University of Alberta

Waiting Lists for Major Joint Arthroplasty

by

Karen Diane Kelly ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of **Doctor of Philosophy**

Medical Sciences - Public Health Sciences

Edmonton, Alberta

Spring, 1999

0-612-39552-9

University of Alberta

Library Release Form

Name of Author: **Karen Diane Kelly**

Title of Thesis: **Waiting Lists for Major Joint Arthroplasty**

Degree: **Doctor of Philosophy**

Year this Degree Granted: **1999**

Karen Kelly

229, 22430 Twp. Rd. 520
Sherwood Park, AB
T8C 1E6

Date: Dec 18, 1998

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **Waiting Lists for Major Joint Arthroplasty** submitted by **Karen Diane Kelly** in partial fulfillment for the requirements for the degree of **Doctor of Philosophy** in Medical Sciences – Public Health Sciences.

M. Suarez-Almazor

L. Redfern

S. Newman

D.W.C. Johnston

K.C. Carriere

K. Teo

L. Roos

Date: Dec 18, 1998

Dedication

I dedicate this thesis to my husband, Don Voaklander.

Abstract

The purpose of this thesis was to examine factors related to waiting time for major joint arthroplasty and determinants of change in pain and function while waiting for replacement surgery. Data was collected prospectively from a cohort of 564 patients who resided in the Edmonton region of Alberta, Canada and were waiting for either total hip or total knee replacement surgery between December 18, 1995 and January 24, 1998. The WOMAC and SF-36 health status instruments were administered at the time the patient was placed on the waiting list and again just prior to surgery. Other demographic, clinical and socioeconomic information was also collected at these two time periods. The main outcome measures were waiting time and change in pain and function.

Patients in our study appeared to be suffering with more pain and disability than patients in other previously cited studies. No biases in waiting time with regard to age, gender, marital status, language spoken, education or work status were observed. Patients with more severe pain and disability did not have surgery substantially earlier. Multivariate analyses identified that patients with increased BMI, decreased social function, and those who were seen by surgeons with a large joint replacement practice had significantly longer waiting times.

Minimal amounts of change in pain and function (physical and psychosocial) occurred for both hip and knee replacement patients during this waiting period, with approximately the same percentage of patients showing improvement as showing a worsening of symptoms. Although some people's symptoms worsened during this waiting time, it was difficult to predict, at the time the patients were placed on the waiting

list for major joint replacement surgery, who would get worse in terms of pain and function while they waited.

Preface

The reader of this theses should note that it is presented in the paper-format. This means that each chapter is presented with its own introduction, set of references, etc.

For this particular thesis, chapters 2 through 4 are written with the intention that they will be subsequently submitted for publication (chapter 2 is presently under review).

Acknowledgements

I would like to thank the following for their valued contribution to this thesis:

- The Capital Health Authority Research Fund for funding this research project.
- The Orthopedic Trust Fund for funding this research project.
- The Alberta Heritage Foundation for Medical Research for my studentship.
- Dr. Maria Suarez-Almazor, a very special appreciation for her continual guidance.
- Dr. K.C. Carriere, Dr. W. Johnston, G. Kramer, Dr. S. Newman, and Dr. L. Redfern, for advice in their respective fields.
- Sue Barrett and Allyson Jones for assisting with data collection, Chris Kendall and Allyson Jones for assisting with data entry, and Brenda Topliss for assisting with typing.

And finally, I would like to thank my husband Don, for his continual encouragement, support, and advice during the completion of this thesis.

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1 Introduction

Major joint arthroplasty is in growing demand, as a result of the aging population and the significant number of persons suffering from arthritis. Joint replacement surgery represents a substantial portion of the total health care budget, and it has been estimated that the bill for direct medical costs for total hip arthroplasty in the United States alone would exceed $1 billion annually, if the potentially needed number of procedures was actually performed (Roos & Little, 1985).

Waiting times for joint replacement surgery have become a concern for the public in recent years, as the demand grows. It appears that the current management of waiting lists - individual surgeon-maintained waiting lists, is not rationalised (across lists) with respect to the burden of symptoms of those awaiting surgery. Inequities in waiting time also result from the combination of varying lengths in surgeons' waiting lists and their allocated operating time. In times of limited resources, it is important to provide the appropriate treatment in a timely manner, while ensuring equitable access based on patient need. Few studies examining factors related to waiting times for joint replacement surgery have been published.

1.2 Joint Replacement Surgery and Outcomes

Total Hip Arthroplasty

Total hip arthroplasty is the surgical replacement of the hip joint with an artificial prosthesis, and has greatly improved the management of hip joint diseases that have responded poorly to conventional medical therapy. Since its introduction in the United States in 1969, total hip arthroplasty has become one of the most widely performed procedures in orthopaedic practice. Briefly, total hip arthroplasty is a procedure that involves surgical excision of the head and proximal neck of the femur and removal of the acetabular cartilage and some of the subchondral bone. The interior medullary canal is opened in the proximal region of the femur, and a metal femoral prosthesis is inserted into the femoral medullary canal. An acetabular component composed of polyethylene articulating surface, with or without metal backing, is inserted proximally into the enlarged acetabular space. Both these components are fixed firmly to the bone either with polymethylmethacrylate cement, or more recently, by bony ingrowth into a porous coating on the implant, resulting in "biological" fixation (Siopak & Jergesen, 1995).

There is widespread consensus regarding the effectiveness of total hip replacement surgery for the alleviation of pain and improvement of physical functioning (Sullivan et al., 1993; Laupacis et al., 1993; Callahan et al., 1994; Kirwan et al., 1994; Siopak & Jergesen, 1995). It is generally preferred that total hip arthroplasty be done in patients older than 60 years because at this age, the physical demands on the prosthesis tend to be fewer, and the longevity of the prosthesis approaches the life expectancy of the patient. Excellent clinical results are achieved for 80% to 85% of patients following cemented total hip arthroplasty for as long as 15 years. Although uncemented hip arthroplasty appear to be slightly less satisfactory, the results from the two procedures are similar after 5 to 20 years (Siopak & Jergesen, 1995).

Laupacis et al. (1993), studied 188 patients who had undergone total hip replacements, and found marked improvement in physical function, social interaction and overall health. Specifically, the mean Harris score (physical functioning) improved from 44 to 98 points, and the mean pain score on the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) decreased from 4.9 to 0.7 points (a low score represents less pain). As well, there was significant improvement for all items, except the work dimension of the Sickness Impact Profile (general health status). The authors found that most of the improvement had occurred by three months post-operatively.

Kirwan et al. (1994) had similar findings from their research, and determined that significant improvements were obtained for up to 3 years after the operation. They also found that greater improvements occurred for patients with osteoarthritis than for patients suffering from rheumatoid arthritis.

Total Knee Arthroplasty

The development of technology for knee replacements began in the 1950's. Prostheses vary by the knee compartments being replaced, the level of femoral-tibial constraint, and the geometry of the articulating surfaces. Variation in surgical technique includes surgical approach, use of instrumentation, prosthetic positioning, patellar replacement, use of cement, and treatment of the cruciate ligaments and other soft-tissue releases (Callagan et al., 1994).

Knee replacement surgery has also been proven to be very effective for alleviating discomfort and improving physical functioning. Callahan et al. (1994), using meta-analytic techniques, examined 130 studies reporting the outcome of total knee arthroplasties. They found that across all studies, the global rating scale scores (measuring physical function) for the typical patient improved 44.0 points (on a 100-point scale) following tri-compartmental knee replacement at a mean follow-up of 4.1 years. As well, 75% of patients reported no pain post-operatively, 20% reported mild pain post-operatively, and 3.7% reported moderate pain post-operatively, at follow-up.

Survivorship analysis showed an overall prosthesis survivorship rate at ten years of over 90%, and for patients younger than 55 years, a 96% survivorship rate (Ranawat et al., 1989).

1.3 Trends and Utilisation

Arthritis affects 30% of the population over the age of 65 years, and once it affects hips or knees, it causes pain, loss of function and reduces ones' quality of life (Coyte et al., 1996). Studies indicate that most of the replacement surgery is performed for either osteoarthritis (73% of knee replacements and 66% of hip replacements) or rheumatoid arthritis (21% of knee replacements and 7% of hip replacements) (Quam et al., 1991; Madhok et al., 1993).

Joint replacement surgeries are in growing demand. A population-based research study conducted in Olmstead County, Minnesota found that between 1971 and 1983, the age-and sex-adjusted utilisation rate for total knee arthroplasty (TKA) increased from 20.5/100,000 person-years to 60.8/100,000 person-years (Quam et al., 1991). Overall, the age-adjusted rate of TKA was significantly greater for women than for men (44.3 versus 31.1 per 100,000 person-years).

A similar study, Madhok et al. (1993) found that between 1969 and 1990 the utilisation rate of total hip arthroplasty (THA) increased from 49.0/100,00 person-years to 59.9/100,000 person-years for residents of the same county. They found that THA was performed more often in women than in men (59.6 versus 46.3 per 100,000 person-years). They also noted that the mean age was significantly less for men than for women (64.5 versus 69.3; $p<0.0001$). A higher proportion of THA in elderly women as a result of hip fractures can partially explain the age difference. Also, men underwent THA for primary degenerative joint disease at a younger age in comparison with women.

The Oxford record linkage study (Seagrott et al, 1991), which collects information on all patients admitted to hospital for National Health System (NHS) care, also noted an increase in elective total hip replacement surgeries - from 43 to 58 operations/100,000 population between 1976 and 1985. Since data on operations in the private sector was not available, it was thought that these rates underestimated the true incidence of total hip replacements in Britain. A substantial proportion of the overall increase was attributed to districts with previously low rates, which was interpreted as a trend towards greater equity in the provision of hip arthroplasty operations.

Kramer et al. (1983) examined the social and economic impact of four musculoskeletal conditions: rheumatoid arthritis, osteoarthritis, lower back pain and tendinitis. They found that in the U.S., musculoskeletal diseases surpass almost all other disease groups in measures of disability, use of vocational rehabilitation and medical costs. Of the four conditions compared, rheumatoid arthritis led to the most frequent use of physician services, and also caused the most restriction in activity. The impact of osteoarthritis on functional ability was next in severity. As a conservative estimate of prevalence, the study found that rheumatoid arthritis is responsible for 2 million physician visits per year, and results in 2 million work loss days. Osteoarthritis is responsible for 46 million physician visits per year, and results in 68 million work loss days.

Ethnic diversity in the rates for major joint arthroplasty has been reported. In a study examining variations in racial rates of total hip arthroplasty in San Francisco, the THA rates were found to be much lower for Asians, Hispanics, and black subjects than for the white population. The greatest annual rate of THA occurred in white women, followed by white men, black women, black men, Hispanic women, and Hispanic men (Hoaglund et al., 1995).

A similar study looking at demographic variation in the rate of total knee arthroplasty (Katz et al., 1996), found that the number of Medicare-funded TKAs increased 18.46 percent between 1985 and 1990. The likelihood of receiving a TKA was a function of age, gender, and race. Each year, TKAs were almost twice as likely to be performed on women than on men, the odds of whites getting surgery was over 1.5 times greater than for blacks, and being in the oldest age group (85 or older) was associated with a 41 percent less chance of having a TKA than being in the youngest age group (65 - 69).

Investigators have also identified marked geographic variation in the rates of joint replacement surgery (Peterson et al., 1992). First of all, the rates of total hip arthroplasty and total knee arthroplasty were found to be highly correlated with each other (Tierney et al., 1994). As well, surprisingly, replacement surgeries were not correlated with the number of orthopaedic surgeons in each state, but rather, they were inversely related to the population density. The highest rates were found in the less densely populated areas. Although this relationship goes against the common trend found in health care utilisation - surgical procedure rates being proportional to population density, the authors postulated that people living in rural setting may be troubled to a greater extent by symptoms of arthritis because physical activity is more critical to their way of life.

An Ontario study (van Walraven et al., 1996), found that replacements were more common among patients in the low-rate region than those in the high-rate region, although baseline characteristics, including preoperative pain and dysfunction, were similar between the two regions.

Another study, conducted in Scandinavia (Visuri & Honkanen, 1982), which looked at the role of socio-economic status and place of residence in total hip replacements, corroborated this hypothesis. The authors found that patients of lower socio-economic status had a lower pre-operative capacity for ADL's and were more disabled before surgery, compared to persons of higher socio-economic status, but no differences were found between the status groups in walking ability preoperatively. Urban patients had better preoperative walking ability, preoperative functional status, and were less disabled preoperatively, than patients living in rural settings. However, neither socio-economic status nor place of residence had any significant influence on the improvement in daily activities or on the decrease in use of an aid following THA. The authors concluded that earlier THA is recommended for patients of lower socio-economic status and for those living in rural areas.

1.4 Waiting Lists

Waiting lists for inpatient surgical procedures are commonplace in universal health care systems, and first drew attention in Canada's health care system during the late 1980's. Initially, the concern focused on coronary bypass surgery in Ontario, due to media coverage of persons dying while awaiting surgery and patients seeking expedited cardiac surgery in the United States. The waiting list situation greatly improved in 1990 as a result of an expanded capacity for cardiac surgery and better resource management - including criteria for determining where patients were placed on the waiting list. Problems with coronary surgery waiting lists also occur in other Canadian provinces (Naylor et al., 1993a).

Research on Coronary surgery waiting lists in Canada began at the Institute of Clinical Evaluative Services (ICES) in Ontario, which conducted a retrospective study of how coronary surgery candidates were being managed before adopting a formal waiting list management system (Naylor et al., 1993a). They found that both symptom status and urgency scores correlated with waiting times, which were indicative of consultants' attempts at fair allocation of scarce services. However, waiting times varied significantly among institutions.

The research group then proceeded to develop criteria for assessing revascularization priorities using a formal panel process. The panellists first agreed on clinical factors affecting surgery, which were then combined into 438 hypothetical case scenarios. The scenarios were rated independently by 16 specialists on a scale with 7 time windows for maximum acceptable delay prior to surgery. Rating discrepancies were resolved at consensus meetings, with unanimous adoption of the waiting list principles.

A regression-based model was created to derive weights for each clinical factor. A scoring system was also developed, where the regression coefficients for the major urgency determinants were combined to produce a multi-factorial urgency rating score, ranging from 1.0 (emergencies) to 7.0 (discretionary surgery with a wait of up to 6 months if necessary). This scoring system quantitatively summarised the consensus principles adopted by the panel.

Using data extracted from 413 patients' charts that pertained to the major determinants of urgency ratings, correlations between actual and maximum recommended waiting times were generated. The correlations between actual and recommended waiting times were moderate, and statistically significant. However, inter-centre discrepancies in waiting times occurred, even after controlling for differences in case-mix. Therefore referrals to other centres, to reduce discrepancies in waiting times, did not occur. The analyses confirmed that even without formal guidelines, cardiologists and cardiac surgeons tended to consciously assign priority to coronary surgery cases that would be deemed more urgent with the formal criteria. The authors concluded that urgency-ranking guidelines, multi-hospital co-ordination of referrals, and monitoring of excessive waits are necessary if waiting lists are to be managed fairly and efficiently.

A follow-up study (Naylor et al., 1993b) looked at the waiting time for coronary revascularization in Toronto, Ontario, comparing the referring physicians' estimates of urgency with the computer-generated multi-factorial urgency rating score (URS) and waiting times. They found that the URS was clearly correlated with the subjective score from the referring physician (r=0.60), which is a measure of the validity and general acceptance of the URS. There was also an overall correlation between waiting time and both the subjective score(r=0.57) and the URS (r=0.46).

Interestingly, the authors found that pre-specification of surgeon by the referring physician increased the delay for surgery by 50%. This delay presumably resulted from either the requested surgeons having consistently longer waiting times, or consequential scheduling restrictions (i.e. not being able to book with surgeons that have unexpected openings or shorter waiting lists).

Like cardiac care some years ago, managing the waiting list is now becoming an issue for orthopaedic surgery. At present, thousands of individuals across Canada are on waiting lists for hip or knee replacement surgery. A comparison of waiting times for knee replacement surgery between Ontario and the United States was conducted by Coyte et al. (1994). The mean waiting time for this type of surgery was 18.9 weeks for Ontario patients and 8.7 weeks for U.S. Medicare recipients. In terms of satisfaction with the waiting times, 95% of the U.S. patients were satisfied, and 85% of the Ontario patients were satisfied. Other Canadian surveys suggest that waiting times of three to four months are well tolerated, but dissatisfaction raises with increasing delays (Coyte et al., 1994; Ho et al., 1994). Recent analysis of data collected from 81 hip and knee replacement surgeries performed in 1995 (May, June and July) at the Royal Alexandra, University and Grey Nuns hospitals in Edmonton revealed that the median waiting time from orthopaedic consultation to surgery was 20 weeks (Redfern & Voaklander, 1995).

Studies have identified considerable diversity among surgeons regarding indications for total knee replacement surgery (Tierney et al., 1994; Wright et al., 1995). In an Ontario survey, orthopaedic surgeons disagreed on how 20 out of 34 patient characteristics affected their decision for knee replacement surgery. Disagreement was even larger when general practitioners were surveyed. These variations in surgery rates raise questions about potential under use and overuse of procedures (Wright et al., 1995).

A similar study which looked at indications for both total hip and total knee arthroplasties, (Mancuso et al., 1996), compared orthopaedists surveyed in New York City and McGill University. They found that although there were wide variations among surgeons, most surgeons required at least severe pain daily, rest pain several days per week, transfer pain either several days per week (THA) or daily (TKA), and destruction of most of the joint space on radiograph. Younger age, comorbidity, technical difficulties, and lack of motivation modified the decision against surgery. The desire to be independent and return to work swayed the decision for surgery. No clear consensus among surgeons regarding the indications for THA or TKA, possibly means that isolated indications are not as important as integrating and weighing several indications, and that patient's desire for surgery is an important driving force in the decision. In light of the fact that thresholds for surgical referral of orthopaedic patients vary among general practitioners, guidelines for appropriate referrals would be valuable to improve the care for patients who might otherwise not receive timely or appropriate referrals (Naylor et al., 1996).

It has also been found that surgeons do not necessarily bring patients with more severe symptoms or disabilities to the front of the waiting list (Coyte et al., 1994; Williams et al., 1997). Studies by the ICES group in Ontario indicate that waiting times for knee and hip replacement were unrelated to the severity of pain and difficulty in functioning (Williams et al., 1997). Pain, as measured by the WOMAC instrument, was unrelated to waiting time (tau-b = -0.004, $p = 0.95$) for 209 patients waiting for major joint arthroplasty. Similarly, physical functioning was unrelated to waiting time (tau-b = 0.026, $p = 0.67$). When comparing the patients general health, using the SF-36, they also found no relationship between physical health and waiting time (tau-b = 0.04, $p = 0.52$). This evidence that patients are not given priority according to severity of symptoms reinforces the need for waiting list guidelines. However, priorities cannot be made using a simple formula because each patients' priority is usually determined by a cluster of factors that vary from one individual to the next. With no common terminology and no urgency ranking system, inter-practitioner and inter-institutional differences are inevitable, cannot be identified for planning purposes, and may be harmful to the patient (Naylor et al., 1990a).

In response to the studies indicating variations in judgement about the appropriateness and urgency of surgery, the ICES in Ontario recently developed criteria to identify appropriate patients for referral to a surgeon for consideration for knee or hip arthroplasty, and to rank them on the waiting list once surgery was agreed (Naylor et al., 1996). Similar to the method used for managing cardiac patients, a multi-disciplinary panel process with modified Delphi methods was used to develop the criteria. The panel first met to agree on the clinical factors that affect surgical referral or timing of surgery. Pain and dysfunction were agreed as the common determinants of surgical referrals. The panellists independently rated 120 case scenarios for appropriateness and 42 for waiting list priority. The scenarios incorporated combinations of relevant clinical factors. The panel developed an appropriateness scale (7 ratings) and an urgency scale (7 ratings). The ratings were then analysed with recursive partitioning (a form of stepwise tree regression), which compares the means and distributions of the summary scores for sets of scenarios partitioned at different factors. The partitioning occurs sequentially (with the factor yielding the largest F value) to develop algorithm trees - an appropriateness algorithm and an urgency algorithm. The summary scores at each step of the analytical tree show how diverse factors combine to determine surgical priority. The appropriateness algorithm explained 84% of the variance in scenario ratings ($r^2=0.84$) and the urgency algorithm explained 63% of variance ($r^2=0.63$).

The authors concluded that these algorithms might serve as tools to support clinical decisions or as adjuncts for audit of practice patterns. Appropriateness ratings should also include simple criteria about co-morbidity and perioperative risk. The criteria and scoring system were designed to help in ranking patients, independent of specific associated waiting times.

Most Canadian hospitals manage surgery waiting lists with various informal criteria for judging the urgency of clinical need (i.e. putting persons with presumably higher risk toward the top of the list). However, if clinical need is inconsistently defined, among practitioners and institutions, the system no longer allocates surgery based on clinical need. The ultimate goal is to standardise waiting list criteria, across the province, so that inter-practitioner and inter-institutional discrepancies in waiting times can be reduced in the interest of fairness and efficiency (Naylor et al., 1990a; 1993a).

Since hip and knee replacements are usually elective procedures, hospitals determine the number of prostheses they purchase and allocate operating times to surgeons. Many hospitals cap expenditures on prostheses and limit the number of procedures (Williams et al., 1995). At this point in time, surgery is allocated by individual surgeon-maintained waiting lists that are not rationalised (across lists) with respect to the burden of symptoms of those awaiting surgery.

A more rational approach would be for surgeons in a hospital and /or hospitals in an area to have a common waiting list system so that patients with marked disabling pain could be referred to consulting surgeons with relatively short times for initial consultations and bookings for surgery (Williams et al., 1995).

To assist in determining acceptable waiting times, physicians and surgeons should seek more input from society at large and from medical ethicists about when procedures should be performed (Naylor et al., 1992). Providers perceptions concerning appropriate or acceptable waiting times are useful indicators of excess demand, but patients' acceptance of waiting times are essential to obtain a balanced evaluation of access to health care (Ho et al., 1994).

1.5 Measurement Instruments

Measurement instruments should represent multiple health concepts and a range of health states pertaining to general function and well being. They should adhere to conventional standards of reliability and validity and be simple and easy to use. Since patients tend to be sicker than the general population, their attention divided and time limited, measures that work well for the general population may not work well for patients (Stewart et al., 1988).

In general, multi-item scales are better than single-item measures, because multi-items are more precise, more reliable and more valid. Multi-item scales also provide more options for estimating scores when a response to an item is missing (Stewart et al., 1988).

There are three different classifications of health measurement instruments; general health surveys, disease specific surveys, and quality of life measures. General health surveys address general health concepts that are not specific to disease or treatment group. They measure basic human characteristics, such as functioning and emotional well being. Also known as generic instruments, they are able to detect complications, side effects, and co-morbid symptoms that may or may not be related to the primary condition being treated. These general surveys allow the impact of treatment to be compared across various medical conditions and different populations, for the purposes of resource allocation and cost-effectiveness assessment. However, it is important that the general health measure is comprehensive and sensitive to a full range of illnesses (Bombardier et al., 1995; Ware & Sherbourne, 1992; Brazier et al., 1992).

Disease-specific instruments, on the other hand, focus on the disorder under examination and patients' problems related to it. They are often more relevant for patients and physicians because they are better at detecting the effects of treatment.

Health measurement instruments have been examined regarding their function in measuring outcomes of total joint replacement (Liang et al., 1990, Bayley et al., 1995). They have been shown to have acceptable sensitivity to changes in patients' health status. However, the application of health measurement instruments with regard to rationalisation of surgery has not yet been attempted.

