orthopedic surgeon directly for a new consult (n = 3,996, mean wait time = 29 days). After the initial MSK screener visit, 46% (n = 3252) were deemed non-surgical, and 54% were directed to see the surgeon for a surgical consult (n = 3,842, mean wait time = 109 days). Out of the total number of patients referred to orthopedic surgeons, 84% were deemed surgical (n = 6,605, mean wait time = 50 days), and 16% were deemed non-surgical (n = 1233). The overall patient journey from referral to surgery (TIS) was 151 days on average.

3.3. Comparison between the base case and wait time management scenario

Overall, in the wait time management scenario, more patient referrals are seen by the MSK screener (7094 compared to 6922) and the number of patients who proceed to surgery is reduced by 282 patients (from 6887 to 6605, a 4% reduction). In terms of the overall patient journey, wait times from referral to surgery are reduced in the model scenario with wait time management strategies compared to the base case.

The wait time for surgery after the first visit with a specialist (TCS) decreased by 50 days (from 100 to 50 days). The wait time management scenario reduced overall wait times for surgery from the receipt of referrals (TIS) by 54 days for surgical patients (from 205 to 151 days). We also observe a reduction of 67 days (from 96 to 29 days) in the time from receipt of complete referral to initial consult with the surgeon (TIC). The wait time management scenario increased time from receipt of complete referral to initial appointment with the screener (TIS) by 35 days (from 43 to 78 days). This wait time could potentially be improved by increasing the capacity of MSK screeners. Fig. 2 summarizes and illustrates these results.

Finally, we compared the wait times in the base case with the wait time management scenario based on urgency levels (Fig. 3a and b). The simulation results suggest that the wait time for surgery after the first visit with a specialist (TCS) decreased by 49 days for urgent patients (from 96 to 47 days), and the wait times for surgery from the receipt of referrals (TIS) decreased by 86 days for urgent surgical patients (from 221 to 135 days). Furthermore, urgent patients experienced lower wait times in all stages of care compared to non-urgent patients.
A detailed comparison and wait time statistics are included in Tables 1 and 2.

4. Discussion

We developed a simulation model to examine the intended and unintended consequences of implementing wait time management strategies to improve the triaging and assessment processes for hip and knee referrals on wait times in a centralized intake system at a high-volume centre with a large number of orthopedic surgeons.

We evaluated changes in triaging processes related to three evidence-based strategies: 1) improved prioritization based on urgency, 2) sorting patients through MSK screening, and 3) management of patients according to guidelines for non-surgical management of OA. We found that wait times on average for the overall patient journey from referral to surgery (TIS) are reduced by 55 days (from 205 to 151 days) in the alternative model scenario (combined effect of the three strategies) compared to the base case. However, the change in wait times differed for each step in the process, from a referral at central intake to surgery, by type of patient (surgical or non-surgical) and level of urgency. For the cohort overall, the time from receipt of complete referral to initial appointment with the screener (TM) and the time from the final appointment with a screener to initial consult with a surgeon (TMC) both increased (by 34 days and 9 days, respectively) while the time from receipt of complete referral to initial consult with a surgeon (TIC), and the time from the final appointment with a surgeon to the scheduled surgery date (TCS) both decreased (by 67 days and 50 days, respectively).

Of note, when evaluating process and system-level changes such as the ones proposed here in the alternative scenario, it is important to examine all stages in the process (wait times) to make sure that changes in one aspect of care delivery do not impact other aspects negatively (intended vs unintended consequences). The need to measure the undesired consequences of interventions was highlighted in the Cochrane systematic review of interventions to reduce wait times for elective procedures [18]. This is particularly relevant in a healthcare system where there are system capacity constraints with regard to surgeons and operating rooms. We have provided only an example of possible scenarios, but one can envision the benefits of using a simulation model such as this one to examine alternative scenarios. The scenario specifications can be adjusted depending on the desired performance goals of the decision-makers to balance, for example, wait time reductions to surgery overall and benchmark targets for urgent patient referrals.

Our results suggest that even small changes in patient flow through this system can substantially reduce wait times. The expected reduction in surgery-related wait times associated with the alternative scenario is substantial (27%), although the number of patients who proceed to surgery is reduced only by 282 patients (4% reduction). This reflects that improving triage for urgent patients and enhancing the precision of screening by deferring more patients to medical management programs can reduce the demand on the surgical queue and consequently reduce wait time for these patients. Furthermore, urgent patients were expected to have lower wait times in all stages of care in the alternative scenario than non-urgent patients. Improved sorting of patients according to their assessed needs into different streams further improves the patient flow [33] by reducing the wait time for surgical patients while providing beneficial non-surgical care for the rest. Given that some patients
are already referred to a specific surgeon in the central intake process, there is also an opportunity to achieve further reductions in wait times if more patients were assigned to the next available surgeon in the centralized intake system.

Nonetheless, from the perspective of the patient, surgical management in advanced stage OA is only a small part of the journey from the first experience of pain and reduced function related to OA [34,35]. Improving the uptake of evidence-based guidelines for the non-surgical management of OA and improving the selection of patients as appropriate candidates for surgery could substantially reduce the number of patients flowing through the referral system. Current evidence-based guidelines recommend weight management, exercise and education as the primary intervention for all OA patients, including those waiting for surgery [29,31,36–38]. Exercise therapy interventions have been reported in a randomized control trial to reduce the risk of hip replacement by 20%, delaying, if not eliminating, the need for surgery [39,40]. Cronstrom et al. reported that patients had less pain and had higher health-related quality of life (EuroQol 5-domain) scores after six weeks of evidence-based OA treatment delivered in digital format, and about 30% of patients with hip and knee OA were no longer considering surgery after evidence-based non-surgical OA treatment. They suggest that non-surgical OA treatment should be offered as the first-line treatment for patients with hip and knee OA as a potential approach to help improve the selection of patients for joint replacement [30]. Exercise and education interventions have even been shown to be cost-effective [41,42] or cost-saving (more effective and less costly) [43]. However, there is low uptake in these clinical recommendations, and some patients may face barriers to access this care [24]. Recent findings in clinical practice in Alberta suggest that only 61% of patients with knee OA had tried any non-surgical management strategy before being referred for TJR surgery [29]. Increasing uptake of managed care by patients with OA is potentially beneficial at the individual patient level to reduce pain and improve function, the health care system level to potentially delay or avoid surgery, and societal levels to increase the overall quality of life for people with OA and their families.

Limitations of the model include the use of data from one central intake system in Alberta. However, this is a high-volume centre with a large number of orthopedic surgeons and a range of patients. The clinical records did not reflect whether the appointment bookings were delayed