To measure disease specific status, general health status, and co-morbidity, both disease-specific and general measurement tools were used is this study.

SF-36

The SF-36 is a widely accepted 36-item general health status questionnaire that takes approximately 10 minutes to complete. It was designed for persons 14 years or older, to be completed by either self-administration, a trained interviewer or by telephone interview. The questions were selected from the RAND Health Insurance "long form" questionnaire. The SF-36 was designed for use in clinical practice, research, health policy evaluations and general population surveys. It contains one multi-item scale that assesses eight health dimensions - including both positive and negative health states. The items are grouped into eight dimensions measuring; emotional role functioning, physical role functioning, physical functioning, mental health, vitality, general health perceptions, social functioning and bodily pain (Ware, 1995).

The score for each scale ranges from 0 to 100 with a high score representing the best health state. The SF-36 items and scales are scored using the Likert method of summated ratings. The linear scales assume that the item scores, on average, linearly relate to the underlying health concept being measured, and research supports this assumption. A scoring manual explains the scoring options - profile and summary scores. Normative data are also available (Ware & Sherbourne, 1992).

The instrument's reliability and validity has been extensively tested and is currently being used by many outcome research teams (Brazier et al., 1992, Ware, 1995). The SF-36 was tested for its reliability and validated, by comparing it with the Nottingham health profile in a study by Brazier et al., 1992. The SF-36 was found to be internally consistent - Cronbach's alpha exceeded the minimum of 0.85. The re-test scores were highly correlated with the main survey ($0.60<r<0.81$). The distributions of scores by sex, age, socio-economic factors and use of health services conformed to what might be expected - providing strong evidence for construct validity. The multi-trait multi-method correlation matrix had satisfactory relations for convergent and divergent validity (i.e. correlation coefficients for comparable dimensions were higher than those for non-comparable dimensions).

Western Ontario McMaster Osteoarthritis Index (WOMAC)

Fundamental differences exist between patients with rheumatoid and osteoarthritis in respect to age of onset, distribution of joint involvement and the natural history of the disease. However the majority of indices that have been developed for use with rheumatic diseases have been based on patients with rheumatoid arthritis. Therefore a measurement instrument was developed specifically to serve as an outcome measure for patients with osteoarthritis of the hip and knee - the WOMAC questionnaire. Its development was based on a study in which one hundred patients with osteoarthritis of the hip and knee were interviewed in order to determine dimensionality and clinical importance of their pain and disability (Bellamy & Buchanan, 1986). The WOMAC is a multi-dimensional health status instrument, capable of measuring clinically important and patient-relevant symptoms of osteoarthritis. The well known disease-specific questionnaire consists of 24 items, using a 5-point Likert scale, which are combined into three dimensions; pain, stiffness, physical functioning. Scores are derived by summing the items under each dimension - no global index is calculated. The WOMAC is to be self-administered, and takes approximately 5 minutes to complete.

The WOMAC's responsiveness, reliability and validity have been tested in the context of knee and hip arthroplasty and clinical trials for anti-inflammatory drugs. Since patients with chronic musculoskeletal disease frequently show a high and unpredictable degree of individual variation in their response to therapeutic interventions, it is important to include responsiveness of the measurement instrument in psychometric testing.

In a validation study of the WOMAC (Bellamy et al., 1988), individual item and aggregate item data were analysed using t-tests to assess item and dimension responsiveness. The results attained were indicative of a high level of responsiveness.

Internal consistency, using Cronbach's alpha, and test re-test reliability, using Kendall's tau c. statistic, were also assessed. High internal consistency was achieved ($0.86<r<0.95$), and moderate test re-test reliability was achieved ($0.48<r<0.68$). Given the constantly fluctuating symptomatology of osteoarthritis, test re-test reliability was predicted to be only moderate.

Construct validity was determined by comparing the WOMAC against other measurement instruments with similar dimensions using Pearson's correlation coefficients. The WOMAC dimensions correlated highly with the respective dimensions of the other instruments (pain, r=0.57; stiffness, r=0.46; physical function, r=0.54).

One study (Bellamy et al., 1991) examined the issue of whether simple addition of items to form subscales was acceptable, using t-test, correlation coefficients and factor analyses. The authors found that the item scores differed significantly from the subscale average suggesting that the items measure different aspects of the three dimensions and therefore all are relevant in aggregation. A high factor loading on each individual component item further suggests that there are no redundant items in the WOMAC. Finally, the high inter-item correlation within each subscale, and each single item having a high factor loading, support the assumption that the WOMAC subscales for pain, stiffness and physical functioning can be derived by simple addition. The authors concluded that subscale scores can be calculated by summing up the items within each dimension, and comparative analyses should treat each dimension as a separate entity.

Pain is probably the most important component of disability of osteoarthritis in weight-bearing joints. Among the difficulties in quantifying pain is the variability of intensity - alternating flares with relative "good" periods. Pain perception has been found to be higher during the evenings and weekends - known as circadian and circaseptan rhythmic variations. To compensate for these rhythmic variations, pain assessment should take place at the same time of the day, and at each visit the patient should be asked to average his pain level during the previous few days (Levesne et al, 1991).

A comparative study (Griffiths et al., 1995) of the relative efficiency of the WOMAC questionnaire, the Arthritis Impact Measurement Scale (AIMS), and the Health Assessment Questionnaire (HAQ), found that the WOMAC scale was greater in relative efficiency (RE) than the two other instruments, particularly in the detection of change in functional status. Relative efficiency was calculated, (*t*WOMAC/*t*HAQ)2 with a RE >1 meaning that the WOMAC is more efficient than the HAQ.

A study comparing generic and disease-specific measures of pain and physical function after knee replacement surgery, found that the WOMAC had consistently higher scores than the SF-36 - indicating less disability from knee arthritis than from other conditions (Bombardier et al., 1995). The WOMAC discriminated better between patients who had varying levels of physical functioning, and between those who did and did not have subsequent operations. The SF-36 discriminated better among varying levels of general health, and between patients with and without limitations caused by other conditions. Overall, the disease-specific instrument detected improvements in post-surgery, whereas the generic instrument illustrated that the elderly subjects suffered from pain and reduced disability caused by other conditions. Since patients over the age of 65 years often have multiple chronic conditions, it is imperative to use both a disease-specific and a general health status questionnaire, because addressing one disease may not markedly improve their overall functioning.

Co-morbidity Scale

Patient reported measures of health status are important in studies of patients with chronic diseases in whom mortality is rare and the goal of medical care is to control the course of the disease and maximise quality of life. Confounding factors, such as severity of primary illness and co-existent conditions may bias the results, especially in non-randomised studies (Greenfield et al., 1993).

The Charlson's weighted co-morbidity scale is a taxonomy for co-morbid conditions which singly, or in combination, might alter the risk of short term morbidity for patients enrolled in longitudinal studies (Charlson et al., 1994). The scale was developed by first calculating the adjusted relative risks for each co-morbid condition. An adjusted relative risk estimates the risk of death with a given co-morbid condition controlling for all co-existent co-morbid diseases as well as illness severity. These adjusted relative risks were then used as weights for the different co-morbid diseases. The resulting weighted index takes into account both the number and seriousness of co-morbid diseases, therefore patients with greater risk can be analysed separately. This method for classifying co-morbidity provides a simple, and valid method of estimating risk of death from co-morbid disease for use in longitudinal studies.

The co-morbidity scale was tested for its ability to predict risk of death from co-morbid disease in a cohort of 685 patients with primary breast cancer. The weighted index of co-morbidity was a significant predictor ($p<0.001$) of 1-year survival (Charlson et al., 1994).

Medication Quantification Score

Patients with chronic pain commonly have multiple symptoms, including depression, insomnia, and anxiety as well as pain. Therefore, multiple medications are prescribed, including narcotics, anti-anxiety agents and anti-inflammatory medications. It is difficult to quantify medication use because the multiple medications vary in pharmacological class and dosage level (Masters-Steedman et al., 1992).

Each pain-related medication for an individual patient is given a score that is based on both the daily dosage and pharmacological classification of that medication. The six pharmacological classifications have assigned detriment weights, based on the potential for detrimental effects from long-term use. Non-narcotics have four dosage levels, based on the recommended daily dosage, and narcotic analgesics have daily dosage levels based on the morphine equivalent in milligrams and therapeutic range. For a given medication, the detriment weight is multiplied by the dosage level to yield a medication quantification score (MQS). For an individual patient, the MQSs for each medication are calculated and then summed to yield the total MQS for that patient. This index score can then be used for clinical assessment of individual patients and for statistical comparison of patient groups.

The MQS provides a method for quantifying medication use in-patients with chronic, non-malignant pain. The MQSs are sensitive to expected clinical changes, and have been proven to be reliable - there is excellent agreement within and between raters. The MQS has demonstrated good concurrent validity, in that there is relatively high correlation between total MQSs and the mean clinical judgement of health professionals who are knowledgeable about pain medications (Masters-Steedman et al., 1992).

1.6 Rationale

This prospective study of patients undergoing complete hip and knee replacements examines factors related to waiting times for major joint arthroplasty and describes how the levels of pain and function are altered while people wait for joint replacement surgery. Information gained from this study is essential for monitoring the length and quality of waiting lists, which will assist in the rationalisation of scarce surgical resources. The results of the study will also be beneficial for the development of criteria for prioritising patients on waiting lists.

1.7 Objectives

1) To describe the impact of health status on waiting time for major joint arthroplasty.

2) To examine patients' demographic and clinical factors, along with several health systems variables, to ascertain whether waiting lists are managed in an equitable fashion.

3) To describe the relationship between change in pain and function experienced while awaiting surgery, and patient characteristics, baseline health status, and waiting time.

1.8 Statistical Analyses

Univariate statistical techniques and multiple linear regression were used to determine the association between the independent variables and the dependent variable (waiting time for the first two objectives and change in pain and function for objective #3).

Differences in mean values of continuous variables were tested with either t-tests or ANOVA (Kruskal-Wallis tests were used for non-parametric comparisons) and chi-square tests were used to test proportions. Pearson correlation coefficients were generated for correlations between continuous variables.

Both stepwise and forced entry procedures in multiple linear regression were used. For objectives 1 and 2, waiting time was transformed into its natural logarithm to adjust for the positive skewness in waiting time. The general model for multiple linear regression was used:

$$Y = \alpha + \beta 1X1 + \beta 2X2 + \ldots + \beta KXK + e$$

where XK is the value of the Kth independent variable for each individual, β the unknown population coefficients, and e the independent random errors. The criterion of ordinary least squares was used for determining the coefficients. The five major assumptions of regression analysis are: the relationship between x and y is linear; the error term has a zero mean; the error term has constant variance; the errors are uncorrelated; and the errors are normally distributed.

The two methods used for modelling the relationship between the predictor variables and outcome variable were:

a) stepwise regression, where independent variables were selected for either entry or removal (forward or backward stepwise regression) according to the partial F-statistic. With forward stepwise, the first regressor selected for entry into the equation was the one producing the smallest probability-of-F value, if the value was smaller than the entry criterion (PIN = 0.05). The steps continued until the value did not meet the entry criterion. Backward stepwise is similar, starting with all predictor variables included in the equation and eliminating the variable with the largest probability-of-F value, if this value was larger than the exit criterion (POUT= 0.10). The purpose of using stepwise regression is to identify the set of predictor variables that were significantly associated with the outcome.

b) forced entry, where all the independent variables considered to be clinically relevant were entered into the equation whether the coefficients were statistically significant or not. The purpose of this technique is to obtain coefficient estimates, while controlling for variables that were thought to have a small effect on the outcome (Montgomery & Peck, 1982).

For objective 3, logistic regression was used, with the logistic equation written in terms of odds:

$$\frac{\text{Prob(event)}}{\text{Prob(no event)}} = e^{B0 + B1X1 + \ldots + BpXp} = e^{B0} e^{B1X1} \ldots e^{BpXp}$$

Where $B0$ and $B1$ are coefficients estimated from the data, X is the independent variable and e is the base of the natural logarithms. Then e raised to the power of B_i is the amount by which the odds change when the ith independent variable increases by one unit. If B_i is positive, this factor will be greater than 1, which means the odds are increased; if B_i is negative, the factor will be less than 1, which means the odds are decreased. When B_i is 0, the factor equals 1, which leaves the odds unchanged.

The forced entry method for model selection was used, where all independent variables were entered in a single step. The purpose of this technique is to obtain odds ratios, while controlling for all variables that were thought to have a small effect on the outcome. Ninety-five percent confidence intervals were calculated to determine statistical significance.

1.9 References

Bayley, M. S., London, M. R., Grunkemeier, G. L., & Lansky, D. J. (1995). Measuring the success of treatment in patient terms. Medical Care, 33(4), AS225-AS235.

Bellamy, N., & Buchanan, W. W. (1986). A preliminary evaluation of dimensionality and clinical importance of pain and disability in osteoarthritis of the hip and knee. Clinical Rheumatology, 5(2), 231-241.

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988). Validation study of the WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. The Journal of Rheumatology, 15, 1833-1840.

Bellamy, N. (1989). Pain assessment in osteoarthritis: experience with the WOMAC osteoarthritis index. Semin Arthritis Rheum, 18(Suppl 2), 14-17.

Bellamy, N., Sothern, R. B., & Campbell, J. (1990). Rhythmic variations in pain perception in osteoarthritis of the knee. The Journal of Rheumatology, 17(3), 364-372.

Bellamy, N., Wells, G., & Campbell, J. (1991). Relationship between severity and clinical importance of symptoms in osteoarthitis. Clinical Rheumatology, 10(2), 138-143.

Bombardier, C., Melfi, C. A., Paul, J., Green, R., Hawker, G., Wright, J., & Coyte, P. (1995). Comparison of a generic and a disease-specific measurement of pain and physical function after knee replacement surgery. Medical Care, 33(suppl), AS131-AS144.

Brazier, J. E., Harper, R., Jones, N. M. B., O'Cathain, A., Thomas, K. J., Usherwood, t., & Westlake, L. (1992). Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ, 305, 160-164.

Callahan, C. M., Drake, B. G., Heck, D. A., & Dittus, R. S. (1994). Patient outcomes following tricompartmental total knee replacement. JAMA, , 1349-1357.

Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined comorbidity index. J Clin Epid, 47, 1245-1251.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis, 40(5), 373-383.

Coyte, P. C., Wright, J. G., Hawker, G. A., Bombardier, C., Dittus, R. S., Paul, J. E., Freund, D. A., & Ho, E. (1994). Waiting times for knee-replacement surgery in the United States and Ontario [see comments]. New England Journal of Medicine, 331(16), 1068-1071.

Coyte, P. C., Young, W., & Williams, J. I. (1996). Devolution of hip and knee replacement surgery? CJS, 39(5), 373-378.

Darlington, R. B. (1990). Regression and Linear Models. U.S.A. McGraw-Hill Inc.

Dawson, J., Fitzpatrick, R., Murray, D., & Carr, A. (1996). A comparison of measures to assess outcomes in total hip replacement surgery. Quality in Health Care, 5, 81-88.

Greenfield, S., Alolone, G., McNeil, B. J., & Cleary, P. D. (1993). The importance of coexistent disease in the occurrence of postoperative complications and the one-year recovery in patients undergoing total hip replacement. Medical Care, 31(2), 141-154.

Griffiths, G., Bellamy, N., Bailey, W. H., Bailey, S. I., McLaren, A. C., & Campbell, J. (1995). A comparative study of the relative efficiency of the WOMAC, AIMS and HAQ instruments in evaluating the outcome of total knee arthroplasty. Inflammopharmacology, 3(1), (pp 1-6).

Ho, E., Coyte, P. C., Bombardier, C., Hawker, G., & Wright, J. G. (1994). Ontario patients' acceptance of waiting times for knee replacements. Journal of Rheumatology, 21(11), (pp 2101-2105).

Hoaglund, F. T., Oishi, C. S., & Gialamas, G. G. (1995). Extreme variations in racial rates of total hip arthroplasty for primary coxarthrosis: a population-based study in San Francisco. Ann Rheum Dis, 54, 107-110.

Kantz, M. E., Hasrris, W. J., Levitsky, K., Ware, J. E., & Davies, A. R. (1992). Methods for assessing condition-specific and generic functional status outcomes after total knee replacement. Medical Care, 30(5), MS240-MS252.

Katz, J. N., Wright, E. A., Guadagnoli, E., Liang, M. H., Karlson, E. W., & Cleary, P. D. (1994). Differences between men and women undergoing major orthopedic surgery for degenerative arthritis [see comments]. Arthritis & Rheumatism, 37(5), 687-694.

Kirwan, J. R., Currey, H. L., Freeman, M. A., Snow, S., & Young, P. J. (1994). Overall long-term impact of total hip and knee joint replacement surgery on patients with osteoarthritis and rheumatoid arthritis. British Journal of Rheumatology, 33(4), 357-360.

Kramer, J. S., Yelin, E. H., & Epstein, W. V. (1983). Social and economic impact of four musculoskeletal conditions. A study using national community-based data. Arthritis and Rheumatism, 26(7), 901-907.

Laupacis, A., Bourne, R., Rorabeck, C., Feeny, D., Wong, C., Tugwell, P., Leslie, K., & Bullas, R. (1993). The effect of elective total hip replacemetn on health-related quality of life. J Bone Joint Surg, 75A, 1619-1626.

Lequesne, M. (1991). Indices of severity and disease activity for osteoarthritis. Seminars in Arthritis and Rheumatism, 20(6), 48-54.

Liang, M. H., Fossel, A. H., & Larson, M. G. (1990). Comparisons of five health status instruments for orthopedic evaluation. Medical Care, 28(7), 632-642.

Madhok, R., Lewallen, D. G., Wallrichs, S. L., Ilstrup, D. M., Kurkland, R. L., & Melton, L. J. (1993). Trends in the utilization of primary total hip arthroplasty, 1969 through 1990: a population-based study in Olmstead County, Minnesota. Mayo Clin Proc, 68, 11-18.

Mancuso, C. A., Ranawat, C. S., Esdaile, J. M., Johanson, N. A., & Charlson, M. E. (1996). Indications for total hip and total knee arthroplasties. Results of orthopaedic surveys. Journal of Arthroplasty, 11(1), 34-46.

Masters-Steedman, S., Middaugh, S. J., Kee, W. G., Steir-Carson, D., Harden, R. N., & Millar, M. C. (1992). Chronic-pain medications: equivalence levels and methods of quantifying usage. Clin J Pain, 8, 204-214.

Montgomery, D. C., & Peck, E. A. (1982). Introduction to Linear Regression Analysis. U.S.A. John Wiley & Sons Inc.

Naylor, C. D., Baigrie, R. S., Goldman, B. S., & Basinski, A. (1990a). Assessment of priority for coronary revascularisation procedures. The Lancet, 335, 1070-1073.

Naylor, C. D., Basinski, A., Baigrie, R. S., Goldman, B. S., & Lomas, J. (1990b). Placing patients in the quque for coronary revasculatization: evidence for practice variations from an expert panel process. AJPH, 80(10), 1246-1252.

Naylor, C. D., Baigrie, R. S., Goldman, B. S., Cairns, J. A., Beanlands, D. S., Berman, N., Borts, D., Fitchett, D. H., Haq, A., Hess, A., Hughes, W., Swan, J., Tinmouth, A., Gunstensen, J., Lightenstein, S. V., Salter, D., Seisel, R. D., Anderson, G. M., Basinski, A., & Lomas, J. (1991). Assigning priority to patients requiring coronary revascularization: consensus principlesfrom a panel of cardiologists and cardiac surgeons. Can J Cardiol, 7(5), 207-213.

Naylor, C. D., Levinton, C. M., & Baigrie, R. S. (1992a). Adapting to waiting lists for coronoary revascularization. Do Canadian specialists agree on which patients come first? Chest, 101(3), 715-722.

Naylor, C. D., Levinton, C. M., Baigrie, R. S., & Goldman, B. S. (1992b). Placing patients in the queue for coronary surgery: do age and work status alter Canadian Specialists' decision? Journal of General Internal Medicine, 7, 492-498.

Naylor, C. D., Levinton, D. M., Wheeler, S., & Hunter, L. (1993a). Queueing for coronary surgery during severe supply-demand mismatch in a Canadian referral centre: A case study of implicit rationing. Soc Sci Med, 37(1), 61-67.

Naylor, C. D., Morgan, C. D., Levinton, C. M., Wheeler, S., Hunter, L., Lkymeciw, K., Baigrie, R. S., & Goldman, B. S. (1993b). Waiting for coronary revasculatization in Toronto: 2 years' experiece with a regional referral office. Can Med Asoc J, 149(7), 955-962.

Naylor, C. D., Sykora, K., Jaglal, S. B., Jefferson, S., & the Steering Committee of the Adult Cardiac Care Network of Ontario. (1995). Waiting for coronary arter bypass surgery: population-based study of 8517 consecutive patients in Ontario, Canada. The Lancet, 346, 1605-1609.

Naylor, C. D., Williams, J. I., & The Ontario panel on hip and knee arthroplasty. (1996). Primary hip and knee replacement surgery: Ontario criteria for case selection and surgical priority. Quality in Health Care, 5, 20-29.

Newton, J. N., Henderson, J., & Goldacre, M. J. (1995). Waiting list dynamics and the impact of earmarked funding. BMJ, 311(7008), 783-785.

Peterson, M. G., Hollenberg, J. P., Scatrowski, T. P., Johanson, N. A., Mancuso, C. A., & Charlson, M. E. (1992). Geographic variation in the rates of elective total hip and knee arthroplasties among medicare beneficiaries in the United States. The Journal of Bone And Joint Surgery, 10, 1530-1539.

Quam, J. P., Michet, C., Wilson, M. G., Rand, J. A., Ilstrup, D. M., Melton, L. J., & Wallrichs, S. L. (1991). Total knee arthroplasty. Mayo Clin Proc, 66, 589-595.

Ranawat, C. S., Padgett, D. E., & Ohashi, Y. (1989). Total knee arthroplasty for patients younger than 55 years. Clinic Orthopaedics and Related Research, 248, 27-33.

Redfern, L., & Voaklander, D. C. Unpublished data on joint replacement waiting lists in the Capital Health Authority. (un pub)

Roos, N. P., & Lyttle, D. (1985). Hip arthroplasty surgery in Manitoba: 1973-1978. Clinical Orthopedics and Related Research, 199, 248-255.

Seagroatt, V., Tan, H. S., Goldacre, M., Bulstrode, C., Nugent, I., & Gill, L. (1991). Elective total hip replacement: incidence, emergency readmission rate, and postoperative mortality. BMJ, 303(6815), 1431-1435.

Siopack, J. A., & Jergeson, H. E. (1995). Total hip Arthroplasty. WJM, 162, 243-249.

Stewart, A. L., Hays, R. D., & Ware, J. E. (1988). The MOS short-form general health survey. Reliability and validity in a patient population. Medical Care, 27(6), 724-735.

Sullivan, P., Scott, K., & Johnston, R. (1992). Current concepts in joint replacement. Iowa Med, 276, 468-469.

Tierney, W. M., Fitzgerald, J. F., Heck, D. A., Kennedy, J. M., Katz, B. P., Melfi, C. A., Dittus, R. S., Allen, D. I., & Freund, D. A. (1994). Tricompartmental knee replacement. Clinical Orthopaedics and Related Research, 305, 209-217.

Van Walraven, C., Paterson, J. M., Kapral, M., Chan, B., Bell, M., Hawker, G., Gollish, J., Schatzker, J., Williams, J. I., & Naylor, C. D. (1996). Appropriateness of primary total hip and knee replacements in regions of Ontario with high and low utilization rates. Canadian Medical Association Journal, 155(6), (697-706).

Visuri, T., Honkanen, R. (1982). The role of socio-economic status and place of residence in total hip replacement. Scand J Soc Med, 10, (95-99).

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36) 1. Conceptual framework and item selection. Medical Care, 30(6), 473-483.

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). SF-36 Health Survey: Manual and Interpretation Guide. Boston,Mass. Nimrod Press.

Ware, J. E. (1995). Interpreting health status measures in outcome research and clinical practice [Abstract]. A paper presented at: AHSR/FHSR Annual Meeting - Chicago,

Williams, J. I., Llewellyn Thomas, H., Arshinoff, R., Young, N., & Naylor, C. D. (1997). The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. Journal of Evaluation in Clinical Practice, 3(1), 59-68.

Wright, J. G., Coyte, R., Hawker, G., Bombardier, C., Cooke, D., Heck, D., Dittus, R., & Freund, D. (1995). Variation in orthopedic surgeons' perceptions of the indications for and outcomes for knee replacement. CMAJ, 152, 687-697.

CHAPTER 2

THE IMPACT OF HEALTH STATUS ON WAITING TIME FOR MAJOR JOINT ARTHROPLASTY

2.1 Introduction

As our population ages, chronic diseases that interfere with years of life in good health and with the ability to function independently are of increasing concern. Since the number of persons suffering from arthritis is increasing, and most major arthroplasties are performed for either osteoarthritis or rheumatoid arthritis, major joint arthroplasty is in growing demand (Quam et al., 1991; Madhok et al., 1993). As a result of this increase in utilisation, long waiting times from orthopaedic consultation to joint replacement surgery are occurring. A comparison of waiting times for knee replacement surgery between Ontario and the United States was conducted by Coyte et al. (1994), and found the mean waiting time for this type of surgery was 18.9 weeks for Ontario patients and 8.7 weeks for U.S. Medicare recipients.

At present, thousands of individuals across Canada are on waiting lists for either total hip or total knee replacement surgery. Since hip and knee replacements are usually elective procedures, Canadian hospitals determine the number of prostheses they purchase, and allocate operating times to surgeons. In general, waiting lists are managed by individual orthopaedic surgeons based on their assessment of the urgency of clinical need. However, without a valid and reliable measurement of the patient's disability, pain and overall health status, this assessment is often crude and speculative. Variations in surgeons' allocated operating times, and discrepancies in length across surgeons' waiting lists, may also affect the patient's waiting time for major joint replacement surgery.

The Canadian health care system is publicly funded, based on the principles of accessibility, universality, and equity. In terms of waiting lists, this translates into ensuring universal and equitable access for all procedures based on patient need.

Research on patient factors related to waiting times for orthopaedic procedures is sparse. However, a few studies have found that surgeons do not necessarily bring patients with more severe symptoms or disabilities to the front of the waiting list (Coyte et al., 1994; Williams et al., 1997). A recent study, conducted in Ontario, Canada indicated that waiting time for both knee and hip replacement was unrelated to the severity of pain and difficulty in functioning as measured by the Western Ontario and McMaster Universities osteoarthritis index (WOMAC) (Coyte et al., 1994). The pre-operative assessment however, was based on patient interviews conducted within 1 - 6 months of surgery, and the post-operative assessment was taken between 12 to 18 months after surgery. Patients who were booked for surgery within 1 month of being placed on the waiting list, or after 6 months of being on the waiting list, were excluded from the study. Waiting time was established from the patient's estimate of how long they waited for their surgery. An assessment of pain and disability taken 6 months prior to surgery may differ greatly from an assessment taken only 1 month prior to surgery, and similarly, a post-operative assessment at 12 month after surgery may vary greatly from one conducted at 18 months post-operatively. Possible recall bias in patients' calculation of waiting time may also have influenced their findings.

The purpose of the present study was to determine the impact of pain, disability and overall health status on waiting time for total hip and knee replacement surgery in a regionally based universal and publicly funded system in Edmonton, Alberta, Canada.

2.2 Method

Patient Selection and Data Collection

The province of Alberta is divided into 17 health regions, each of which is managed by a single health board that oversees both acute care and community health programs. The Capital Health Region (CHR) is located in the northern part of the province, has a population of 723,000, and a referral area of 1.2 million people. Major surgeries such as hip and knee replacements are performed at only 2 of the 5 acute care hospitals within the CHR (Hamilton et al., 1997). In 1995, there were 24 orthopaedic surgeons in the region who performed all knee and hip replacements, with 19 of these surgeons accounting for 90% of major joint replacement surgeries.

Between the dates of December 18, 1995 and January 24, 1997, individuals living in the CHR who had been recommended by their orthopaedic surgeon for total knee or hip replacement surgery at either of the 2 referral hospitals, and were placed on the electronic CHR waiting lists for these procedures, became eligible for the study. All orthopaedic surgeons within the region were informed of the study and asked to inform their patients that a research assistant would be contacting them regarding participation in the study. As patients were entered onto the waiting list at either referral hospital, they were contacted by the research assistant, via telephone, and recruited for the study. If the patient declined to participate, they were not contacted again. If the patient agreed to participate, an appointment for a home visit was made to further explain the study, obtain written informed consent, and complete the self-administered questionnaire. Patients were advised that they could withdraw from the study at any time without giving a reason, and that withdrawal would not affect their present or future medical care. Inclusion criteria for the study included: residence within the CHR, a clear understanding of written English, and the ability to give informed consent. Patients who were undergoing revisions of hip or knee arthroplasties were excluded. Weekly extracts of the regional joint replacement database were conducted to capture new patients on the waiting list and to flag people for pre-operative measurement once the surgery date had been established. Some patients were retrospectively entered such that their waiting list date was too far in the past to allow a baseline measure within one month of that date. These patients were not included in the study to avoid any potential biases. The waiting time and demographic characteristics of these patients did not significantly differ from those patients included in the study. The data from the baseline interview were linked electronically with the CHR operating room data to determine prospectively when the patients were booked for and subsequently underwent total joint replacement surgery. The patient's diagnosis (generally either osteoarthritis or rheumatoid arthritis) was determined from the computerized hospital discharge abstract.

Health Status Measurement

Both disease-specific and general health status measurement tools were used in this study. The SF-36 is a widely used 36 item general health status questionnaire designed for persons 14 years or older, to be completed by self-administration, in-person interview or telephone interview (Ware et al., 1993). The items are grouped into 8 dimensions measuring; emotional role functioning, physical role functioning, physical functioning, mental health, vitality, general health perceptions, social functioning and bodily pain. The score for each dimension ranges from 0 to 100 with a high score representing the best health state. The instrument's reliability and validity has been extensively tested and is currently being used widely in health outcomes research (Ware et al., 1993; Brazier et al., 1992).

The WOMAC is a multi-dimensional self-administered health status instrument, capable of measuring clinically important and patient-relevant symptoms of osteoarthritis (Bellamy et al., 1988). It consists of 24 items, using a 5-point Likert scale, which are divided into 3 dimensions; pain, stiffness, functioning. Scores are derived by summing the items under each dimension; no global index is calculated. The score for each dimension ranges from 0 to 100 with a low score representing the best health state. The WOMAC's responsiveness, reliability and validity have been tested in the context of knee and hip arthroplasty and clinical trials for anti-inflammatory drugs Bellamy et al., 1988; Bellamy et al., 1988; Bellamy, 1989; Bellamy et al., 1991).

In addition to these health status measures, information pertaining to; previous major joint replacement, age, gender, height, weight, and chronic conditions was obtained from all subjects. Comorbidity was assessed using a 23-item list of chronic problems and conditions based on the Ontario Health Survey (Ontario Ministry of Health, 1992). Patients were asked to indicate if they were presently suffering from any of the conditions. The comorbidities were then summed to a score ranging from 0 to 23.

Data Analyses

Missing values for the SF-36 subscales were imputed with the mean values of the remaining items for the subscale, according to the SF-36 guidelines (Ware et al., 1993).

Univariate analysis was conducted to determine the association between the independent variables (age, gender, diagnosis, chronic conditions, body mass index (BMI), and the health status subscales) and the dependent variable, waiting time. Results were generated separately for hip and knee replacement patients, and then compared to determine if differences existed between these 2 groups of patients. Waiting time was categorised into 3 groups (< 3 months, 3 - 6 months, and > 6 months). The subscales for the health status instruments were categorised into 3 equal groups for descriptive purposes, similar to previous research in this area (Williams et al., 1997). The recoding for the WOMAC instrument was as follows: a score of < 33.33 was recoded as mild pain or stiffness, or good function; a score between 33.34 and 66.66 was recoded as moderate pain or stiffness, or fair function; and a score >66.66 was recoded as severe pain or stiffness, or poor function. For the SF-36 instrument the recoding was as follows: a score >66.66 was recoded as good (mild for bodily pain); a score between 33.34 and 66.66 was recoded as fair (moderate for bodily pain); and a score <33.33 was recoded as poor (severe for bodily pain). Differences in mean values of continuous variables were tested using t-tests or ANOVA (Kruskal-Wallis tests for non-parametric comparisons) and chi-square tests were used to test proportions.

Multivariate analysis was utilised to determine the independent impact of pain, disability and overall health status on waiting time for all patients in the sample. Stepwise and forced entry procedures in multiple linear regression were used, with waiting time as the dependent variable. A natural logarithmic transformation of waiting time was performed to adjust for its positive skewness. Independent variables considered in model development included; age, gender, previous major joint replacement, diagnosis (rheumatoid arthritis or osteoarthritis), BMI (kg/m^2), total number of chronic conditions, WOMAC subscales, and the SF-36 subscales. Since the relationship between waiting time and the continuous independent variables was not clearly evident, the independent variables were dichotomized for ease of interpretation in the regression analysis. Statistical analyses were performed using SPSS® software version 7.5. The statistical significance level for the univariate procedures was established at $p < 0.05$. When reporting summary statistics, the convention of mean (sd) was used.

2.3 Results

Patient Accrual

During the study time period, 1040 patients residing within the urban areas of the CHR were placed on the waiting list for major joint arthroplasty surgery. There were 293 patients who were excluded from the study because they were placed retrospectively on the CHR electronic waiting list, a month or later after they had been recommended for surgery and therefore a baseline measure could not be obtained within a month of the referral. Recruitment attempts (telephoning the patient for a maximum of three attempts at various times of the day and on different days) were made on the remaining 747 patients. Twenty patients did not speak English, and therefore were not eligible for the study. Of the eligible patients, there were 89 patients who refused to participate, 32 patients were unable to be contacted, and 11 patients had surgery before an initial home visit could be made. The aggregate participation rate was 82%.

The patients who were excluded from the study because of the delay in placement on the CHR waiting list, were found to be similar to the study group with regards to age, gender, affected joint and waiting time. The patients who did not participate in the study (refusals, unable to contact, surgery already performed) were found to be similar to the study group with respect to gender, affected joint, and waiting time, although non-participants tended to be younger (on the average they were about 3 years younger).

During the study period, 31 patients were placed on the waiting list for more than 1 major joint replacement. The second procedure was not included in the analyses.

Patient Characteristics

In total, there were 564 patients included in our study. Of these patients, 98% (553) had surgery during the study period – patients were followed for at least 1 year. The average age of the population was 68.4 years, ranging from 27 to 89 years, and 58% were female. Four hundred and seventy-four (94%) patients had osteoarthritis and 30 (6%) had rheumatoid arthritis or other arthropathies. Three hundred and four (55%) of major joint arthroplasties were total knee replacements and 249 (45%) were total hip replacements. One hundred and seventy (29%) had a previous joint replaced, of which 89 (51%) were hips and 81 (47%) were knees.

The average number of comorbidities the patients suffered at the time they were placed on the waiting list for surgery was 3.5, with the maximum number of comorbid conditions being 13. Thirty-five percent of patients had 2 comorbidities or less, 39% had between 3 and 4, and 26% had greater than 4 comorbidities. The average BMI was 28.7. Thirty-nine percent of patients had a normal BMI (≤26), 40% were overweight (BMI between 27 and 32), and 21% of patients were obese with a BMI of ≥ 33.

When comparing knee replacement patients with hip replacement patients, certain differences existed. Knee replacement patients were on average 2 years older than hip replacement patients (p=.002), and were heavier than hip replacement patients (p=.000) (mean BMI for knee patients was 29.4 and for hip patients was 27.7). No statistically significant differences were seen between the 2 groups in terms of gender or diagnosis.

Health Status

The mean WOMAC subscale scores were as follows: pain 56.6 (17.1); stiffness 60.7 (21.3); and function 59.4 (16.8). The mean SF-36 subscale scores were as follows: general health 58.8 (21.0); role physical 12.0 (24.7); social function 52.0 (28.5); role emotional 47.4 (44.8); vitality 41.0 (20.0); bodily pain 28.4 (17.0); physical functioning 20.7 (17.6); and mental health 66.9 (19.9). Again, when comparing hip replacement patients with knee replacement patients, some differences existed. Hip replacement patients had significantly poorer function, as measured by the WOMAC instrument, than the knee replacement patients – mean function scores for hip and knee replacement patients were 61.3 (15.8) and 58.0 (17.2) respectively (p=.04). No other statistically significant differences existed between the 2 groups of patients on the other WOMAC or the SF-36 subscales.

Waiting Time

The mean waiting time for major joint replacement was 107 (90 days). Overall, 52% of patients waited less than 3 months for their replacement surgery; 27% waited between 3 and 6 months, and 16% waited longer than 6 months.

On average, patients receiving a total knee replacement waited 9 days longer than patients receiving a total hip replacement (mean waiting time for hip replacement and knee replacement patients were 102 (89) days and 111 (89) days respectively), but this difference was not statistically significant.

Health Status and Waiting Time

Table 2.1 outlines the relationship between each of the demographic variables and waiting time separately for hip and knee replacement patients. No patterns in waiting time differences were observed with respect to age, gender, and the total number of chronic conditions for either group of patients. In the hip replacement population, patients with osteoarthritis waited an average of 34 days longer for surgery compared to patients with rheumatoid arthritis (p=.02). In the knee replacement population, there was a trend (p=.08) indicating that patients with a higher BMI waited longer for their surgery. Figures 2.1 and 2.2 show the mean WOMAC subscale scores for the three waiting time categories separately for hip and knee patients. For the hip replacement patients, there appeared to be a decline in the mean stiffness scores, indicating less stiffness with increased waiting time, but was not substantiated in the analysis (p=.09). No distinct patterns in waiting time were apparent with the other subscales. Table 2.2 describes the relationship between the WOMAC subscales and waiting time, after categorization. For the hip replacement patients, those with severe stiffness waited an average of 43 days longer for their surgery compared to patients with mild stiffness ($p=.09$). This pattern was not observed for the knee replacement patients, and no significant waiting time differences were detected for the other WOMAC subscales.

Figures 2.3 and 2.4 show the mean SF-36 subscale scores for the three waiting time categories. For the hip replacement patients, distinct increases in mean scores (indicating better functioning) for the bodily pain, role physical and social functioning subscales with increasing waiting time can be seen. Similarly, for the knee replacement patients, mean scores for the social function subscale appeared to increase with longer waiting times. Tables 2.3 and 2.4 outline the relationship between each of the SF-36 subscales and waiting time (after categorization) separately for hip and knee replacement patients. For hip replacement patients (Table 2.3), patients with high scores on the bodily pain, role physical and social function subscales, which is interpreted as better functioning, waited significantly longer for their replacement surgery (all with p values $<.05$). Patients who scored good on the role physical subscale waited an average of 85 days longer for their surgery ($p=.02$), in comparison with patients who scored poor. Patients with poor social functioning waited an average of 57 days less for their surgery than patients with good social functioning ($p=.002$). Although shown to be statistically significant, no clear trends in waiting time were observed with the vitality, mental health or role emotional subscales. For the knee replacement group (Table 2.4), patients with poor social functioning waited an average of 39 days less for their surgery compared to those with good functioning ($p=.06$).

Multiple linear regression was performed using age, gender, joint, diagnosis, previous replacement, total chronic conditions, BMI and the WOMAC and SF-36 subscales as independent variables. The forced entry regression model yielded poor social function (SF-36) ($b=-.253$; $p=.048$), and obesity ($b=.241$; $p=.020$) as the only significant predictors of waiting time. Patients with fair social function (SF-36) ($b=-.07$; $p=.50$) and overweight patients ($b=.12$; $p=.15$) were not significant predictors of waiting time. The amount of explained variance in waiting time that was explained by this model was 4%. A stepwise regression was also generated, and then refined to include only those variables that were statistically significant. This yielded the same significant variables with similar coefficients.

For interpretation of the regression coefficients in a model with a transformed dependent variable, the coefficients were then exponentiated. The final model suggests that persons with poor social function waited .77 times as long for their surgery than persons with good social functioning. Obese persons waited 1.3 times longer than persons of normal weight.

2.4 Discussion

Waiting time for major joint replacement surgery in the Edmonton region was, on average, 3.8 months, comparable to previous Canadian studies from the province of Ontario (Coyte et al., 1994; Williams et al., 1997). Previous research has also indicated that this waiting period is acceptable to approximately 85% of the orthopedic population (Coyte et al., 1994). Interestingly, patients in our population appeared to be suffering with more pain and disability than patients in the previously cited study (Williams et al., 1997).

In the present study waiting time was an exact calculation, taken directly from the hospital databases, and therefore not subject to recall bias as in previous studies. Further strengths include the population-based sampling frame, adequate participation rate, and analyses indicating that the participants and non-participants were similar with respect to gender, affected joint and waiting time. Even though the non-participants were significantly younger than the study group, most likely because they were working and were more difficult to contact, they had equivalent waiting times. Therefore, it is unlikely that either selection bias or response bias influenced our findings. This study did not include persons residing outside the region who had a major joint arthroplasty performed at either of these 2 referral hospitals. The results of the study should be generalizable to urban populations only, as rural patients may differ with respect to the level of pain and function they experience at the time they are placed on the waiting list (Visuri & Honkanen, 1982). In regards to patient demographics, no inequities in waiting time were apparent with respect to the patient's age, gender, diagnosis, or comorbidity. This is similar to findings of previous research (Coyte et al., 1994; Williams et al., 1997; Gabriel et al., 1994). However, for patients waiting for knee replacement surgery, a trend was seen indicating that waiting time increased as patient's BMI increased. Multivariate analyses for all patients also indicated that BMI was a significant predictor of waiting, while controlling for other demographic and health status variables. This finding is not surprising considering the fact that many orthopaedic surgeons encourage overweight patients to lose weight prior to surgery. Excessive body weight that a patient carries puts additional force on the prosthetic joint, which may create instability, or wear of the prosthesis, and therefore reduce the chances of a successful result.

When considering the physical components of health status, as measured by the WOMAC and SF-36 instruments, certain patterns in waiting time emerged. For patients waiting for total hip arthroplasties, a trend was seen in the univariate analyses suggesting that patients experiencing severe stiffness waited less time for their surgery, compared to those patients with mild stiffness. This tendency was also seen with the SF-36 subscales that focus on pain, and function (bodily pain, role physical, and physical functioning). The magnitude of the differences however was small. The mean bodily pain scores increased from 24.2 in patients waiting less than 3 months to 32.6 in patients waiting more than 6 months, the mean role physical scores increased from 6.8 to 16.9 respectively, and the mean physical functioning scores increased from 18.2 to 24.0. Patients who scored good or fair scores in these subscales had longer waiting times. However, these patients constituted a small group, and only had minor impact on the overall waiting time, as seen when categorized into waits of <3, 3-6, and >6 months. Multivariate analyses accounting for the combined effects of the other variables on waiting time, did not find pain and disability as significant predictors of waiting time for either knee or hip arthroplasty, when controlling for age, gender, diagnosis, affected joint, previous replacement, total number of chronic conditions, and health status. The model only explained 4% of the total variance in waiting time. Our findings indicate that there is minimal impact of pain and disability and overall health status on waiting time for total hip and knee replacement surgery.

Although equity based on patient need should be a key factor in determining where patients are placed on the waiting list, when one considers the patient as a whole, those with more severe pain and disability did not have surgery substantially earlier. As previously mentioned, surgeons do not have a valid and reliable measurement of the patient's pain, disability, and overall health -- that is necessary to judge the urgency of major joint arthroplasty. An accurate estimate of the burden of suffering, uniformly applied by all orthopaedic surgeons in the region, could improve the equity of waiting lists. Although, the health status measurement instruments utilised in this study have been used solely for research purposes in the past, their application to waiting list management could prove to be beneficial.

In the hip replacement patient group, patients with poor social functioning had surgery earlier. Multivariate analyses of the entire study sample also identified social function as significantly impacting waiting time -- those with poor social function waited significantly less time for their surgery. This relationship has not been established in previous work, and could perhaps represent random variation in a large sample study. However, in our present society, with dispersed extended family units, and more elderly people living on there own, daily needs of those suffering from arthritis may be difficult to meet. Moreover, social interaction remains an important part of people's lives. If an elderly person is not able to tend to his/her groceries, errands, and socialising with family and friends, this can become an overwhelming burden. In fact, this burden may be perceived as being greater than the amount of pain or stiffness they are experiencing.

2.5 <u>Conclusion</u>

This study's major finding was that BMI and social functioning were significantly related to waiting time, but these variables accounted for only a very small proportion of waiting time variability. Since only a small portion of waiting time can be predicted by variables analysed in this study, none of which were related to patients' pain and disability, further research is necessary to determine what other factors relate to waiting time for major joint replacement surgery. It is also suggested that patients' burden of suffering be assessed using a standard protocol, to ensure an equitable waiting list system that is based on patient need.

Table 2.1: Demographic variables and waiting time for hip and knee replacement patients

	Knee						Hip					
	Total (n=249)	Waiting Time (days) Mean (sd)	P Value	< 3 Months (n=154)	3 - 6 Months (n=90)	>6 Months (n=60)	Total (n=304)	Waiting Time (days) Mean(sd)	P value	< 3 Months (n=150)	3 - 6 Months (n=64)	>6 Months (n=35)
Age –yrs. (mean±sd)				69.7(9.3)	69.7(9.8)	67.8(7.9)				67.8±12.2	66.5±12.0	63.5±12.6
< 55	21	113(76)	>.20	8(38%)	9(43%)	4(19%)	40	98(76)	.04*	24(60%)	10(25%)	6(15%)
55-64	71	110(100)		42(59%)	13(18%)	16(23%)	53	129(106)†		25(47%)	17(32%)	11(34%)
65-75	125	117(90)		58(46%)	37(30%)	30(24%)	84	104(100)		51(61%)	19(23%)	14(17%)
≥ 75	87	103(82)		46(53%)	31(36%)	10(11%)	71	82(64)†		49(69%)	18(25%)	4(6%)
Gender												
Male	123	110(86)	>.20	63(51%)	34(28%)	26(21%)	104	102(78)	>.20	64(61%)	25(24%)	15(14%)
Female	181	112(91)		91(50%)	56(31%)	34(19%)	145	102(97)		86(59%)	39(27%)	20(14%)
Diagnosis												
OA	271	111(88)	>.20	136(50%)	83(31%)	52(19%)	216	99(81)	.02	125(60%)	58(27%)	28(13%)
RA	18	107(82)		9(50%)	6(33%)	3(17%)	13	65(81)		11(85%)	1(8%)	1(8%)
Comorbidities (mean±sd)				3.6(2.1)	3.7(2.2)	3.5(1.8)				3.3±2.2	3.7±2.0	2.8±2.6
≤ 2	99	105(86)	>.20	50(51%)	30(30%)	19(19%)	96	111(106)	>.20	59(61%)	18(19%)	19(20%)
3-4	125	121(101)		61(49%)	35(28%)	29(23%)	89	100(79)		51(57%)	28(31%)	10(11%)
> 4	80	102(70)		43(54%)	25(31%)	12(15%)	64	92(75)		40(63%)	18(28%)	6(9%)
BMI (mean ±sd)				28.8(4.9)	29.9(6.4)	30.9(5.6)				27.4±4.7	27.8±5.1	28.9±6.5
≤ 26	93	95(74)	.08	51(55%)	30(32%)	12(13%)	104	99(98)	>.20	63(61%)	28(27%)	13(13%)
27-32	120	117(95)		62(52%)	30(25%)	28(23%)	79	100(83)		48(61%)	22(28%)	9(11%)
> 32	66	128(90)		27(41%)	22(33%)	17(26%)	39	112(91)		22(56%)	8(21%)	9(23%)

* P < 0.05; † category of patients that was responsible for the significance.