| Measure                      | Referral receipt to screener appointment (T_{Ma}) | Referral receipt to consult with surgeon (T_{Mc}) | Screener appointment to consult with surgeon (T_{Msc}) | Referral receipt to surgery date (T_{Is}) | Consult with surgeon to surgery date (T_{Cs}) |
|------------------------------|--------------------------------------------------|--------------------------------------------------|-------------------------------------------------------|------------------------------------------|--------------------------------------------|
| **# of patients**            | 6922                                             | 4168                                             | 4235                                                  | 6887                                     | 6887                                       |
| **Average wait (days)**      | 43                                               | 96                                               | 100                                                   | 205                                      | 100                                        |
| **Median wait (days)**       | 42                                               | 86                                               | 92                                                    | 212                                      | 100                                        |
| **90th percentile**          | 71                                               | 126                                              | 128                                                   | 253                                      | 115                                        |
| **Urgent patients**          |                                                  |                                                  |                                                       |                                           |                                            |
| **# of patients**            | 1468                                             | 774                                              | 919                                                   | 924                                      | 924                                        |
| **Average wait (days)**      | 38                                               | 104                                              | 109                                                   | 221                                      | 96                                         |
| **Median wait (days)**       | 37                                               | 95                                               | 95                                                    | 227                                      | 96                                         |
| **90th percentile**          | 67                                               | 132                                              | 135                                                   | 268                                      | 111                                        |
| **Non-urgent patients**      |                                                  |                                                  |                                                       |                                           |                                            |
| **# of patients**            | 5454                                             | 3394                                             | 3316                                                  | 5963                                     | 5963                                       |
| **Average wait (days)**      | 45                                               | 94                                               | 98                                                    | 203                                      | 101                                        |
| **Median wait (days)**       | 43                                               | 85                                               | 90                                                    | 209                                      | 99                                         |
| **90th percentile**          | 72                                               | 122                                              | 125                                                   | 257                                      | 118                                        |
| **Surgical patients**        |                                                  |                                                  |                                                       |                                           |                                            |
| **# of patients**            | 2919                                             | 2509                                             | 2861                                                  | 6887                                     | 6887                                       |
| **Average wait (days)**      | 44                                               | 94                                               | 99                                                    | 205                                      | 100                                        |
| **Median wait (days)**       | 43                                               | 87                                               | 92                                                    | 212                                      | 100                                        |
| **90th percentile**          | 79                                               | 129                                              | 139                                                   | 253                                      | 115                                        |
| **Non-Surgical patients**    |                                                  |                                                  |                                                       |                                           |                                            |
| **# of patients**            | 4003                                             | 1659                                             | 1374                                                  | N/A                                      | N/A                                        |
| **Average wait (days)**      | 42                                               | 97                                               | 102                                                   | N/A                                      | N/A                                        |
| **Median wait (days)**       | 41                                               | 89                                               | 95                                                    | N/A                                      | N/A                                        |
| **90th percentile**          | 78                                               | 132                                              | 132                                                   | N/A                                      | N/A                                        |

N/A = not applicable.
in response to a patient request. It should also be noted that this is a combined strategy, and the result of the application of each of the three strategies in isolation is not considered in this study. Furthermore, we were not able to constrain the model system to assign the same orthopedic surgeon for the surgery as the orthopedic consult. We also had to make some assumptions around the decision rules for assigning urgency since these rules are not consistently and explicitly implemented in practice.

The long term solution to reduce wait times needs to consider a blend of solutions addressing the patient journey across all stages of the disease and the care continuum, including appropriate non-surgical management of OA, better assessment of patients who need to be seen by a surgeon, and better triaging of patients who do require surgery. On its own, prioritization strategies improve the wait times of urgent patients but increase that of less urgent patients [44]. Combining a prioritization strategy with a sorting policy allows the provision of benefit for less urgent patients while ensuring the urgent patients do not unnecessarily wait longer to receive theirs. This study highlights how implementing a combination of strategies could potentially contribute to reducing wait times for surgery within a constrained system. Future studies should consider other measures such as quality of life and costs.

### Table 2

Numbers of patients and wait time statistics for the alternative model scenario.