Table 2.2: WOMAC and waiting time for hip and knee replacement patients

Hip	Total (n=249)	Waiting Time (days) Mean (sd)	P Value	< 3 Months (n=150)	3 - 6 Months (n=64)	> 6 Months (n=35)
WOMAC – Pain						
Mild	17	78 (62)	.12	12 (71%)	4 (24%)	1 (6%)
Moderate	169	110 (95)		97 (57%)	44 (26%)	28 (17%)
Severe	56	88 (81)		37 (66%)	14 (25%)	5 (9%)
WOMAC – Stiffness						
Mild	25	135 (112)	.09	12 (48%)	7 (28%)	6 (24%)
Moderate	130	102 (85)		77 (59%)	36 (28%)	17 (13%)
Severe	94	92 (88)		61 (65%)	21 (22%)	12 (13%)
WOMAC – Function						
Good	10	109 (37)	.13	4 (40%)	6 (60%)	0
Fair	139	108 (96)		80 (58%)	37 (27%)	22 (16%)
Poor	74	88 (70)		50 (68%)	15 (20%)	9 (12%)
Knee	**Total (n=304)**	**Waiting Time (days) Mean (sd)**	**P Value**	**< 3 Months (n=154)**	**3 - 6 Months (n=90)**	**> 6 Months (n=60)**
WOMAC – Pain						
Mild	28	152 (112)	.05	9 (32%)	10 (36%)	9 (32%)
Moderate	191	106 (86)		102 (53%)	52 (27%)	37 (19%)
Severe	78	110 (84)		39 (50%)	26 (33%)	13 (19%)
WOMAC – Stiffness						
Mild	28	116 (93)	>.20	11 (39%)	13 (46%)	7 (25%)
Moderate	170	109 (92)		87 (51%)	47 (28%)	36 (21%)
Severe	105	114 (85)		55 (52%)	30 (29%)	20 (19%)
WOMAC – Function						
Good	29	148 (117)	.17	9 (31%)	11 (38%)	9 (31%)
Fair	169	109 (90)		88 (52%)	47 (29%)	34 (20%)
Poor	81	106 (78)		43 (53%)	26 (32%)	12 (15%)

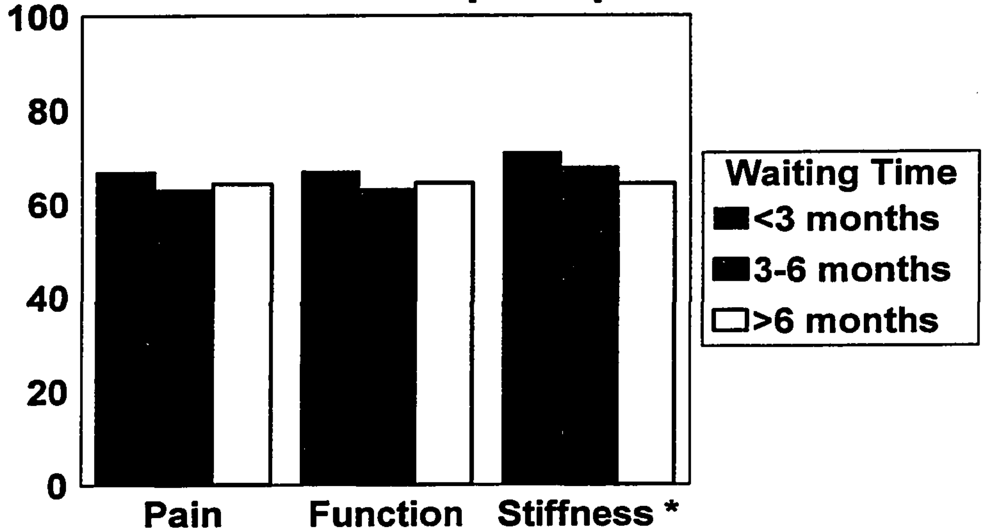
Table 2.3: SF–36 and waiting time for hip replacement patients

Hip	Total (n=249)	Waiting Time (days) Mean (sd)	P Value	< 3 Months (n=150)	3 - 6 Months (n=64)	> 6 Months (n=35)
Bodily Pain						
Mild	2	216 (67)	.008	0	1 (50%)	1 (50%)
Moderate	65	128 (115)		32 (49%)	20 (31%)	13 (20%)
Severe	182	91 (76)		118 (65%)	43 (24%)	21 (12%)
Role Physical						
Good	11	181 (165)	.02	3 (75%)	6 (55%)	2 (18%)
Fair	14	133 (98)		6 (43%)	4 (29%)	4 (29%)
Poor	224	96 (82)		141 (63%)	54 (24%)	29 (13%)
Physical Functioning						
Good	4	85 (57)	.08	3 (75%)	1 (25%)	0
Fair	51	128 (114)		27 (53%)	14 (27%)	10 (20%)
Poor	194	85 (82)		120 (62%)	49 (25%)	25 (13%)
General Health						
Good	105	108 (92)	>.20	57 (54%)	32 (30%)	16 (15%)
Fair	111	98 (86)		71 (64%)	25 (23%)	15 (14%)
Poor	33	96 (96)		22 (67%)	7 (21%)	4 (12%)
Vitality						
Good	19	80 (71)	.0006	15 (79%)	3 (16%)	1 (5%)
Fair	147	116 (93)		75 (50%)	46 (31%)	26 (18%)
Poor	83	83 (83)		60 (72%)	15 (18%)	8 (10%)
Mental Health						
Good	135	113 (90)	.01	71 (53%)	40 (30%)	24 (18%)
Fair	96	83 (79)		68 (71%)	21 (22%)	7 (7%)
Poor	18	119 (122)		11 (61%)	3 (17%)	4 (22%)
Role Emotional						
Good	111	110 (94)	.011	59 (53%)	36 (32%)	16 (14%)
Fair	29	132 (125)		19 (66%)	2 (7%)	8 (28%)
Poor	104	87 (70)		67 (64%)	26 (25%)	11 (1%)
Social Function						
Good	65	135 (111)	.002	28 (43%)	22 (34%)	15 (23%)
Fair	117	98 (83)		75 (64%)	26 (22%)	16 (14%)
Poor	66	78 (65)		46 (70%)	16 (24%)	4 (6%)

Table 2.4: SF–36 and waiting time for knee replacement patients

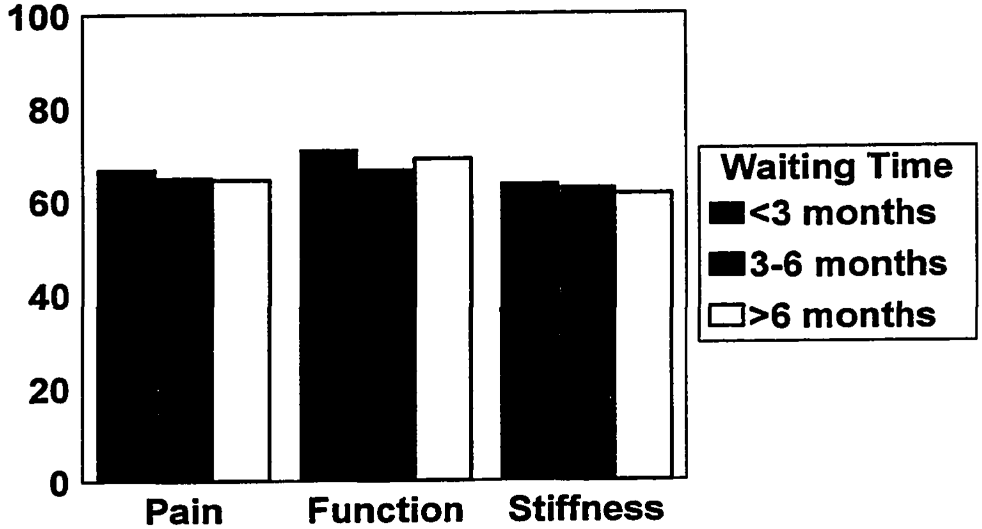
Knee	Total (n=304)	Waiting Time (days) Mean (sd)	P Value	<3 Months (n=154)	3 - 6 Months (n=90)	>6 Months (n=60)
Bodily Pain						
Mild	9	75 (48)	>.20	5 (55%)	4 (45%)	0
Moderate	86	126 (102)		38 (44%)	27 (31%)	21 (24%)
Severe	209	107 (84)		111 (54%)	59 (29%)	39 (19%)
Role Physical						
Good	25	110 (98)	>.20	12 (48%)	8 (32%)	5 (20%)
Fair	16	107 (83)		10 (63%)	2 (13%)	4 (25%)
Poor	263	111 (89)		132 (50%)	80 (30%)	51 (19%)
Physical Functioning						
Good	10	120 (110)	.10	7 (70%)	0	3 (30%)
Fair	40	138 (108)		16 (40%)	12 (30%)	12 (30%)
Poor	254	106 (84)		131 (52%)	78 (31%)	45 (18%)
General Health						
Good	116	117 (96)	>.20	54 (47%)	32 (28%)	30 (26%)
Fair	157	106 (84)		84 (54%)	51 (32%)	22 (14%)
Poor	31	114 (88)		16 (52%)	7 (23%)	8 (26%)
Vitality						
Good	37	147 (119)	.07	15 (41%)	10 (27%)	12 (32%)
Fair	163	112 (88)		78 (48%)	54 (33%)	31 (19%)
Poor	104	96 (74)		61 (59%)	26 (25%)	17 (16%)
Mental Health						
Good	170	119 (96)	.13	80 (47%)	51 (30%)	39 (23%)
Fair	116	104 (80)		60 (52%)	36 (31%)	20 (17%)
Poor	17	75 (63)		13 (76%)	3 (18%)	1 (6%)
Role Emotional						
Good	136	118 (97)	>.20	65 (48%)	38 (28%)	33 (24%)
Fair	48	110 (92)		20 (42%)	18 (38%)	10 (21%)
Poor	116	105 (78)		66 (57%)	33 (28%)	17 (15%)
Social Function						
Good	84	133 (109)	.06	48 (57%)	26 (31%)	24 (29%)
Fair	144	107 (80)		72 (50%)	45 (31%)	27 (19%)
Poor	76	94 (77)		34 945%)	19 (25%)	9 (12%)

Figure 2.1: WOMAC subscale scores for hip replacement



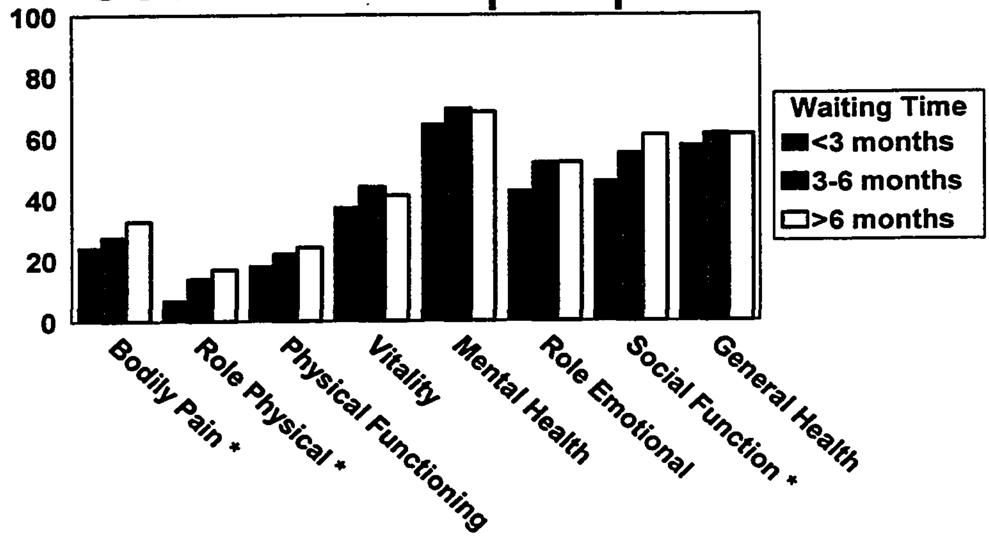
* = p<.05

Figure 2.2: WOMAC subscale scores for knee replacement



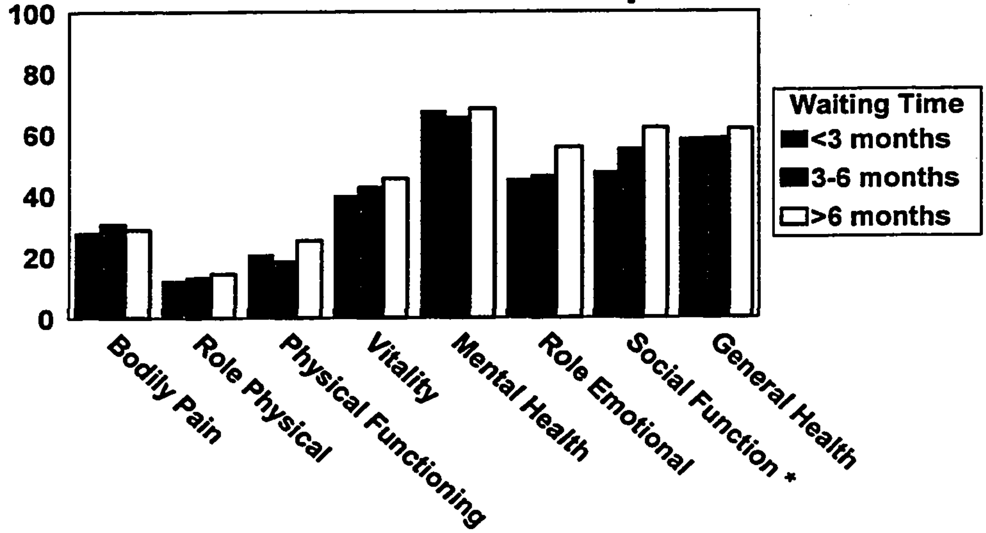
* = p<.05

Figure 2.3: SF-36 subscale scores for hip replacement



* = p<.05

Figure 2.4: SF-36 subscale scores for knee replacement



* = p<.05

2.6 References

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988). Validation study of the WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. The Journal of Rheumatology, 15, 1833-1840.

Bellamy N. Buchanan WW, Goldsmith CH, Campbell J, Stitt L.(1988). Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. Journal of Orthopaedic Rheumatology, 1, 95-108.

Bellamy, N. (1989). Pain assessment in osteoarthritis: experience with the WOMAC osteoarthritis index. Semin Arthritis Rheum, 18(Suppl 2), 14-17.

Bellamy, N., Wells, G., & Campbell, J. (1991). Relationship between severity and clinical importance of symptoms in osteoarthitis. Clinical Rheumatology, 10(2), 138-143.

Brazier, J. E., Harper, R., Jones, N. M. B., O'Cathain, A., Thomas, K. J., Usherwood, t., & Westlake, L. (1992). Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ, 305, 160-164.

Coyte, P. C., Wright, J. G., Hawker, G. A., Bombardier, C., Dittus, R. S., Paul, J. E., Freund, D. A., & Ho, E. (1994). Waiting times for knee-replacement surgery in the United States and Ontario [see comments]. New England Journal of Medicine, 331(16), 1068-1071.

Gabriel SE, Wenger DE, Ilstrup DM, Lewallen DG, Melton LJ. (1994). Lack of evidence for gender bias in the utilization of total hip arthroplasty among Olmsted County, Minnesota residents with osteoarthritis. Arthritis Rheum,37(8), 1171-1176.

Hamilton SM, Letourneau S, Pekeles E, Voaklander D, Johnston DWC. (1997). The impact of regionalization on a surgery program in the Canadian health care system. Arch Surg,132, 605-610.

Madhok, R., Lewallen, D. G., Wallrichs, S. L., Ilstrup, D. M., Kurkland, R. L., & Melton, L. J. (1993). Trends in the utilization of primary total hip arthroplasty, 1969 through 1990: a population-based study in Olmstead County, Minnesota. Mayo Clin Proc, 68, 11-18.

Ontario Ministry of Health. (1990). Ontario Health Survey, User's Guide Volume 1, Documentation. Ministry of Health, Toronto, Ontario.

Quam, J. P., Michet, C., Wilson, M. G., Rand, J. A., Ilstrup, D. M., Melton, L. J., & Wallrichs, S. L. (1991). Total knee arthroplasty. Mayo Clin Proc, 66, 589-595.

Visuri, T., Honkanen, R. (1982). The role of socio-economic status and place of residence in total hip replacement. Scand J Soc Med, 10, (95-99).

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). SF-36 Health Survey: Manual and Interpretation Guide. Boston,Mass. Nimrod Press.

Williams, J. I., Llewellyn Thomas, H., Arshinoff, R., Young, N., & Naylor, C. D. (1997). The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. Journal of Evaluation in Clinical Practice, 3(1), 59-68.

CHAPTER 3

EQUITY IN WAITING LISTS FOR MAJOR JOINT ARTHROPLASTY

3.1 Introduction

The Canadian health care system is publicly funded, and based on universal and equitable access for all procedures. In terms of waiting lists, this translates into ensuring universal and equitable access for all procedures based on patient need. In a well-organized health care system, waiting lists should not include people for whom there is the potential that their health will deteriorate rapidly while they wait for surgery. Nor should people who would benefit very little with early treatment get precedence over people for whom the benefit of earlier treatment is quite large (Gudex et al., 1990). Furthermore, people should not be discriminated against because of social or economic factors. Research in the area of equity in waiting lists is limited, and in a universal health system, where social equity is of concern, further research is necessary to monitor the quality of waiting lists for major joint replacement surgery.

At present thousands of Canadians are on waiting lists for either total hip or total knee replacement surgery. Hip and knee replacements are usually elective procedures, and Canadian hospitals determine the number of prostheses they purchase and allocate operating times to surgeons. Generally, waiting lists are managed by individual orthopedic surgeons based on their assessment of the urgency of clinical need. However, research has shown that there is considerable diversity among surgeons regarding the indications for this type of surgery (Tierney et al., 1994; Wright et al., 1995; Mancuso et al., 1996). It appears that the current management of waiting lists are not rationalized (across lists) with respect to the burden of symptoms of those awaiting surgery. (Coyte et al., 1994; Williams et al., 1997; Kelly et al., 1998). Inequities in waiting time can also result from the combination of varying lengths in surgeon's waiting lists and their allocated operating time. This study is a extension of a previously published study (Kelly et al., 1998), in which we examined the impact of health status on waiting time for major joint arthroplasty and discovered that the association between health status and waiting time was small. We concluded that since only a small portion of waiting time can be predicted by the variables analyzed in the study, none of which were related to patients' pain and disability, further research was necessary to determine what other factors relate to waiting time for major joint arthroplasty. The purpose of the present study was to examine patients' socio-demographic factors, along with clinical and health systems variables, to ascertain whether waiting lists were managed in a socially equitable fashion.

3.1 Method

Patient Selection and Data Collection

The province of Alberta is divided into 17 health regions, each of which is managed by a single health board that oversees both acute care and community health programs. The Capital Health Region (CHR) is located in the northern part of the province, and has a population of approximately 723,000, and a referral area of 1.2

million people. Major surgery, such as hip and knee replacements, are performed at only two of the five acute care hospitals within the CHR (Hamilton et al., 1997). In 1995, there were 24 orthopaedic surgeons in the region who performed all the knee and hip replacements, with 19 of these surgeons accounting for 90% of major joint replacement surgeries.

Between the dates of December 18, 1995 and January 24, 1997, a consecutive sample of patients living in the Edmonton region, and who had been recommended by their orthopaedic surgeon for total knee or hip replacement surgery at either of the 2 referral hospitals were eligible for the study. All orthopaedic surgeons within the region were informed of the study and asked to inform their patients that a research assistant would be contacting them regarding participation in the study. As patients were entered onto the waiting list at either referral hospital, they were contacted by the research assistant, via telephone, and recruited for the study. If the patient declined to participate, they were not contacted again. If the patient agreed to participate, an appointment for a home visit was made to further explain the study, obtain written informed consent, and complete the self-administered questionnaire. Patients were advised that they could withdraw from the study at any time without giving a reason, and withdrawal would not affect their present or future medical care. Inclusion criteria for the study were: residence within the CHR, a clear understanding of written English, and the ability to give informed consent. Patients who were undergoing revisions of hip or knee arthroplasties were excluded. In some instances, patients were retrospectively entered onto the waiting list, such that their waiting list date was too far in the past to allow a baseline measure within one month of that date. These patients were not included in the study. Weekly extracts of the regional joint replacement database were conducted to capture new patients on the waiting list and to flag people for pre-operative measurement once the surgery date had been established. Data from the baseline interview were linked electronically with the CHR operating room records to determine prospectively when the patients were booked for and subsequently underwent total joint replacement surgery. Patients were followed for a minimum of one year to ascertain their surgery date. The patient's diagnosis (generally either osteoarthritis or rheumatoid arthritis) was determined from the computerised hospital discharge abstract.

Socio-demographic and clinical variables

The following socio-demographic information was collected from all patients when they were initially placed on the waiting list: age, gender, marital status (married or unmarried), primary language (English, French, or other), education, and work status. Information pertaining to the patient's formal education was collected as a measure of their socio-economic status, and work status data was obtained to ascertain whether the obligation of returning to work affected the patients' waiting time for surgery. Information on certain clinical variables were also obtained at baseline, and included: diagnosis (rheumatoid arthritis or osteoarthritis), affected joint (knee or hip), previous arthroplasty, body mass index, walking aids, residence type (apartment, condominium, house, and senior's complex), health status, comorbidies, and pain medication use.

Both disease-specific and general health status measurement tools were used to measure health status. The SF-36 is a widely used 36 item general health status questionnaire, with the items grouped into 8 dimensions measuring; emotional role functioning, physical role functioning, physical functioning, mental health, vitality, general health perceptions, social functioning and bodily pain. The score for each dimension ranges from 0 to 100, with a high score representing the best health state. The instrument's reliability and validity has been extensively tested (Brazier et al., 1992; Ware, 1993).

The WOMAC is a multi-dimensional self-administered questionnaire that was designed specifically for patients with osteoarthritis. It consists of 24 items that are divided into 3 dimensions; pain, stiffness, and functioning. The score for each dimension ranges from 0 to 100, with a low score representing the best health state. The WOMAC's responsiveness, reliability and validity have been tested with patients suffering from arthritis of the hip and knee (Bellamy et al., 1988a; Bellamy et al., 1988b; Bellamy et al., 1989; Bellamy et al., 1991).

Comorbidity was assessed using a 23 item list of chronic problems and conditions based on the Ontario Health Survey (Charlson et al., 1987; Greenfield et al., 1993; Charlson et al., 1994). Patients were asked to indicate if they were presently suffering from any of the conditions. The comorbidities were then summed to a score ranging from 0 to 23.

Patient's pain medication use was measured using the Medication Quantification Score (MQS), which provides a method for quantifying medication use for patients with chronic and non-malignant pain. Each pain-related medication is given a score that is based on both the daily dosage and pharmacological classification of that medication. For a given medication, the detriment weight is multiplied by the dosage level to yield a MQS. For a individual patient, the MQS for each medication is calculated and then summed to yield the total MQS for that patient. The index score can be used for clinical assessment of individual patients and for statistical comparison of patient groups. The MQS has demonstrated good concurrent validity, in that there is relatively high correlation between total MQSs and the mean clinical judgement of health professionals who are knowledgeable about pain medications (Masters-Steedman et al., 1992).

Generally, a MQS score of 1-3 is the result of either a nonsteroidal antiinflammatory drug taken in quantities that are less than the low therapeutic dose, or acetaminophen taken is low doses. A MQS score of 4-6 usually occurs when a patient is taking non-steroidal anti-inflammatory drugs in low to high therapeutic doses, or weak narcotics taken less than the low therapeutic dose. A score of ≥ 7 results when a combination of the above scenarios occur, or when the patient requires a higher dose of narcotics.

Information regarding the patient's orthopedic surgeon, and surgical site was also obtained.

Data Analyses

Missing values for the SF-36 subscales were imputed with the mean values of the remaining items for the subscale, according to the SF-36 guidelines (Ware et al., 1993).

Univariate analysis was conducted to determine the association between the independent variables (age, gender, body mass index (BMI), language spoken, education, marital status, work status, walking aids, type of residence, MQS, diagnosis, affected joint, previous replacement, chronic conditions, WOMAC and SF-36 subscales, referral hospital and orthopedic surgeon) and the dependent variable - waiting time.

Age was categorized into 4 groups (<55, 55-64.9, 65-74.9, and ≥ 75 years). Education was ranked as ≤ grade 8, partial High School, completed High School, partial Technical School or University, completed Technical School, and completed University.

Body mass index was grouped into three levels (≤ 26, 27-32 and > 32), and the number of comorbidies were classified as; ≤ 2, 3-4, and >4. The subscales for the health status instruments were categorised into 3 equal groups for descriptive purposes, similar to previous research in this area (Williams et al., 1997). The recoding for the WOMAC instrument was as follows: a score of < 33.33 was recoded as mild pain or stiffness, or good function; a score between 33.34 and 66.66 was recoded as moderate pain or stiffness, or fair function; and a score >66.66 was recoded as severe pain or stiffness, or poor function. For the SF-36 instrument the recoding was as follows: a score >66.66 was recoded as good (mild for bodily pain); a score between 33.34 and 66.66 was recoded as fair (moderate for bodily pain); and a score <33.33 was recoded as poor (severe for bodily pain).

Differences in mean values of continuous variables were tested with either t-tests or ANOVA (Kruskal-Wallis tests were used for non-parametric comparisons) and chi-square tests were used to test proportions. Multivariate analysis was utilized to determine the relationship between the independent variables on waiting time. Stepwise and enter procedures in multiple linear regression were used, with waiting time as the dependent variable. A natural logarithmic transformation was performed on waiting time to adjust for its positive skewness. Independent variables considered in model development were the same as those analyzed univariately. Since the relationship between waiting time and the continuous independent variables was not clearly evident, the independent variables were dichotomized for ease of interpretation in the regression analysis.

Statistical analyses were performed using SPSS® software version 7.5. The statistical significance level for the univariate procedures was established at $p < 0.05$. When reporting summary statistics, the convention of mean(sd) was used.

3.3 Results

Patient Accrual

During the study period, 1040 patients residing within the urban areas of the CHR were placed on the waiting list for major joint arthroplasty surgery. There were 293 patients who were excluded from the study because a baseline measure could not be obtained within 1 month of the patient being placed on the waiting list. Recruitment attempts (telephoning the patient for a maximum of three attempts at various times of the day and on different days) were made on the remaining 747 patients. Twenty patients did not speak English, and therefore were not eligible for the study. Of the eligible patients, there were 89 patients who refused to participate, 32 patients were unable to be contacted, and 11 patients had surgery before an initial home visit could be made. The aggregate participation rate was 82%.

The patients who were excluded from the study (did not meet inclusion criteria) were found to be similar to the study group with regards to age, gender, affected joint and waiting time. The patients who did not participate in the study (refusals, unable to contact, surgery already performed) were found to be similar to the study group with respect to gender, affected joint, and waiting time. However, patients who did not participate were significantly younger (p=.03) than the participants (mean age for non-participants = 65.5(13.2) years; mean age for participants = 68.3(10.8) years).

During the study period, 31 patients were placed on the waiting list for more than 1 major joint replacement. The second procedure was not included in the analyses.

Patient Characteristics

In total, there were 564 patients included in our study. Of these patients, 98% (553) had surgery during the study period.

The average age of the population was 68.4 years, and ranged from 27 to 89 years. Fifty-nine percent of the study sample was female, and 63% of patients were married. Seventy-five percent of the sample reported English as their first language, 3% reported French, and 22% reported that their first language was other than French or English.

Forty-two percent of patients did not complete high school, and 27% had completed post-secondary education. At the time of the study, 58% of patients were retired, 27% stated they were homemakers, 9% were working full time, and 5% were working part time. Sixty-nine percent of patients lived in a house, 26% of patients lived in an apartment or condominium, and 6% lived in a senior's complex.

The breakdown of patients according to their primary diagnosis was: (94%) osteoarthritis; and (6%) rheumatoid arthritis or other arthropathies. Fifty-five percent of major joint arthroplasties were total knee replacements and 44% were total hip replacements. Thirty percent of patients had a previous joint replaced, of which 51% were hips and 47% were knees. The average BMI for the patient population was 28.7, and 60% of the population were either overweight (BMI between 27 and 32) or obese (BMI ≥ 33). The average number of comorbidities the patients suffered at the time they were placed on the waiting list for surgery was 3.5 with the maximum number of comorbid conditions being 13.

Pain and Disability

At the time the patients were placed on the waiting list, 33% stated they ambulated without any assistive devices, 54% used a cane, and 10% used a walker. In terms of pain medications taken by patients, 17% stated that they did not take any medications at the time they were placed on the waiting list, 29% had a MQS score of 1-3, 24% of patients had MQS scores of ≥ 7, and the rest had scores between 4 and 7.

The mean pain and disability scores at the time the patients were placed on the waiting list, were measured with the WOMAC and SF-36 health status instruments. The mean WOMAC subscale scores were: pain 56.6(17.1); stiffness 60.7(21.3); and function 59.4(16.8). The mean SF-36 subscale scores were as follows: general health 58.8(21.0); role physical 12.0(24.7); social function 52.0(28.5); role emotional 47.4(44.8); vitality 41.0(20.0); bodily pain 28.4(17.0); physical functioning 20.7(17.6); and mental health 66.9(19.9).

Patient Characteristics and Waiting Time

The mean waiting time for major joint replacement was 107(90) days. Overall, 52% of patients waited less than 3 months for their replacement surgery; 27% waited between three and 6 months, and 16% waited longer than 6 months.

Tables 3-1 and 3-2 describe the relationship between the demographic and clinical characteristics of the patient population and the length of time they waited for their surgery. As can be seen in Table 3-1, no significant differences in waiting time were observed for the various categories of the demographic variables - age, gender, marital status, education, work status, and residence type. However, patients who spoke other than English or French waited, on average, 18 days less for their surgery (p=.02). Table 3-2 outlines the univariate relationship between the clinical variables and waiting time. No significant differences in waiting time were identified among the various categories of: diagnosis, affected joint, previous arthroplasty, total number of chronic conditions, walking aids, and MQS. However, patients with a BMI >32 waited on average 24 days longer for their surgery, compared to patients with a BMI ≤ 26 (p=.04).

The relationship between the health status at the time the patients were placed on the waiting list and waiting time, are outlined in Tables 3-3 and 3-4. Patients with poor function on the WOMAC instrument (Table 3-3) waited on average 40 days less for their surgery than patients with good function (p=.04). No significant relationships between waiting time and pain and stiffness were detected. When health status was measured with the SF-36 instrument, a few significant trends in waiting times for the subscale categories were apparent (Table 3-4). Patients who scored poor on the vitality subscale waited on average 21 days less for their surgery than patients who scored in the good category (p=.002). And, patients with poor social function waited on average 47 days less for their surgery than patients with good social function (p<.001). Although shown to be statistically significant, no clear trends in waiting times were observed with the bodily pain, physical function, and mental health subscales.

Hospital and Surgeon Characteristics and Waiting Time

There was an even distribution of major joint arthroplasties performed at the two referral hospitals – 55% of patients had their surgery performed at one hospital, and 45% had their surgery at the other referral hospital. The waiting times for surgery were also found to be similar for the two hospitals: 103.8(86.2) and 110.0(94.2) (p=.39).

Seventy-nine percent of patients were referred to orthopedic surgeons who performed more than 50 major arthroplasties during 1996/97, and 5% were seen by surgeons who performed less than 25 such surgeries that year. Table 3-5 outlines the relationship between the orthopedic surgeon's practice characteristics and the length of time their patients waited for surgery. On average, patients who were seen by surgeons with a small major joint arthroplasty practice (< 25 major joint arthroplasties per year) waited 56 days less for their surgery than patients seen by surgeons with larger major joint arthroplasty practices (p<.001).

Table 3-6 outlines the univariate relationship between patients' characteristics and their orthopedic surgeon's clinical practice. As can be seen in the table, patients undergoing knee replacements, saw orthopedic surgeons who performed fewer arthroplasties more often than did hip replacement patients. Seven percent of knee replacement patients and 2% of hip replacement patients were seen by surgeons who performed less than 25 arthroplasties per year (p=.02). The table also indicates that patients who were referred to surgeons that performed fewer major arthroplasties per year, had fewer comorbidities (p=.01), but the difference in the mean number of comorbidities was small.

Multivariate Analyses

A multiple linear stepwise regression procedure was performed using the demographic, clinical and health system variables that were analyzed univariately. The final model (Table 3-7) contained: < 25 arthro/yr., obesity, overweight, poor social function, and fair social function. The amount of explained variance in waiting time that was explained by this model was 6% (adjusted $R^2 = .06$).

For interpretation of the regression coefficients in a model with a transformed dependent variable, the coefficients were then exponentiated. The final model suggests that persons who were seen by surgeons who performed less than 25 major arthroplasties per year waited on average .53 times as long for their surgery, in comparison with patients who were seen by surgeons who performed more than 25 major arthroplasties per year. As well, persons with poor social functioning waited .67 times as long for their surgery than persons with good social functioning, and persons with fair social functioning waited .83 times as long for their surgery than those who were classified as having good social function. Obese persons waited 1.3 times longer than persons of normal weight, and overweight persons waited 1.2 times longer than those of normal weight. These estimations were made while controlling for the effects of all the other demographic, clinical and health system variables mentioned earlier.

3.4 Discussion

The results of this study indicate that waiting lists for major joint replacement surgery are managed in an equitable fashion, from a social perspective. No biases in waiting time with regard to age, gender, marital status, language spoken, or socioeconomic status as measured by education and work status were identified. Specifically, no significant differences in waiting time were observed among the various categories for these variables. Although, research in this area is limited, one previous study also found that gender bias was not observed when placing patients of waiting lists for major hip replacement surgery (Gabriel et al., 1994). Therefore, patients waiting for major joint arthroplasty in the Edmonton area were treated fairly, with no partiality given to a specific social or economic subgroup.

It has been mentioned that waiting lists should ensure equitable access based on patient need. Nonetheless, it has also been shown that there is considerable diversity regarding the appropriateness for this type of surgery, and it has been hypothesized that less appropriate indications for surgery are being employed in some areas (Tierney et al., 1994; Wright et al., 1995; Mancuso et al., 1996). When comparing our study population to others in Canada (Williams et al., 1997), it appears that major joint arthroplasties in this region were appropriately performed.

Although pain, functional limitation and evidence of intraarticular disease on radiographs are the primary indicators of major joint arthroplasty (Wright et al., 1995), the extent of disease that should exist before joint surgery is considered has not been agreed upon by orthopedic surgeons. Clinical disagreement among surgeons has three possible explanations: limitation of available knowledge (e.g., effect of different patient factors on surgical outcome); controversial orthopedic literature (e.g., detrimental effect of obesity on outcome); and inadequate dissemination of information and adoption into practice (Wright et al., 1995). Even though there are wide variations among surgeons, most surgeons require at least severe daily pain, pain at rest several days per week, and transfer pain several days per week (Mancuso et al., 1996; Naylor et al., 1996). These authors concluded that factors should be considered simultaneously, not independently, as isolated indications are not as important as integrating and weighing several factors.

When one considers the patient as a whole, we found that those with more severe pain and disability did not have surgery substantially earlier. Previous studies examining the relationship between health status and waiting time for major joint arthroplasties have also found similar results (Kelly et al., 1998; Williams et al., 1997; Coyte et al., 1994). In this study, pain and disability were measured by the WOMAC and SF-36 instruments. Other clinical variables such as diagnosis, affected joint, previous arthroplasty, comorbidities, pain medication use, walking aids, and residence type, were also included to determine if an association existed between these variables and waiting time. We found that no significant relationships existed between pain and disability and waiting time, or between the additional clinical factors and waiting time. Therefore, it would appear that specific consideration was not given to pain and functioning when patients were placed on the waiting list.

Multivariate analysis, which controls for the effects of all independent variables included in the model, indicated that the patient's social functioning, BMI and the size of the orthopedic surgeon's major joint arthroplasty practice were the only significant predictors of waiting time. The model only explained 6% of the total variance in waiting time. Consequently, when placing a patient on the waiting list for major joint replacement surgery, and considering the patient as a whole, only the patients' BMI, and social functioning determined their waiting time. It is likely that patients who were either overweight or obese were encouraged by their surgeons to lose weight prior to surgery, for the purposes of improving surgical recovery and overall outcome. And, it is possible that social functioning was an indicator of overall health, and was used to determine placement on orthopedic waiting lists, rather than pain or disability. But what the model infers is that all patients who were placed on the waiting list for major joint replacement surgery were treated equitably, with no preferential biases in terms of their socio-demographic background taking place.

The multivariate analysis also identified that patients who were seen by surgeons with a small joint replacement practice had a significantly shorter waiting time. However, this group of patients was also more likely to be knee replacement patients with few comorbid conditions. The exercise of having surgeons who generally perform fewer major arthroplasties per year, carry out the more uncomplicated knee replacements, is judicious to ensure high quality outcome. Therefore, operating times allocated to these surgeons should reflect this common standard, so that patients with complicating conditions are not unjustly disadvantaged.

This study employed a population-based sampling frame, with an adequate response rate, and analysis indicated that the participants and non-participants were similar with respect to gender, affected joint and waiting time. Even though the non-participants were significantly younger than the study group, most likely because they were working and were difficult to contact, they had equivalent waiting times. Therefore, it is unlikely that either selection bias or response bias influenced the findings. Waiting time was an exact calculation, taken directly from the hospital databases, and therefore not subject to recall bias, as in previous studies (Williams et al., 1997; Coyte et al., 1994). The study, however, did not include persons residing outside the region who had a major joint arthroplasty performed at either of these two referral hospitals. Therefore, the results may be generalized to urban populations only, as rural patients may differ with respect to the level of pain and function they experience at the time they are placed on the waiting list (Visuri & Honkanen, 1982).

3.5 Conclusion

The study found that waiting lists for major joint replacement surgery were managed in a socially equitable fashion, and that preferential treatment was not given to specific social or economic subgroups. Multivariate analysis identified patients' BMI and social functioning as being significantly related to waiting time, suggesting that greater emphasis was placed on patients' overall functioning than on the amount of pain and disability they were experiencing, when deciding where to situate them on the waiting list. In view of the results that the size of their surgeons' arthroplasty practice was also significantly related to waiting time, it is recommended that surgeons who perform more total hip and knee replacements per year have their operating room time adjusted proportionately, so that their patients do not have a significantly longer wait.

This study further emphasizes the complexity surrounding waiting list placement, and reinforces the need for continuous monitoring of procedural waiting lists in a universal health care system.

Table 3-1: Demographic variables and waiting time

	Number (%) (n=553)	Waiting Time (days) Mean(sd)	P. Value
Age			.37
<55	61 (11%)	103.0(75.6)	
55 - 64.9	124 (22%)	117.8(102.3)	
65 - 74.9	209 (38%)	112.2(95.8)	
≥75	158 (28%)	92.4(74.4)	
Gender			.69
Female	326 (59%)	106.4(84.3)	
Male	227(41%)	107.0(93.8)	
Marital Status			.63
Married	351 (63%)	105.4(88.5)	
Unmarried	202 (37%)	108.9(92.6)	
Language			.02
English or French	431 (78%)	110.5(91.5)	
Other	122 (22%)	93.2(83.3)	
Education			.52
Grade 8 or Less	105 (19%)	102.3(84.8)	
Partial High School	126 (23%)	115.1(99.9)	
Completed High School	102 (19%)	112.9(84.1)	
Partial Tech. Or Univ.	67 (13%)	102.1(79.5)	
Complete Tech. School	72 (13%)	91.3(71.7)	
Completed University	74 (14%)	111.3(110.8)	
Working Full Time			.76
Yes	50 (9%)	105.8(77.2)	
No	503 (91%)	106.7(91.2)	

Table 3-2: Clinical variables and waiting time

	Number (%)	Waiting Time (days) Mean(sd)	P. Value
Diagnosis			.19
Rheumatoid Arthritis	31 (6%)	89.4(83.1)	
Osteoarthritis	487 (94%)	105.3(85.9)	
Affected Joint			.15
Knee	304 (55%)	111.2(90.3)	
Hip	249 (45%)	101.1(89.3)	
Previous Arthroplasty			.73
Yes	166 (30%)	107.5(87.7)	
No	386 (70%)	106.2(91.1)	
BMI			.04
≤26	197 (39%)	97.6(88.9)	*
27 - 32	199 (39%)	109.8(90.5)	
>32	105 (21%)	121.9(90.5)	*
Total Number of Comorbidities			.60
≤ 2	195 (35%)	107.7(96.1)	
3 - 4	214 (38%)	110.4(92.9)	
> 4	144 (26%)	99.6(75.9)	
MQS			.74
0	94 (17%)	102.3(85.8)	
1 - 3	161 (29%)	109.6(95.1)	
4 - 6	167 (30%)	109.1(91.5)	
≥ 7	131 (24%)	103.1(84.9)	
Walking aids			.29
Yes	369 (67%)	103.0(85.0)	
No	184 (33%)	114.0(99.0)	
Residence Type			.38
Apartment	72 (13%)	91.2(69.7)	
Condominium	63 (12%)	117.8(93.3)	
House	372 (69%)	108.4(93.3)	
Senior's Complex	31 (6%)	105.8(85.9)	

Table 3-3: WOMAC subscales and waiting time

	Number (%)	Waiting Time (days) Mean(sd)	P. Value
Pain			.44
Mild	45 (8%)	124.1(102.3)	
Moderate	360 (67%)	107.6(90.2)	
Severe	135 (25%)	100.7(83.0)	
Function			.04
Good	39 (8%)	137.8(103.4)	*
Fair	310 (62%)	108.3(92.6)	
Poor	154 (31%)	97.4(74.8)	*
Stiffness			.21
Mild	53 (10%)	124.8(101.8)	
Moderate	299 (54%)	106.0(88.5)	
Severe	201 (36%)	103.6(86.9)	

* mean waiting times for these groups differ significantly.

Table 3-4: SF-36 subscales and waiting time

	Number (%) (n=553)	Waiting Time (days) Mean(sd)	P. Value
Bodily Pain			.02
Mild	11 (2%)	100.6(74.1)	
Moderate	151 (27%)	127.0(108.9)	*
Severe	391 (71%)	99.0(80.8)	*
Physical Function			.04
Good	14 (3%)	106.1(100.2)	*
Fair	91 (16%)	131.5(110.7)	*
Poor	448 (81%)	101.6(84.1)	
Role Physical			.34
Good	36 (7%)	131.8(124.3)	
Fair	30 (5%)	118.8(89.4)	
Poor	487 (88%)	104.1(86.8)	
General Health			.70
Good	221 (40%)	112.0(93.7)	
Fair	268 (48%)	101.7(84.6)	
Poor	64 (12%)	108.8(98.0)	
Mental Health			.01
Good	305 (55%)	115.8(93.4)	*
Fair	212 (38%)	95.3(82.0)	*
Poor	35 (6%)	97.5(99.4)	
Vitality			.002
Good	56 (10%)	122.0(109.4)	
Fair	310 (56%)	112.7(90.3)	*
Poor	187 (34%)	91.5(80.9)	*
Role Emotional			.20
Good	247 (45%)	114.6(97.0)	
Fair	77 (14%)	118.1(105.4)	
Poor	220 (41%)	95.8(74.7)	
Social Function			.000
Good	149 (27%)	132.4(109.7)	*
Fair	261 (47%)	103.9(83.1)	*
Poor	142 (26%)	85.3(71.1)	*

* mean waiting times for these groups differ significantly.

Table 3-5: Surgeons' practice characteristics and waiting time

Group	# Major Arthro./Yr.	# Surgeons/ group (%)	Number (%)	Waiting Time (days) Mean(sd)	P Value
1	<25	3 (13%)	28 (5%)	53.9 (42.3)	*
2	25-50	7 (29%)	90 (16%)	111.7 (94.2)	*
3	51-100	9 (4%)	221 (40%)	102.5 (77.9)	
4	>100	5 (21%)	214 (39%)	115.8 (101.4)	*
	Total	24 (100%)	553 (100%)	106.7 (89.9)	.001

* mean waiting times for group 1 is significantly different from groups 2 and 4.

Table 3-6: Surgeons' practice characteristrics and patient demographics

	Total	<25 Arthro./yr.	≥ 25 Arthro./yr.	P Value
Mean Age (SD)	68.4 (10.8)	68.2 (11.6)	68.4 (10.8)	.94
Mean # Comorbidities (SD)	3.5 (2.1)	2.7 (1.5)	3.5 (2.1)	.01
Diagnosis - RA	31	1 (3%)	30 (97%)	1.0
OA	489	23 (5%)	466 (95%)	
Joint - Knee	323	22 (7%)	301 (93%)	.02
Hip	258	6 (2%)	252 (98%)	

Table 3-7: Multiple Linear Regression Model predicting waiting time

Variables	B	Standard Error	Beta	t	Model Summary
< 25 arthro/yr	-.64	.16	-.17	-4.06***	$R^2 = .07$
Obese	.24	.10	.11	2.48*	
Overweight	.15	.08	.09	1.90	Adj. $R^2 = .06$
Poor Social Function (SF-36)	-.39	.10	-.21	-4.08***	F = 7.89
Fair Social Function (SF-36)	-.19	.08	-.11	-2.24*	Sig. F < .000
Constant	4.45	.08		56.12***	

*$p < .05$, **$p < .01$, ***$p < .001$

3.6 References

Bellamy N. Buchanan WW, Goldsmith CH, Campbell J, Stitt L. (1988) Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. Journal of Orthopaedic Rheumatology,1, 95-108.