| Measure                        | Referral receipt to screener appointment (TAd) | Referral receipt to consult with surgeon (TIC) | Screener appointment to consult with surgeon (TSc) | Referral receipt to surgery date (TS) | Consult with surgeon to surgery date (TCS) |
|--------------------------------|-----------------------------------------------|-----------------------------------------------|----------------------------------------------------|--------------------------------------|------------------------------------------|
| # of patients                  | 7094                                          | 3996                                          | 3842                                               | 6605                                 | 6605                                     |
| Average wait (days)            | 78                                            | 29                                            | 109                                                | 151                                  | 50                                       |
| Median wait (days)             | 75                                            | 18                                            | 99                                                 | 164                                  | 47                                       |
| 90th percentile (days)         | 109                                           | 61                                            | 140                                                | 212                                  | 69                                       |
| Absolute mean difference from baseline | 34                                           | 67                                            | 9                                                  | 55                                   | 50                                       |
| % average time change from baseline | 79%                                         | –70%                                         | 9%                                                 | –27%                                 | –50%                                     |
| Urgent                         |                                               |                                               |                                                    |                                      |                                          |
| # of patients                  | 1511                                          | 731                                           | 832                                                | 864                                  | 864                                      |
| Average wait (days)            | 62                                            | 20                                            | 82                                                 | 135                                  | 47                                       |
| Median wait (days)             | 66                                            | 19                                            | 79                                                 | 142                                  | 49                                       |
| 90th percentile (days)         | 109                                           | 41                                            | 124                                                | 211                                  | 59                                       |
| Absolute mean difference from baseline | 24                                           | 84                                            | 26                                                 | 67                                   | 50                                       |
| % average time change from baseline | 62%                                         | –81%                                         | –24%                                                | –39%                                 | –52%                                     |
| Non-urgent                     |                                               |                                               |                                                    |                                      |                                          |
| # of patients                  | 5583                                          | 3265                                          | 3010                                               | 5741                                 | 5741                                     |
| Average wait (days)            | 82                                            | 31                                            | 116                                                | 153                                  | 50                                       |
| Median wait (days)             | 78                                            | 28                                            | 101                                                | 162                                  | 47                                       |
| 90th percentile (days)         | 112                                           | 70                                            | 122                                                | 213                                  | 68                                       |
| Absolute mean difference from baseline | 37                                           | 63                                            | 18                                                 | 50                                   | 51                                       |
| % average time change from baseline | 83%                                         | –67%                                         | 19%                                                 | –25%                                 | –50%                                     |
| Surgical                       |                                               |                                               |                                                    |                                      |                                          |
| # of patients                  | 2919                                          | 2509                                          | 2584                                               | 6605                                 | 6605                                     |
| Average wait (days)            | 79                                            | 29                                            | 109                                                | 151                                  | 50                                       |
| Median wait (days)             | 75                                            | 24                                            | 101                                                | 164                                  | 47                                       |
| 90th percentile (days)         | 113                                           | 78                                            | 146                                                | 212                                  | 69                                       |
| Absolute mean difference from baseline | 35                                           | 65                                            | 11                                                 | 55                                   | 50                                       |
| % average time change from baseline | 77%                                         | –69%                                         | 11%                                                 | –27%                                 | –50%                                     |
| Non-Surgical                   |                                               |                                               |                                                    |                                      |                                          |
| # of patients                  | 4157                                          | 1487                                          | 1258                                               | N/A                                  | N/A                                      |
| Average wait (days)            | 76                                            | 28                                            | 106                                                | N/A                                  | N/A                                      |
| Median wait (days)             | 73                                            | 25                                            | 97                                                 | N/A                                  | N/A                                      |
| 90th percentile (days)         | 116                                           | 67                                            | 137                                                | N/A                                  | N/A                                      |
| Absolute mean difference from baseline | 34                                           | 69                                            | 5                                                  | N/A                                  | N/A                                      |
| % average time change from baseline | 80%                                         | –71%                                         | 4%                                                  | N/A                                  | N/A                                      |

N/A = not applicable.

Contributions

DM, DB, DD, TR, JW, and BS contributed to the conception and design of the study. DM, TR, JW, and BS contributed to the acquisition of data. TR contributed to the provision of study materials or patients. CM contributed to the collection and analysis of data as well as technical and logistic support. DM, FZ, BS, DB contributed statistical expertise. DM, DB, JR, TR, FZ, BS, and CS contributed to the analysis and interpretation of data. DM, DB, TR, JW, and BS contributed to the drafting of the article. DM, DB, DD, TR, JW, BS, and CS contributed to the final approval of the article. DM, DB, FZ, BS take responsibility for the integrity of the work as a whole, from inception to finished article.

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Declaration of competing interest

Jill Robert is an employee of Alberta Health Services. The authors declare no other conflict of interests.

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Appendix A. Base case discrete event simulation (DES) model flow logic

OS = Orthopedic surgeon  
MSK = Musculoskeletal specialist  
S = Surgery  

$T_i$ = receipt date of complete referral  
$T_{MS}$ = consult date with MSK  
$T_{OS}$ = consult date with OS  
$T_5$ = scheduled surgery date