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988). Validation study of the WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. The Journal of Rheumatology, 15, 1833-1840.

Bellamy, N. (1989). Pain assessment in osteoarthritis: experience with the WOMAC osteoarthritis index. Semin Arthritis Rheum, 18(Suppl 2), 14-17.

Bellamy, N., Wells, G., & Campbell, J. (1991). Relationship between severity and clinical importance of symptoms in osteoarthitis. Clinical Rheumatology, 10(2), 138-143.

Brazier, J. E., Harper, R., Jones, N. M. B., O'Cathain, A., Thomas, K. J., Usherwood,T., & Westlake, L. (1992). Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ, 305, 160-164.

Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined comorbidity index. J Clin Epid, 47, 1245-1251.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis, 40(5), 373-383.

Coyte, P. C., Wright, J. G., Hawker, G. A., Bombardier, C., Dittus, R. S., Paul, J. E., Freund, D. A., & Ho, E. (1994). Waiting times for knee-replacement surgery in the United States and Ontario. New England Journal of Medicine, 331(16), 1068-1071.

Gabriel SE, Wenger DE, Ilstrup DM, Lewallen DG, Melton LJ. (1994). Lack of evidence for gender bias in the utilization of total hip arthroplasty among Olmsted County, Minnesota residents with osteoarthritis. Arthritis & Rheumatism,37(8), 1171-1176.

Greenfield, S., Alolone, G., McNeil, B. J., & Cleary, P. D. (1993). The importance of coexistent disease in the occurrence of postoperative complications and the one-year recovery in patients undergoing total hip replacement. Medical Care, 31(2), 141-154.

Gudex C, Williams A, Jourdan M, Mason R, MaynardJ, O'Flynn R, Rendall M. (1990). Prioritising waiting lists. Health Trends,3, 103-108.

Hamilton SM, Letourneau S, Pekeles E, Voaklander D, Johnston WC. (1997). The impact of regionalization on a surgery program in the Canadian health care system. Arch Surg,132, 605-610.

Kelly K, Voaklander D, Carriere KC, Johnston DW, Kramer G, Newman S, Redfern L, Suarez-Almazor M. The Impact of Health Status on Waiting Time for Major Joint Arthroplasty. (Submitted for Publication).

Mancuso, C. A., Ranawat, C. S., Esdaile, J. M., Johanson, N. A., & Charlson, M. E. (1996). Indications for total hip and total knee arthroplasties. Results of orthopaedic surveys. Journal of Arthroplasty, 11(1), 34-46.

Masters-Steedman, S., Middaugh, S. J., Kee, W. G., Steir-Carson, D., Harden, R. N., & Millar, M. C. (1992). Chronic-pain medications: equivalence levels and methods of quantifying usage. Clin J Pain, 8, 204-214.

Naylor, C. D., Williams, J. I., & The Ontario panel on hip and knee arthroplasty. (1996). Primary hip and knee replacement surgery: Ontario criteria for case selection and surgical priority. Quality in Health Care, 5, 20-29.

SPSS 7.5 for Windows, Chicago: SPSS, 1997.

Tierney, W. M., Fitzgerald, J. F., Heck, D. A., Kennedy, J. M., Katz, B. P., Melfi, C. A., Dittus, R. S., Allen, D. I., & Freund, D. A. (1994). Tricompartmental knee replacement. Clinical Orthopaedics and Related Research, 305, 209-217.

Visuri, T., Honkanen, R. (1982). The role of socio-economic status and place of residence in total hip replacement. Scand J Soc Med, 10, (95-99).

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36) 1. Conceptual framework and item selection. Medical Care, 30(6), 473-483.

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). SF-36 Health Survey: Manual and Interpretation Guide. Boston,Mass. Nimrod Press.

Williams, J. I., Llewellyn Thomas, H., Arshinoff, R., Young, N., & Naylor, C. D. (1997). The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. Journal of Evaluation in Clinical Practice, 3(1), 59-68.

Wright, J. G., Coyte, R., Hawker, G., Bombardier, C., Cooke, D., Heck, D., Dittus, R., & Freund, D. (1995). Variation in orthopedic surgeons' perceptions of the indications for and outcomes for knee replacement. CMAJ, 152, 687-697.

CHAPTER 4

DETERMINANTS OF CHANGE IN PAIN AND FUNCTION WHILE WAITING FOR MAJOR JOINT ARTHROPLASTY

4.1 Introduction

At present thousands of Canadians are on waiting lists for major joint replacement surgery in hopes of reducing their disability and improving their quality of life. In a publicly funded health care system, such as in Canada, waiting lists for elective surgical procedures are common. This health system has been criticized for rationing health care at the expense of individual suffering, in that waiting times are inordinately long (Coyte et al., 1994). Therefore, management of waiting lists is of public concern.

It is known that once arthritis affects the hips or knees, it causes pain, loss of function and reduces ones' quality of life (Coyte et al., 1996). What is not known is how waiting for major joint arthroplasty affects patients' pain and function - or rather, the relationship between patient characteristics, baseline health status, waiting time and the change in pain and physical function that occurs while waiting for total hip and knee replacement surgery – which is the objective of this study.

The measurement of change has been a topic of considerable debate in the medical literature. Several authors in education and psychology have advocated against the use of difference scores to measure change, but their positions are based on different views of the goals of measurement (Chronbach & Furby, 1970; Burckhardt et al., 1982; Streiner & Norman, 1995). Nonetheless, it has been shown that the reliability of change scores can be upheld if certain criteria are met - namely controlling for the effects of the pretest scores (Darlington, 1990; Streiner & Norman, 1995). As well, one major strength favoring the use of change scores is their ease of interpretation (Darlington, 1990). For the purposes of this study we utilized change scores to describe how the levels of pain and function were altered while people waited for major joint replacement surgery.

4.2 Method

Patient Selection and Data Collection

The province of Alberta is divided into 17 health regions, each of which is managed by a single health board that oversees both acute care and community health programs. The Capital Health Region (CHR) is located in the northern part of the province, and has a population of 723,000, and a referral area of 1.2 million people. Major surgeries such as hip and knee replacements are performed at only two of the five acute care hospitals within the CHR (Hamilton et al.,1997). In 1995, there were 24 orthopaedic surgeons in the region who performed all the knee and hip replacements, with 19 of these surgeons accounting for 90% of major joint replacement surgeries.

Between the dates of December 18, 1995 and January 24, 1997, a consecutive sample of patients living in the Edmonton region, and who had been recommended by their orthopaedic surgeon for total knee or hip replacement surgery at either of the two referral hospitals were eligible for the study. All orthopaedic surgeons within the region were informed of the study and asked to inform their patients that a research assistant would be contacting them regarding participation in the study. As patients were entered onto the waiting list at either referral hospital, they were contacted by the research assistant, via telephone, and recruited for the study. If the patient declined to participate, they were not contacted again. If the patient agreed to participate, an appointment for a home visit was made to further explain the study, obtain written informed consent, and complete the self-administered questionnaire. Patients were advised that they could withdraw from the study at any time without giving a reason, and withdrawal would not affect their present or future medical care. Inclusion criteria for the study were: residence within the CHR, a clear understanding of written English, and the ability to give informed consent. Patients who were undergoing revisions of hip or knee arthroplasties were excluded. In some instances, patients were retrospectively entered onto the waiting list, such that their waiting list date was too far in the past to allow a baseline measure within one month of that date. These patients were not included in the study. Weekly extracts of the regional joint replacement database were conducted to capture new patients on the waiting list and to flag people for pre-operative measurement once the surgery date had been established. Data from the baseline interview were linked electronically with the CHR operating room records to determine prospectively when the patients were booked for and subsequently underwent total joint replacement surgery. Patients were followed for a minimum of one year to ascertain their surgery date. The patient's diagnosis (generally either osteoarthritis or rheumatoid arthritis) was determined from the computerised hospital discharge abstract.

Health Status Measurement

Pain medication use was quantified using the Medication Quantification Score (MQS), which provides a method for quantifying medication use in-patients with chronic and non-malignant pain. Each pain-related medication is given a score that is based on both the daily dosage and pharmacological classification of that medication. For a given medication, the detriment weight is multiplied by the dosage level to yield a MQS. For an individual patient, the MQS for each medication is calculated and then summed to yield the total MQS for that patient. The MQS has demonstrated good concurrent validity, in that there is relatively high correlation between total MQSs and the mean clinical judgement of health professionals who are knowledgeable about pain medications (Masters-Steedman et al., 1992).

Generally, a MQS score of 1-3 is the result of either a nonsteroidal anti-inflammatory drug taken in quantities that are less than the low therapeutic dose, or acetaminophen taken is low doses. A MQS score of 4-6 usually occurs when a patient is taking non-steroidal anti-inflammatory drugs in low to high therapeutic doses, or weak narcotics taken less than the low therapeutic dose. A score of ≥ 7 results when a combination of the above scenarios occurs, or when the patient requires a higher dose of narcotics.

Patients' comorbidity was assessed using the Charlson comorbidity index. This weighted index provides a simple and valid method for estimating the risk of death from comorbid diseases for use in longitudinal studies (Charlson et al., 1987; Charlson et al., 1994). It is based on adjusted relative risks, and takes into account both the number and seriousness of comorbid diseases. The comorbidity index has been successfully tested for its ability to predict increased risk of death from comorbid diseases for patients with primary breast cancer (Charlson et al., 1994). Generally speaking, patient's comorbidities are weighted in terms of seriousness and then summed to give an overall rating of comorbid influence.

Both disease-specific and general health measurement tools were used to measure health status. The WOMAC is a multi-dimensional self-administered questionnaire that was designed specifically for patients with osteoarthritis. The questionnaire yields separate scores for pain (5 items) and function (17 items) of the lower extremities. The score for each dimension ranges from 0 to 100, with a low score representing the best health state. The WOMAC's responsiveness, reliability and validity has been tested in the context of hip and knee arthroplasty (Bellamy et al., 1988a; Bellamy et al., 1988b; Bellamy et al., 1989; Bellamy et al., 1991).

The SF-36 is a widely used 36 item general health status questionnaire, to be completed by self-administration, in-person interview, or telephone interview. The items are grouped into 8 dimensions measuring; emotional role functioning, physical role functioning, physical functioning, mental health, vitality, general health perceptions, social functioning and bodily pain. The score for each dimension ranges from 0 to 100, with a high score representing the best health state. The instrument's reliability and validity has been extensively tested and is currently being widely used in health outcomes research (Brazier et al., 1992; Ware, 1992; Ware 1993).

In addition to these health status measures, demographic and clinical information was obtained from all subjects at baseline.

Data Analyses

Missing values for the SF-36 subscales were imputed with the mean values of the remaining items for the subscale, according to the SF-36 guidelines (Ware et al., 1993). Missing values for the WOMAC subscales were also imputed with the mean values of the remaining items for the subscale, conditional on 40% of the items having values.

The SF-36 scores were recoded to coincide with the WOMAC instrument, such that a high score indicates a worsened health state. Change scores for all the WOMAC and SF-36 subscales were calculated as the pre-operative score minus the baseline score. Therefore a negative change indicates improvement, and a positive change indicates a worsening of pain or function. Change scores were also categorized into three groups, with those having a negative change score categorized as improving, those having a positive change score categorized as worsening, and those with a zero score categorized as the same.

Univariate analyses were conducted to determine the association between the independent variables (age, gender, body mass index (BMI), language spoken, education, marital status, work status, MQS, diagnosis, affected joint, previous replacement, chronic conditions, WOMAC and SF-36 subscales, and waiting time) and the dependent variables - change in pain and function as measured with the WOMAC instrument, and change in bodily pain and physical function subscales as measured with the SF-36 instrument.

Differences in mean values of continuous variables were tested with either t-tests or ANOVA. Pearson correlation coefficients were generated to determine associations between continuous variables. Univariate and multiple logistic regression models were calculated using the forced entry method for model selection to determine the relationships between the independent variables and worsened pain and function. Change in bodily pain (SF-36) and pain (WOMAC) were combined for logistic modeling, such that patients who showed a positive change (worsened) in either pain scale were combined and all other patients were combined to form the reference group. Similarly, change in physical function (SF-36) and function (WOMAC) were combined for logistic modeling, such that patients who showed a positive change (worsened) in either function scale were combined into one group, and all other patients were combined to form the reference group. The independent variables used in model development were the same as those analyzed univariately, with the exception of using only the WOMAC subscales to measure baseline pain and function (the SF-36 baseline pain and physical function subscales were not included).

Statistical analyses were performed using SPSS® software version 7.5. The statistical significance level for the univariate procedures was established at $p < 0.05$. When reporting summary statistics, the convention of mean(sd) was used. Statistical significance for the logistic regression analyses was determined using confidence intervals.

4.3 <u>Results</u>

Patient Accrual

During the study time period, 1040 patients residing within the urban areas of the CHR were placed on the waiting list for major joint arthroplasty surgery. There were 293 patients who were excluded from the study because a baseline measure could not be obtained within 1 month of the patient being placed on the waiting list. Recruitment attempts (telephoning the patient for a maximum of three attempts at various times of the day and on different days) were made on the remaining 747 patients. Twenty patients did not speak English, and therefore were not eligible for the study. Of the eligible patients, there were 89 patients who refused to participate, 32 patients were unable to be contacted, and 11 patients had surgery before an initial home visit could be made. The aggregate participation rate was 82%.

The patients who were excluded from the study because of the delay in placement on the CHR waiting list, were found to be similar to the study group with regards to age, gender, affected joint and waiting time. The patients who did not participate in the study (refusals, unable to contact, surgery already performed) were found to be similar to the study group with respect to gender, affected joint, and waiting time. However, patients who did not participate were statistically significantly younger ($p=.04$) than the participants (mean age for non-participants =65.5; mean age for participants = 68.3).

During the study period, 31 patients were placed on the waiting list for more than 1 major joint replacement. The second procedure was not included in the analyses.

In total, there were 564 patients included in our study. Of these patients, 98% (553) had surgery during the study period. A pre-operative measurement was obtained on 467 patients – for 86 patients we were unable to obtain a pre-operative measurement. Patients who did not have a pre-operative measurement were similar to the group with a pre-operative measurement with regards to age, gender, affected joint, and baseline pain and function (measured by both the WOMAC and SF-36 instruments) and waiting time.

If the patient received their surgery within one month of their baseline measurement, the pre-operative health status information was copied from the baseline information. The decision to do this was made a priori with input from specialists in the field, because it was thought that health status wouldn't change sufficiently during 30 days to warrant a second home visit. Since the focus of this paper is change in pain and function, these patients (154) were not included the analyses. Therefore a total of 313 patients were included in the subsequent analyses.

Patient and Surgeon Characteristics

The average age of the population was 68.1 years, and ranged from 27 to 89 years. Fifty-nine percent of the study sample was female, and 64% of patients were married. Eighty percent of patients reported English or French as their first language, and 20% reported that their first language was other than English or French. Forty-one percent of patients did not complete high school, 21% completed high school, and 38% had some post-secondary education.. At the time of the study, 9% were working full time.

The breakdown of patients according to their primary diagnosis was; 96% osteoarthritis, and 4% rheumatoid arthritis or other arthropathies. Fifty-seven percent of major joint arthroplasties were total knee replacements and 43% were total hip replacements. Twenty-eight percent of patients had a previous joint replaced. The average BMI for the patient population was 29.1, and the mean Charlson comorbidity index was .47.

Pain, Disability and Waiting Time

The mean pain and disability scores at the time the patients were placed on the waiting list were measured with the WOMAC and SF-36 health status instruments. For both the WOMAC and SF-36 scores, a high score indicates a worsened health state. The mean WOMAC subscale scores were: pain 64.3(13.1); stiffness 68.0±16.3; and function 62.9(12.7). The mean SF-36 subscale scores were as follows: general health 40.1(19.9); role physical 86.8(25.8); social function 45.0(28.0); role emotional 52.2(44.9); vitality 57.4(18.7); bodily pain 70.7(16.5); physical functioning 77.8(18.2); and mental health 31.1(19.2). Although patients waiting for hip and knee replacement surgery were found to be similar with respect to most of their baseline WOMAC or SF-36 subscale scores, hip replacement patients had poorer function, when measured by the WOMAC instrument, than the knee replacement patients. The mean baseline function scores for hip and knee replacement patients were 88.5(22.1) and 85.5(28.2) respectively ($p=.03$).

At the time the patients were placed on the waiting list, their average MQS score was 4.5. The study included only those patients waiting more than 1 month for major joint replacement surgery, and their average waiting time was 131.5(81.3) days.

Change in Pain and Function

Change scores were calculated as the pre-operative score minus the baseline score. Therefore a negative change indicates improvement and a positive change indicates a worsening of pain or function.

Figures 4.1 and 4.2 display the relationships between the change scores for the WOMAC subscales and the SF-36 subscales respectively and waiting time (categorized into three groups: 1-3 months, 3-6 months, and greater than 6 months). As can be seen in the graphs, no substantial differences in change scores for either scale were observed for the three waiting time categories – differences were not statistically significant. However, although not statistically significant, a trend can be seen indicating that patients improved in the role emotional subscale with increasing waiting time.

A significant difference in change in bodily pain (SF-36) was observed between patients waiting for knee replacement surgery and those waiting for hip replacement surgery. The mean bodily pain change scores for hip and knee replacement patients were respectively as follows: .95(13.9) and –3.5(15.7) ($p=.01$). In view of this difference in change scores, patients waiting for hip and knee replacement surgery were analyzed separately for the univariate comparisons.

Table 4-1 displays the mean change scores for the WOMAC and SF-36 subscales for the knee replacement patients. Change was also categorized into three groups, with those having a negative change score categorized as improving, those having a positive change score categorized as worsening and those with a zero score categorized as the same. As can be seen in the table, when change did occur, the average amount of change was minimal, even though the bodily pain, mental health, role emotional and general health change scores were statistically significant ($p<.05$). The mean change scores for pain and function as measured with the WOMAC instrument were –1.0(15.2) and – 1.8(14.6) respectively, and the mean change scores for bodily pain and physical function as measured with the SF-36 instrument were –3.5(15.7) and –0.38(15.6) respectively. The percentage of patients whose condition worsened while they waited for surgery was comparable to the percentage whose condition improved while they waited.

Table 4-2 outlines the mean change scores for the WOMAC and SF-36 subscales for the hip replacement patients. Similarly, a minimal amount of change occurred while patients waited for surgery, although the change score for general health was statistically significant ($p<.05$) The mean change scores for pain and function as measured with the WOMAC instrument were .81(13.3) and .16(11.9) respectively, and the mean change scores for bodily pain and physical function as measured with the SF-36 instrument were .95(13.9) and 2.5(18.4) respectively. Again, the percentage of patients who improved while waiting was comparable to the percentage of patients who worsened while they waited.

Tables 4-3 and 4-4 outline the relationships between the demographic and clinical variables and the mean change scores for bodily pain and physical function (SF-36), pain and function (WOMAC) separately for knee and hip replacement patients. Overall, small differences in mean change scores between the levels of the variables were seen for both groups of patients. For knee replacement patients (Table 4-3) with rheumatoid arthritis, their functioning - as measured with the WOMAC instrument, appeared to worsen while they waited for their surgery, and for knee replacement patients with osteoarthritis, their functioning appeared to improve while they waited for their replacement surgery (difference in mean change scores; $p=.04$). For knee replacement patients who were working full time, their pain – as measured with the WOMAC instrument, appeared to improve while they waited for surgery, compared to those knee replacement patients who were not working full time (difference in mean change scores; p=.03). No significant differences in change scores for pain and function with the demographic and clinical variables were observed in the hip replacement patients (Table 4-4).

Tables 4-5 and 4-6 display the correlations between the continuous demographic and clinical variables and the change scores for pain and function. Overall, the correlations were small. For knee replacement patients, no significant correlations were noted. However, for hip replacement patients significant negative correlations between vitality ($r = -.19$; $p<.05$), role emotion ($r = -.21$; $p<.05$), social function ($r= -.26$; $p<.01$), and change in bodily pain (SF-36) were observed, as well as a significant correlation between vitality and change in pain using the WOMAC instrument ($r= -.18$; $p<.05$). These correlations indicate that those patients who scored low on these subscales of the SF-36 instrument (good emotional and social functioning) at the baseline interview, had an increase in pain (WOMAC or SF-36) while they waited for surgery.

When looking at the correlation between waiting time and the change scores, a significant negative correlation existed between waiting time and change in physical function -SF-36 ($r=-.23$; $p<.05$). This means that patients who waited longer for their surgery showed an improvement in physical functioning while they waited.

No significant correlations existed between the change scores and age, BMI, MQS, and comorbidities.

Table 4-7 and 4-8 describe the results of the multivariate analyses, using logistic regression, that were conducted using the same independent variables used in the univariate analyses, with the exception of not including the SF-36 pain and physical function subscales, and worsened pain and function as the dependent variables. Significant predictors of worsened pain (Table 4-7) were: baseline pain (WOMAC) and gender. These variables showed statistically significant relationships with increased pain while controlling for the effects of the other independent variables. The results of the regression indicate that women have three times the risk of increased pain, compared to men, and patients scoring high on the WOMAC pain subscale (severe pain) at baseline, have a decreased risk of increased pain while they wait for surgery.

Significant predictors of worsened functional ability (Table 4-8) were: completing high school education, and baseline function (WOMAC). These variables showed statistically significant relationships with worsened functional ability while controlling for the effects of the other independent variables. The results of the regression indicate that people with a high school education have two times the risk of worsened functional ability, compared to people with post-secondary education, and patients scoring high on the WOMAC function subscale (severe dysfunction) at baseline, have a decreased risk of worsened functional ability while they wait for surgery.

4.4 Discussion

Although patients in our study were exhibiting a great deal of pain and functional disability when they were placed on the waiting list, the amount of change in pain and function that occurred while they waited was minimal. Minimal amounts of change in pain and function (physical and psychosocial) occurred for both hip and knee replacement patients during this waiting period, with approximately the same percentage of patients showing improvement as showing a worsening of symptoms. Therefore, waiting time did not appear to have a negative impact on the amount of pain and functional disability experienced while waiting for major joint arthroplasty.

Patients differ in their pain thresholds, and their thresholds for bringing symptoms to the attention of a physician or surgeon. However, there is no "gold standard" for objectively determining patients' level of distress (Naylor et al., 1996). The perceived seriousness and duration of symptoms, and coping failure have been identified as important determinants of the decision to seek medical help (Cameron et al., 1993). As well, the intensity of the symptoms may be influenced by their perceived interference with social relationships, employment and physical activity (Zola, 1973). In this study, patients' perceptions regarding their level of pain and functional disability were collected at two separate time intervals. The first measurement was taken when the patient was initially placed on the waiting list, and the second measurement was taken within a few days of undergoing major surgery. It is possible that the first measurement was negatively skewed because of the perceived seriousness of their condition, the interference with their daily functioning, and the anticipated lengthy wait for surgery. It is also possible that the second measurement was positively skewed, with the perceived knowledge that the symptoms will soon be minimised. The net effect of these two biases would result in an improvement in symptoms during the waiting time for surgery. Some patients in our study showed a slight improvement in their pain and disability, and it is possible that the above mentioned biases might have influenced these findings. Therefore, it is conceivable that some of the patients who showed an improvement in symptoms while they waited for surgery, actually remained unchanged during this waiting period.

While none of the patient characteristics measured here had a strong relationship with worsened pain and functional ability, a few are worth consideration for those interested in the management of waiting lists for major joint arthroplasty. Women in this study had an increased risk of worsened pain while they waited for hip or knee replacement surgery. Research has shown that women suffering from osteoarthritis experience a greater amount of pain and have an overall less favourable course of the disease (Hernborg & Nilsson, 1996). Considering this, it is not surprising to find that women's pain symptoms increased, in comparison to men, while they waited for surgery.

Patients with a high school education were found to have an increased risk of worsened functional ability while they waited for hip or knee replacement surgery, compared to those with some post-secondary education. This relationship has not been established in previous work. However, the results are plausible since persons whose highest level of education is grade 12 are more likely to have been unskilled workers during their employment years, and physical functioning was a large component of their lifestyle. As a result of this, a reduction in functioning ability would have a greater perceived impact on their usual activities.

Multivariable analyses indicated that people with severe pain when they were placed on the waiting list had a decreased risk of worsened pain while they waited for their surgery. A similar result was found with worsened functional ability, such that those with poor function initially, had a decreased risk of worsened functional ability while they waited. These findings are likely the result of a ceiling effect with the WOMAC instrument and a floor effect with the SF-36 instrument – patients experiencing severe symptoms selected the most severe category for both baseline and pre-operative measurements.

This study employed a population-based sampling frame, with an adequate response rate. Although, non-participants were found to be significantly younger than the study population, they had equivalent waiting times and age was not significantly associated with change in pain or function. Therefore, it is unlikely that either selection bias or response bias influenced the findings. The present study did not include persons residing outside the region who had a major joint arthroplasty performed at either of these two referral hospitals. Therefore, the results of the study should be generalised to urban populations only, as rural patients may differ with respect to the amount of pain and function they experience while they wait for surgery (Visuri & Honkanen, 1982).

4.5 Conclusion

Overall, waiting time did not appear to have a negative impact on the amount of pain and dysfunction experienced while waiting for major joint arthroplasty. Patients in this study were enduring a great deal of pain and functional disability when they were placed on the waiting list, however the amount of change in pain and function that occurred while waiting for surgery was minimal. Consequently, the burden of suffering was "merely" prolonged. Although some people's symptoms worsened during this waiting time, it was difficult to predict, at the time the patients were placed on the waiting list for major joint replacement surgery, who would get worse in terms of pain and function while they waited.

Table 4-1: Change scores for WOMAC and SF-36 subscales – knee replacement patients

	Change* Mean (sd)	Worsened # (%)	Same # (%)	Improved # (%)	Total # (%)
WOMAC					
Pain	-1.0(15.2)	67 (37%)	28 (16%)	81 (45%)	176 (100%)
Function	-1.8(14.6)	70 (41%)	6 (4%)	95 (56%)	171 (100%)
Stiffness	-1.6(20.7)	55 (31%)	56 (32%)	66 (37%)	177 (100%)
SF-36					
Bodily Pain	-3.5(15.7)†	55 (31%)	54 (30%)	71 (39%)	180 (100%)
Physical Function	-0.38(15.6)	67 (37%)	37 (21%)	76 (42%)	180 (100%)
Role Physical	2.6(31.9)	39 (22%)	109 (61%)	31 (17%)	179 (100%)
Role Emotional	-15.9(46.5)†	28 (16%)	79 (44%)	71 (40%)	178 (100%)
Mental Health	-3.1(15.4)†	67 (37%)	25 (14%)	87 (49%)	179 (100%)
Vitality	-0.42(17.6)	70 (39%)	27 (15%)	82 (46%)	179 (100%)
Social Function	-2.9(26.0)	57 (41%)	49 (27%)	74 (32%)	180 (100%)
General Health	-3.2(18.4)†	67 (37%)	20 (11%)	93 (52%)	180 (100%)

* a positive mean indicates worsening, and negative mean indicates improvement

† $p<.05$

Table 4-2: Change scores for WOMAC and SF-36 subscales – hip replacement patients

	Change* Mean (sd)	Worsened # (%)	Same # (%)	Improved # (%)	Total # (%)
WOMAC					
Pain	.81(13.3)	57 (43%)	24 (18%)	52 (39%)	133 (100%)
Function	.16(11.9)	60 (45%)	7 (5%)	61 (46%)	133 (100%)
Stiffness	-.75(20.2)	46 (35%)	35 (26%)	52 (39%)	133 (100%)
SF-36					
Bodily Pain	.95(13.9)	49 (37%)	41 (31%)	43 (32%)	133 (100%)
Physical Function	2.5(18.4)	64 (48%)	21 (16%)	48 (36%)	133 (100%)
Role Physical	2.3(26.5)	27 (21%)	84 (64%)	21 (16%)	132 (100%)
Role Emotional	-2.05(53.0)	34 (26%)	60 (45%)	36 (27%)	130 (100%)
Vitality	.45(15.3)	61 (46%)	22 (17%)	50 (38%)	133 (100%)
Mental Health	.14(14.7)	56 (42%)	24 (18%)	53 (40%)	133 (100%)
Social Function	1.2(26.4)	56 (42%)	31 (23%)	46 (35%)	133 (100%)
General Health	-3.6(15.8)†	41 (31%)	9 (7%)	82 (62%)	132 (100%)

* a positive mean indicates worsening, and negative mean indicates improvement
† $p<.05$

Table 4-3: Categorical demographic and clinical variables and change scores for knee replacement patients

	Total (n=180)	Change in WOMAC pain* Mean(sd)	Change in SF-bodily pain* Mean(sd)	Change in WOMAC-function* Mean(sd)	Change in SF-physical function* Mean(sd)
Gender					
Male	72	-3.4(14.7)	-6.2(16.5)	-3.6(12.8)	-2.3(15.0)
Female	108	0.5(15.4)	-1.6(14.9)	-0.6(15.6)	0.9(16.0)
Marital Status					
Married	114	0.0(13.3)	-3.7(16.3)	-1.8(14.0)	-0.7(15.1)
Other	66	-2.8(18.1)	-2.9(14.7)	-1.9(15.7)	-0.2(16.6)
Language					
English or French	143	-1.0(15.3)	-3.3(14.2)	-1.7(13.2)	-2.0(12.5)
Other	37	-1.2(15.2)	-4.0(20.8)	-2.1(18.9)	5.8(23.3)
Education					
Not completed High School	80	2.8(16.9)	-4.0(16.2)	-3.6(14.0)	-2.3(16.5)
Completed High School	39	1.8(13.7)	-1.7(16.5)	2.5(16.2)	2.0(12.4)
Post secondary	59	-0.5(13.7)	-3.5(14.3)	-1.7(1.8)	-0.5(13.2)
Working Full Time					
Yes	11	-10.9(17.3)	-3.3(15.7)	-7.8(14.8)	-5.5(21.4)
No	169	-0.4(14.9)†	–5.1(15.5)	-1.4(14.5)	-0.05(15.2)
Diagnosis					
OA	163	-1.5(15.4)	-3.6(15.8)	-2.5(14.5)†	-0.8(16.1)
RA	8	7.5(15.4)	0.0(12.8)	8.2(12.8)	5.6(10.5)
Previous Arthroplasty					
Yes	48	-1.6(13.7)	-3.8(13.8)	-1.5(16.3)	0.1(17.2)
No	132	-0.8(15.8)	-2.4(20.0)	-1.9(14.0)	-0.6(15.1)

* a positive mean indicates worsening, and negative mean indicates improvement
† p<.05

Table 4-4: Categorical demographic and clinical variables and change scores for hip replacement patients

	Total (n=133)	Change in WOMAC pain* Mean(sd)	Change in SF-bodily pain* Mean(sd)	Change in WOMAC-function* Mean(sd)	Change in SF-physical function* Mean(sd)
Gender					
Male	56	.08(12.3)	-0.3(1.8)	-0.5(11.8)	3.7(17.3)
Female	77	1.3(14.0)	1.8(14.6)	0.6(12.0)	1.5(19.3)
Marital Status					
Married	85	-0.3(12.5)	1.9(13.8)	0.2(11.5)	3.9(16.9)
Other	48	2.7(14.4)	0.4(13.9)	0.08(12.6)	-0.02(20.8)
Language					
English or French	107	0.8(12.7)	0.9(14.2)	0.3(12.3)	2.7(17.9)
Other	26	0.7(15.5)	1.2(12.4)	-0.6(10.4)	1.7(20.7)
Education					
Not completed High School	48	0.9(13.2)	1.4(11.8)	0.04(11.1)	4.2(22.3)
Completed High School	26	0.4(12.7)	-2.2(15.6)	0.6(12.4)	2.3(20.4)
Post secondary	58	1.2(13.7)	2.0(14.7)	0.2(12.6)	1.1(13.7)
Working Full Time					
Yes	17	3.0(14.3)	-0.3(11.9)	3.2(12.9)	8.2(12.7)
No	116	0.6(13.8)	1.0(13.5)	-0.3(11.7)	1.6(19.0)
Diagnosis					
OA	119	0.8(12.9)	1.4(14.0)	0.1(11.7)	3.7(17.5)
RA	4	1.3(9.5)	-9.8(13.7)	5.1(8.4)	-1.3(9.5)
Previous Arthroplasty					
Yes	41	0.4(14.0)	0.1(12.6)	1.1(13.1)	1.1(16.3)
No	92	1.0(13.0)	1.3(14.4)	-0.3(11.4)	3.1(19.3)

* a positive mean indicates worsening, and negative mean indicates improvement

Table 4-5: Continuous demographic and clinical variable correlations with change scores – knee replacement patients (n=180)

Baseline Measurements	Change in SF-Bodily Pain	Change in WOMAC-Pain	Change in SF-Physical Function	Change in WOMAC-Function
AGE	.07	-.02	.11	-.13
BMI	.14	.01	-.002	.07
MQS	-.04	-.01	-.01	-.07
Comorbidities	.01	.13	.006	.03
SF-vitality	-.13	-.10	-.11	-.10
SF-mental health	-.003	-.004	-.03	-.04
SF-role emotional	-.06	-.04	-.03	-.12
SF-social function	-.07	-.09	-.07	-.03
Waiting Time ‡	.04	.06	.01	.003

* p<.05; ** p<.01; ‡ only includes patients who waited > 1 month

Table 4-6: Continuous demographic and clinical variable correlations with change scores – hip replacement patients (n=133)

Baseline Measurements	Change in SF-Bodily Pain	Change in WOMAC-Pain	Change in SF-Physical Function	Change in WOMAC-Function
AGE	-.02	.07	.03	.0008
BMI	-.03	-.02	-.09	-.12
MQS	-.07	.09	.14	.10
Comorbidities	-.12	-.04	.004	-.10
SF-vitality	-.19*	-.18*	-.03	-.13
SF-mental health	-.09	-.04	-.10	-.03
SF-role emotional	-.21*	-.10	-.0006	.06
SF-social function	-.26**	-.15	-.11	-.16
Waiting Time ‡	-.02	.02	-.23*	-.04

* <.05; ** p<.01; ‡ only includes patients who waited > 1 month

Table 4-7: Predictors of worsened pain – logistic regression

Factor	Univariate Odds Ratio [95% CI] †	Adjusted Odds Ratio[a] [95% CI] †
Age (years)	.98 [.95,1.00]	.98 [.94,1.02]
BMI	1.03 [.98,1.09]	1.06 [1.00,1.12]
Comorbidities	.77 [51,1.14]	.80 [.50,1.27]
MQS (baseline)	1.01 [.94,1.07]	1.04 [.96,1.13]
Gender		
Male	1.00	1.00
Female	2.14 [1.13,4.07]	3.05 [1.34,6.97]
Affected Joint		
Hip	1.00	1.00
Knee	.63 [.35,1.13]	.65 [.32,1.34]
Diagnosis		
Osteoarthritis	1.00	1.00
Rheumatoid Arthritis	.90 [.19,4.26]	1.10 [.18,6.74]
Previous Replacement		
No	1.00	1.00
Yes	1.00 [.53,1.90]	1.03 [.48,2.25]
Education:		
Not Completed High School	.90 [.47,1.70]	.83 [.38,1.82]
Completed High School	.74 [.33,1.68]	.75 [.30,1.91]
Post Secondary Education	1.00	1.00
Language		
English or French	1.00	1.00
Other	.96 [.47,2.00]	.99 [.41,2.40]
Marital Status		
Unmarried	1.00	1.00
Married	.79 [.44,1.40]	.87 [.41,1.85]
Working Status		
Not full time	1.00	1.00
Full time	1.28 [.49,3.30]	1.22 [.35,4.34]
WOMAC – Function (baseline)	.98 [.96,1.00]	1.02 [.99,1.06]
WOMAC – Pain (baseline)	.97 [.95,.98]	.94 [.92,.98]
SF-36 Social Function (baseline)	.99 [.98,1.00]	1.00 [.98,1.01]
SF-36 Vitality (baseline)	.98 [.96,1.00]	.97 [.95,1.00]
SF-36 Role Emotional (baseline)	.99 [.99,1.00]	.99 [.99,1.00]
SF-36 Mental Health (baseline)	1.00 [.98,1.01]	1.01 [.99,1.04]
Waiting Time ‡	1.00 [1.00,1.00]	1.00 [1.00,1.01]

† CI = Confidence Interval; ‡ only includes patients who waited > 1 month; [a] adjusted for all other variables in the model.

Table 4-8: Predictors of worsened function – logistic regression

Factor	Univariate Odds Ratio [95% CI] †	Adjusted Odds Ratio[¤] [95% CI] †
Age (years)	.98 [.96,1.00]	.99 [.96,1.02]
BMI	1.01 [.96,1.05]	1.03 [.98,1.09]
Comorbidities	1.17 [.92,1.48]	1.27 [.96,1.67]
MQS (baseline)	1.00 [.94,1.06]	1.01 [.94,1.09]
Gender		
Male	1.00	1.00
Female	.78 [.46,1.31]	.88 [.46,1.69]
Affected Joint		
Hip	1.00	1.00
Knee	.69 [.41,1.16]	.58 [.31,1.08]
Diagnosis		
Osteoarthritis	1.00	1.00
Rheumatoid Arthritis	2.21 [.68,7.17]	3.20 [.81,12.53]
Previous Replacement		
No	1.00	1.00
Yes	.93 [.52,1.65]	.76 [.38,1.5]
Education:		
Not Completed High School	.66 [.36,1.23]	.71 [.35,1.42]
Completed High School	1.90[.99,3.64]	2.21 [1.05,4.66]
Post Secondary Education	1.00	1.00
Language		
English or French	1.00	1.00
Other	1.05 [.56,2.00]	.99 [.47,2.07]
Marital Status		
Unmarried	1.00	1.00
Married	.93 [.55,1.59]	.83 [.43,1.60]
Working Status		
Not full time	1.00	1.00
Full time	1.81 [.80,4.10]	1.35 [.45,4.07]
WOMAC – Function (baseline)	.98 [.96,.99]	.96 [.93,.98]
WOMAC – Pain (baseline)	.99 [.97,1.00]	1.02 [.99,1.06]
SF-36 Social Function (baseline)	.99 [.98,1.00]	1.00 [.98,1.01]
SF-36 Vitality (baseline)	.99 [.97,1.00]	.99 [.97,1.01]
SF-36 Role Emotional (baseline)	1.00 [.99,1.01]	1.00 [1.00,1.01]
SF-36 Mental Health (baseline)	1.00 [.98,1.01]	1.01 [.99,1.03]
Waiting Time ‡	1.00 [1.00,1.00]	1.00 [.99,1.00]

† CI = Confidence Interval; ‡ only includes patients who waited > 1 month; [¤] adjusted for all other variables in the model.

Figure 4.1: WOMAC subscale change scores and waiting time

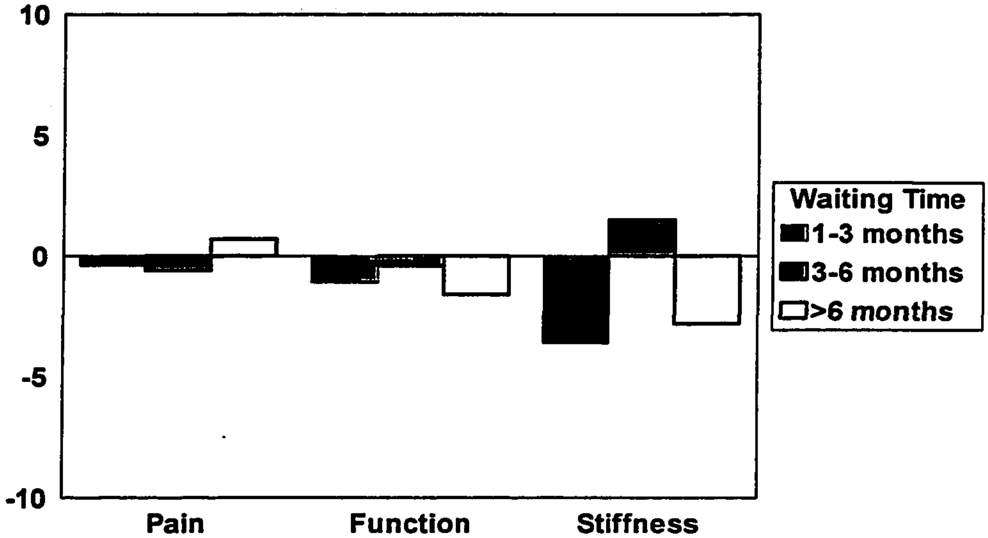
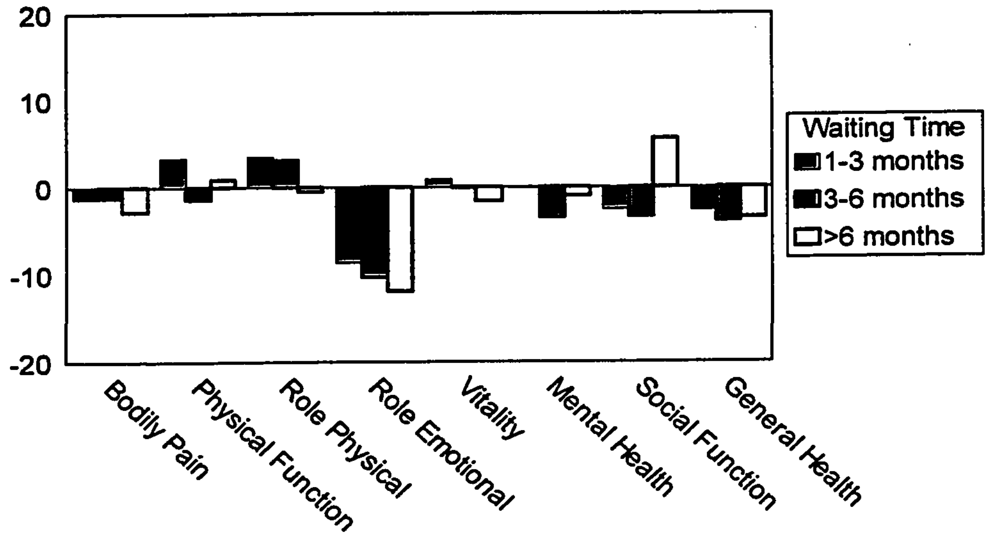


Figure 4.2: SF-36 subscale change scores and Waiting Time



4.6 References

Bellamy N. Buchanan WW, Goldsmith CH, Campbell J, Stitt L. (1988a). Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. Journal of Orthopaedic Rheumatology,1,95-108.

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988b). Validation study of the WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. The Journal of Rheumatology, 15, 1833-1840.

Bellamy, N. (1989). Pain assessment in osteoarthritis: experience with the WOMAC osteoarthritis index. Semin Arthritis Rheum, 18(Suppl 2), 14-17.

Bellamy, N., Sothern, R. B., & Campbell, J. (1990). Rhythmic variations in pain perception in osteoarthritis of the knee. The Journal of Rheumatology, 17(3), 364-372.

Bellamy, N., Wells, G., & Campbell, J. (1991). Relationship between severity and clinical importance of symptoms in osteoarthritis. Clinical Rheumatology, 10(2), 138-143.

Brazier, J. E., Harper, R., Jones, N. M. B., O'Cathain, A., Thomas, K. J., Usherwood, T., & Westlake, L. (1992). Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ, 305, 160-164.

Burckhardt, C.S., Goodwin, L.D., Prescott, P.A. (1982). The measurement of change in nursing schools: Statistical considerations. Nursing Research, 31,53-55.

Cameron L, Leventhal EA, Leventhal H. (1993). Symptom representations and affect as determinants of care seeking in a community-dwelling, adult sample population. Health Psychology, 12,171-9.

Charlson, M., Szatrowski, T. P., Peterson, J., & Gold, J. (1994). Validation of a combined comorbidity index. J Clin Epid, 47, 1245-1251.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis, 40(5), 373-383.

Chronbach, L.J. and Furby,L. (1970). How should we measure 'change' – or should we? Psychological Bulletin, 74,68-80.

Coyte, P. C., Wright, J. G., Hawker, G. A., Bombardier, C., Dittus, R. S., Paul, J. E., Freund, D. A., & Ho, E. (1994). Waiting times for knee-replacement surgery in the United States and Ontario [see comments]. New England Journal of Medicine, 331(16), 1068-1071.

Darlington, R. B. (1990). Regression and Linear Models. U.S.A. McGraw-Hill Inc.

Hamilton SM, Letourneau S, Pekeles E, Voaklander D, Johnston WC. The impact of regionalization on a surgery program in the Canadian health care system. Arch Surg 1997;132:605-610.

Hernborg J.S., Nilsonn B.E. (1977). The natural course of untreated osteoarthritis of the knee. Clinical Orthopaedics and Related Research 123, 130-7.

Ho, E., Coyte, P. C., Bombardier, C., Hawker, G., & Wright, J. G. (1994). Ontario patients' acceptance of waiting times for knee replacements. Journal of Rheumatology, 21(11), (pp 2101-2105).

Katz, J. N., Wright, E. A., Guadagnoli, E., Liang, M. H., Karlson, E. W., & Cleary, P. D. (1994). Differences between men and women undergoing major orthopedic surgery for degenerative arthritis. Arthritis & Rheumatism, 37(5), 687-694.

Mancuso, C. A., Ranawat, C. S., Esdaile, J. M., Johanson, N. A., & Charlson, M. E. (1996). Indications for total hip and total knee arthroplasties. Results of orthopaedic surveys. Journal of Arthroplasty, 11(1), 34-46.

Masters-Steedman, S., Middaugh, S. J., Kee, W. G., Steir-Carson, D., Harden, R. N., & Millar, M. C. (1992). Chronic-pain medications: equivalence levels and methods of quantifying usage. Clin J Pain, 8, 204-214.

Naylor, C. D., Williams, J. I., & The Ontario panel on hip and knee arthroplasty. (1996). Primary hip and knee replacement surgery: Ontario criteria for case selection and surgical priority. Quality in Health Care, 5, 20-29.

Peterson, M. G., Hollenberg, J. P., Scatrowski, T. P., Johanson, N. A., Mancuso, C. A., & Charlson, M. E. (1992). Geographic variation in the rates of elective total hip and knee arthroplasties among medicare beneficiaries in the United States. The Journal of Bone And Joint Surgery, 10, 1530-1539.

Streiner, D.L. and Norman, G.R. (1995). Health Measurement Scales: A practical guide to their development and use. New York, Oxford Medical Publications.

Van Walraven, C., Paterson, J. M., Kapral, M., Chan, B., Bell, M., Hawker, G., Gollish, J., Schatzker, J., Williams, J. I., & Naylor, C. D. (1996). Appropriateness of primary total hip and knee replacements in regions of Ontario with high and low utilization rates. Canadian Medical Association Journal, 155(6), (697-706).

Visuri, T., Honkanen, R. (1982). The role of socio-economic status and place of residence in total hip replacement. Scand J Soc Med, 10, (95-99).

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36) 1. Conceptual framework and item selection. Medical Care, 30(6), 473-483.

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). SF-36 Health Survey: Manual and Interpretation Guide. Boston,Mass. Nimrod Press.

Williams, J. I., Llewellyn Thomas, H., Arshinoff, R., Young, N., & Naylor, C. D. (1997). The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. Journal of Evaluation in Clinical Practice, 3(1), 59-68.

Wright, J. G., Coyte, R., Hawker, G., Bombardier, C., Cooke, D., Heck, D., Dittus, R., & Freund, D. (1995). Variation in orthopedic surgeons' perceptions of the indications for and outcomes for knee replacement. CMAJ, 152, 687-697.

Zola L. (1973). Pathways to the doctor – from person to patient. Social Science and Medicine, 7, 677-89.

CHAPTER 5

OVERVIEW AND FUTURE DIRECTIONS

5.1 Overview

The preceding chapters have examined factors related to waiting time for major joint arthroplasty and determinants of change in pain and function while waiting for replacement surgery. Chapter 1 provided a review of the surgical procedures for performing total hip and knee replacements, and discussed the trends and utilisation of this type of surgery. Previous research on waiting lists for surgical procedures, which began in the late 1980's, was outlined, and a description of the health status instruments used for this research project. At the end of Chapter 1 the research objectives were listed, and a description of the statistical analyses used for this research project.

Chapter 2 reported on an investigation of the impact of health status on waiting time for major joint arthroplasty and examined the relationship between health status, as measured with the WOMAC and SF-36 health status instruments, age, gender, diagnosis, comorbidities, BMI and waiting time. It was determined that patients with more severe pain and disability did not have surgery substantially earlier. Patients' BMI and social functioning were the only variables that were significantly related to waiting time, but these variables accounted for only a very small proportion of waiting time variability. Since only a small portion of waiting time can be predicted by variables analysed in this study, none of which were related to patients' pain and disability, it was concluded that further research was necessary to determine what other factors relate to waiting time for major joint arthroplasty.

Chapter 3 examined patient's health status, demographic and clinical characteristics, and several health systems variables, to ascertain whether waiting lists were managed in an equitable fashion. It was determined that there was no bias in waiting time with regard to age, gender, marital status, language spoken, and socio-economic status as measured by education, and work status. As well, no association was observed between other clinical factors such as previous arthroplasty, affected joint, pain medication use, walking aids, residence type and waiting time. Patients' BMI, social functioning, and the size of their surgeons' arthroplasty practices were significantly related to waiting times. It was concluded that greater emphasis was placed on the patient's overall functioning than on the amount of pain and disability they were experiencing, when deciding where to place them on the waiting list. It was also recommended that surgeons who perform more total hip and knee replacements per year should have operating room time adjusted proportionately, so that their patients do not have a significantly longer wait.

Chapter 4 illustrated the effects that waiting for major joint arthroplasty have on patients' pain and physical functioning, and describes the relationships between patient characteristics, baseline health status and change in pain and physical function that occurred while patients wait for surgery. It was determined that minimal amounts of change in pain and function (physical and psychosocial) occurred for both hip and knee replacement patients during this waiting period, with approximately the same percentage of patients showing improvement as showing a worsening of symptoms. Women in this study had an increased risk of worsened pain while they waited for hip or knee replacement surgery. As well, patients with a high school education were found to have an increased risk of worsened functional ability while they waited for hip or knee replacement surgery, compared to those with some post-secondary education. Chapter 4 concluded with the opinion that it was difficult to predict, at the time the patients were placed on the waiting list for major joint replacement surgery, who would get worse in terms of pain and function while they waited.

The contribution of the present research to the body of knowledge regarding waiting time for total hip and knee replacement surgery, lies in the corroboration with other recent studies, that the patients level of pain and physical function did not predict the length of time patients waited for surgery. While Williams (Williams et al., 1997) determined this relationship in their Ontario study, research was needed on waiting list management in this region to ascertain whether a change in waiting list policy was required. No biases in terms of age, gender, socio-economic, or surgical site were unveiled. The average waiting time for major joint arthroplasty, and the level of pain and disability that patients were experiencing when they were placed on the waiting list was also determined. The present study further discovered that patients' levels of pain and physical function changed minimally while they were on the waiting list. A study such as this, addressing changes in pain and function while waiting for major joint arthroplasty, has never been published.

5.2 Future Direction

It has been hypothesised that residents in higher-rate areas undergo joint replacements for less appropriate indications than residents in lower-rate areas (Van Walraven et al., 1996; Wright et al., 1995; Katz et al., 1996; Naylor et al., 1996). Major joint arthroplasty utilisation patterns have not been assessed for this region, nor have comparisons been made to other regions in the province and country. It is now possible to determine specific rates of total hip and knee replacements, and to analyse factors related to high and low rate areas, using data collected for this study.

Research has shown that waiting times for major joint replacement surgery do not have a negative impact on outcome (Williams et al., 1997). The findings of this study indicated a similar trend, in that waiting time did not appear to have a negative impact on patients' level of pain and disability. Coupled with follow-up data on our patient population that is currently being collected, it can be determined whether waiting time has a negative impact on surgical outcomes. To date, few studies focusing on the consequential effects of waiting time for this type of surgery have been published, therefore further work in this area is necessary for continual monitoring of waiting list policies.

Waiting time in this study was an exact calculation, taken directly from the hospital databases. However, this waiting period captures only the inpatient waiting period, and does not incorporate the time spent waiting for the specialist's appointment. It has been suggested that including the initial general practitioner referral in the total postreferral waiting time is a more valid indication of the total time that patients have to wait for surgery (Smith, 1994). Although existing computerised information systems do not currently capture this information, it may be possible to calculate the total postreferral waiting time with information gained from this study and primary care physicians data.

The methods used for this study provided an accurate, efficient and acceptable way of calculating exact waiting times for major joint arthroplasty, and for assessing the level of pain and function patients experienced while waiting for surgery. The length of waiting time for major joint replacement surgery should be monitored on a continual basis, and data linkage procedures and calculations outlined in this study could easily be reproduced on an annual basis. The appropriateness of total joint replacements in this region could also be monitored, utilising an abbreviated data collection form on a random sample of patients. Finally, if a change in waiting list policy was initiated, the results of the study would be beneficial in the development of criteria for prioritising patients on waiting lists.

In a universally funded health system, monitoring of waiting lists for elective surgical procedures are paramount. The study's protocol has proven effective for total replacement surgery, and could be used for monitoring other elective surgical procedures.

5.3 References

Katz, J. N., Wright, E. A., Guadagnoli, E., Liang, M. H., Karlson, E. W., & Cleary, P. D. (1994). Differences between men and women undergoing major orthopedic surgery for degenerative arthritis [see comments]. Arthritis & Rheumatism, 37(5), 687-694.

Naylor, C. D., Williams, J. I., & The Ontario panel on hip and knee arthroplasty. (1996). Primary hip and knee replacement surgery: Ontario criteria for case selection and surgical priority. Quality in Health Care, 5, 20-29.

Smith, T. (1994). Waiting times: monitoring the total postreferral wait. BMJ 309, 593-596.

Van Walraven, C., Paterson, J. M., Kapral, M., Chan, B., Bell, M., Hawker, G., Gollish, J., Schatzker, J., Williams, J. I., & Naylor, C. D. (1996). Appropriateness of primary total hip and knee replacements in regions of Ontario with high and low utilization rates. Canadian Medical Association Journal, 155(6), (697-706).

Williams, J. I., Llewellyn Thomas, H., Arshinoff, R., Young, N., & Naylor, C. D. (1997). The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. Journal of Evaluation in Clinical Practice, 3(1), 59-68.

Wright, J. G., Coyte, R., Hawker, G., Bombardier, C., Cooke, D., Heck, D., Dittus, R., & Freund, D. (1995). Variation in orthopedic surgeons' perceptions of the indications for and outcomes for knee replacement. CMAJ, 152, 687-697.

APPENDIX A

Sample Size Calculations

To answer the primary objective - objective #1, an estimated sample size of 170 is required to detect a medium effect size (correlation of 0.39; $R^2 = 0.15$), and 1100 is required to detect a small effect size (correlation of 0.14; $R^2 = 0.02$) between the independent variables and waiting time. These estimations assume an alpha level of 0.05, power of 80%, and are based on 24 variables in the model. Since, the ability to detect a small effect size will have little clinical significance, the ability to detect a small to medium effect size is sought.

It is expected that some variables in this study will be highly correlated with change in pain and function - objective #3. A similar study (Williams et al., 1997) using a sample of 209 patients, yielded multiple correlations (R^2) of 0.43, 0.43 and 0.33 respectively, when regressing initial pain, age, and co-morbidity, from the WOMAC instrument, on change in pain, change in functioning and change in stiffness. Since large differences are easier to detect, the above sample size calculations may be conservative estimations, but will have sufficient power for subgroup comparisons.

The SF-36 instrument (1994) has accompanying estimated sample size calculations that are based on formulas published by Cohen (1988) and variance estimates from general U.S. population studies. For all estimates, the authors assumed a non-directional hypothesis (two-tailed), with a false rejection rate of 5% (alpha = 0.05) and a statistical power of 80%. To detect a 5 point difference (clinically significant) on the SF-36, the sample size required for the: physical functioning subscale is 137; bodily pain subscale is 142; and overall general health is 105.

With consideration given to the above calculations, a sample size of 550 major joint replacement patients has been chosen. This estimation is sufficient to allow for subgroup analyses, minimal attrition, and difficulties arising from incomplete data.

APPENDIX B

Capital Health Authority

INFORMATION SHEET

Hip and Knee Replacement in the Capital Health Region

Principal Investigators: Dr. Don Voaklander
Dr. Maria Suarez-Almazor

Co-Investigators: Dr. Bill Johnston
Mr. Gordon Kramer
Dr. Lynn Redfern

Background: As our population ages, chronic diseases which interfere with years of life in good health and with the ability to function independently are of increasing concern. Mobility is an important factor in independent living. The significant number of persons suffering from arthritis, an aging population, and the good results attained with joint replacement surgery have resulted in a growing demand for such surgery. However, waiting times for joint replacement surgery have become a concern for the public in recent years as the demand grows.

Purpose: You are being asked to participate in this research study. The purpose of this study is to identify factors related to waiting times for hip or knee replacement surgery.

Procedures: Participating in this study will involve three assessments: today, just prior to surgery, and at 6 months post surgery. At these times you will be asked to complete surveys regarding you health, daily activities, and quality of life. Each assessment will need about thirty minutes. The first questionnaire will be administered in your home, while the follow-up questionnaires will be administered either in your home or the pre-admission surgery clinic.

Possible Benefits: There may not be direct benefits to you for being in this study. However, it is expected that once the study is complete, the results will help caregivers understand who has been receiving surgery with the least wait.

Possible Risks: There are no risks involved in this study.

Confidentially: Personal records relating to the study will be kept confidential. Any report coming of this research will not give your name.

You are free to with draw from the research study at any time and your continuing medical care will not be affected in any way. If the study is discontinued at any time, the quality of your medical care will not be affected.

Please contact any of the individuals identified below if you have any questions or concerns.
Dr. Don Voaklander at (403) 492-5099 or Dr. Maria Suarez-Almazor at (403) 492-9589

APPENDIX C

CONSENT FORM (To be completed by research subject)

Title of Project:	Hip and Knee Replacement in the Capital Health Region
Principal Investigators:	Don Voaklander, Ph.D.
	Maria Suarez-Almazor, Ph.D.
Co-Investigators:	Bill Johnston, M.D.
	Gordon Kramer, M.H.S.A.
	Lynn Redfern, Ph.D.

Please circle YES or NO in response to each of the following questions:

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached the information sheet?	Yes	No
Do you understand that there are no benefits and risks involved in taking part in this study?	Yes	No
Do you understand that you are free to withdraw from this study at any time without having to give a reason and without affecting your future medical care?	Yes	No
Has the issue of confidentiality been described to you, and do you understand who will have access to the information you provide?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No

Who explained this study to you? ______________________

I agree to take part in this study: YES NO

Signature of Participant______________________ Date ___________

(Printed Name) ______________________

Signature of Witness ______________________

Signature of Investigator or Designee ______________________

APPENDIX D

UNIVERSITY OF ALBERTA HIP AND KNEE REPLACEMENT IN THE CAPITAL HEALTH REGION

Name		Sex	Male	Female	Age	
Site	Hip	Knee	Side	Right	Left	Both	Personal Health #
Height	Weight	Referral Date		Waiting List Date		
Home Phone		Work Phone				
Address				SURVEY DATE		

WOMAC SCALE

You are being asked to indicate on this scale the amount of pain, stiffness, or disability you are experiencing. The further you place your 'X' to the right, the more pain, stiffness or disability you are indicating that you experience.

The following questions concern the amount of pain you are currently experiencing due to arthritis in your hips and/or knees. For each situation please tell me the amount of pain recently experienced.

Question: How much pain do you have?

1. Walking on a flat surface.	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme
2. Going up or down stairs.	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme
3. At night while in bed.	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme
4. Sitting or lying.	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme
5. Standing upright.	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme

The following questions concern the amount of joint stiffness (not pain) you are currently experiencing due to arthritis in your hips and/or knees. Stiffness is a sensation of restriction or slowness in the ease with which you move your joints.

6. How severe is your stiffness after first wakening in the morning?	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme
7. How severe is your stiffness after sitting, lying, or resting later in the day?	1. None	2. Mild	3.Moderate	4. Severe	5.Extreme

The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities, please indicate the degree of difficulty you are currently experiencing due to arthritis in your hips and/or knees.

Question: What degree of difficulty do have with-?

8. Descending stairs.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
9. Ascending stairs.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
10. Rising from sitting.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
11. Standing. .	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
12. Bending to floor.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
13. Walking on flat.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
14. Getting in/out of car.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
15. Going shopping.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
16. Putting on socks/stockings.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
17. Rising from bed.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
18. Taking off socks/stockings.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
19. Lying in bed.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
20. Getting in/out of bath.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
21. Sitting.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
22. Getting on/off toilet.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
23. Heavy domestic duties.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme
24. Light domestic duties.	◯ 1. None	◯ 2. Mild	◯ 3.Moderate	◯ 4. Severe	◯ 5.Extreme

SF-36 HEALTH SURVEY

INSTRUCTIONS: This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities.

Answer every question by marking the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

1. In general, would you say your health is:

(circle one)

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

2. Compared to one week ago, how would you rate your health in general now?

(circle one)

Much better now than one week ago	1
Somewhat better now than one week ago	2
About the same as one week ago	3
Somewhat worse now than one week ago	4
Much worse now than one week ago	5

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(circle one number on each line)

ACTIVITIES	Yes, Limited A Lot	Yes, Limited A Little	No, Not Limited At All
a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
c. Lifting or carrying groceries	1	2	3
d. Climbing several flights of stairs	1	2	3
e. Climbing one flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking more than a kilometre	1	2	3
h. Walking several blocks	1	2	3
i. Walking one block	1	2	3
j. Bathing or dressing yourself	1	2	3

4. During the past week, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

(circle one number on each line)

	YES	NO
a. Cut down on the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Were limited in the kind of work or other activities	1	2
d. Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

5. During the past week, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

(circle one number on each line)

	YES	NO
a. Cut down the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Didn't do work or other activities as carefully as usual	1	2

6. During the past week, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

(circle one)

Not at all 1
Slightly 2
Moderately 3
Quite a bit 4
Extremely 5

7. How much bodily pain have you had during the past week?

(circle one)

None 1
Very mild 2
Mild 3
Moderate 4
Severe 5
Very severe 6

8. During the past week, how much did pain interfere with your normal work (including both work outside the home and housework)?

(circle one)

Not at all 1

A little bit 2

Moderately 3

Quite a bit 4

Extremely 5

9. These questions are about how you feel and how things have been with you during the past week. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past week -

(circle one number on each line)

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
a. Did you feel full of pep?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6
f. Have you felt downhearted and blue?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

10. During the past week, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

(circle one)

All of the time 1

Most of the time 2

Some of the time 3

A little of the time 4

None of the time 5

11. How TRUE or FALSE is each of the following statements for you?

(circle one number on each line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a. I seem to get sick a little easier than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

OTHER INFORMATION

1. Do you presently suffer from or are you being treated for any of the following chronic conditions?

- ◯ 1. Serious trouble with back pain.
- ◯ 2. Other serious problems with joints or bones.
- ◯ 3. Circulatory problems.
- ◯ 4. Heart disease.
- ◯ 5. Emphysema or chronic bronchitis or persistent cough.
- ◯ 6. Arthritis or rheumatism.
- ◯ 7. Moderate or severe kidney disease.(eg. transplant or dialysis patient)
- ◯ 8. Asthma
- ◯ 9. Digestive problems
- ◯ 10. Cancer
- ◯ 11. Eye problems, for example, glaucoma, cataracts.
- ◯ 12. Diabetes
- ◯ 13. Severe Diabetes (Some organ or eye damage)
- ◯ 14. Stomach ulcer.
- ◯ 15. High blood pressure or hypertension.
- ◯ 16. Skin allergies or other skin disease.
- ◯ 17. Goitre or thyroid trouble.
- ◯ 18. Hay fever or other allergies.
- ◯ 19. Epilepsy.
- ◯ 20. Paralysis or speech problems due to stroke.
- ◯ 21. Liver disease (eg. chronic hepatitis)
- ◯ 22. Moderate or severe liver disease (eg. severe cirrhosis)
- ◯ 23. Other chronic health problem

2. Who lives with you? (check all that apply)

- ◯ No one
- ◯ Husband or wife
- ◯ Children
- ◯ Grandchildren
- ◯ Parents
- ◯ Grandparents
- ◯ Brothers and/or sisters
- ◯ Other relatives
- ◯ Other relatives
- ◯ Friends
- ◯ Other
- ◯ Non-related paid helper

3. How many people do you know well enough to visit within their homes?

◯ None 1 ◯ One or two 2 ◯ Three or four 3 ◯ Five or more 4

4. About how many times did you talk to someone-friends, relatives, or others on the telephone in the past week (either you called them or they called you)?

◯ Not at all 1	◯ Once 2	◯ 2-6 times 3	◯ Once a day or more 4

5. How many times during the past week did you spend some time with someone who does not live with you; that is you went to see them or they came to visit you, or you went out to do things together?

◯ Not at all 1	◯ Once 2	◯ 2-6 times 3	◯ Once a day or more 4

6. Do you see your relatives and friends as often as you want to, or not?	◯ 1. As often as wants to	◯ 2. Not as often as wants to
7. Is there someone who would give you any help at all if you were sick or disabled, for example your husband/wife, a member of your family, or a friend?	◯ 1. Yes	◯ 2. No one willing and able to help
8a. Is there someone who would take care of you now and then (taking you to the doctor or getting you groceries, etc.)?	◯ 1. Yes	◯ 2. No one willing and able to help

8b. Who is this person?

- ◯ 1. Spouse
- ◯ 2. Sibling
- ◯ 3. Offspring
- ◯ 4. Grandchild
- ◯ 5. Other kin
- ◯ 6. Friend
- ◯ 7. Other

9a. Is there someone who would take care of you for a short time (a few weeks to six months)?	◯ 1. Yes	◯ 2. No one willing and able to help

9b. Who is this person?

- ◯ 1. Spouse
- ◯ 2. Sibling
- ◯ 3. Offspring
- ◯ 4. Grandchild
- ◯ 5. Other kin
- ◯ 6. Friend
- ◯ 7. Other

10a. Is there someone who would take care of you for as long as needed?	◯ 1. Yes	◯ 2. No one willing and able to help

10b. Who is this person?

- ◯ 1. Spouse
- ◯ 2. Sibling
- ◯ 3. Offspring
- ◯ 4. Grandchild
- ◯ 5. Other kin
- ◯ 6. Friend
- ◯ 7. Other

11. What medications are you presently taking to manage pain?

MEDICATION	DOSAGE	FREQUENCY	COST

INJECTIONS(Please List)

12. Have you had a previous joint replaced?	◯ 1. Yes	◯ 2. No	Date of Replacement
13. If yes to #12, which?	◯ 1. Hip	◯ 2. Knee	

14. What is the highest level of education that you have attained?

- ◯ 1.Grade 8 or less.
- ◯ 2. Partial high school.
- ◯ 3. Completed high school.
- ◯ 4. Partial technical school or university.
- ◯ 5. Completed technical school.
- ◯ 6. Completed university.

15. Residence type.

- ◯ 1.Apartment.
- ◯ 2. Condominium.
- ◯ 3. House.
- ◯ 4. Senior's complex.
- ◯ 5. Nursing home.

16. What is your first language?	◯ 1. English	◯ 2. French	◯ 3. Other
17. If you could have surgery sooner by changing surgeons, would you?	◯ 1. Yes	◯ 2. No	
18. In the last 2 weeks, have you had any visits with:			

			If yes, how many?	Did you pay for this service yourself?		
Physiotherapists	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Occupational Therapists	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Social Workers	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Nutrionists	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Community Nurses	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Research Nurses	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Chiropractors	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Homemakers	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Meals on Wheels	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Psychologists	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes
Other	◯ No	◯ Yes		◯ No	◯ Part	◯ Yes

19. What type of aids do you use in getting around? (mark all that apply)

- ◯ None
- ◯ Cane
- ◯ One Crutch
- ◯ Two Canes
- ◯ Two Crutches
- ◯ Walker
- ◯ Knee Brace
- ◯ Ankle Brace

20. What is your current employment status? (mark all that apply)

- ◯ Working full time
- ◯ Working part time
- ◯ Self-employed
- ◯ Student
- ◯ Homemaker
- ◯ On sick leave
- ◯ On Workers' Compensation
- ◯ On Unemployment Insurance
- ◯ On Disability Plan
- ◯ Retired from work
- ◯ Receiving a pension
- ◯ Unemployed

21. Approximately what is your family's combined monthly income before deductions from all sources?

- ◯ 1. $0 to $499
- ◯ 2. $500 to $999
- ◯ 3. $1,000 to $1,999
- ◯ 4. $2,000 to $2,999
- ◯ 5. $3,000 to $3,999
- ◯ 6. $4,000 to $4,999
- ◯ 7. $5,000 to $5,999
- ◯ 8. $6, 000 or over

22. All together, how many people live on this income?	

APPENDIX E

TABLE 6.II FORMULAS FOR SCORING AND TRANSFORMING SCALES

Scale	Sum Final Item Values *(after recoding items as in Tables 6.1-6.8)*	Lowest and highest possible raw scores	Possible raw score range
Physical Functioning	3a+3b+3c+3d+3e+ 3f+3g+3h+3i+3j	10, 30	20
Role–Physical	4a+4b+4c+4d	4, 8	4
Bodily Pain	7+8	2, 12	10
General Health	1+11a+11b+11c+11d	5, 25	20
Vitality	9a+9e+9g+9i	4, 24	20
Social Functioning	6+10	2, 10	8
Role–Emotional	5a+5b+5c	3, 6	3
Mental Health	9b+9c+9d+9f+9h	5, 30	25

Formula and example for transformation of raw scale scores

$$\text{Transformed Scale} = \left[\frac{\text{(Actual raw score} - \text{lowest } \textit{possible} \text{ raw score)}}{\textit{Possible} \text{ raw score range}}\right] \times 100$$

Example: A Physical Functioning raw score of 21 would be transformed as follows:

$$\left[\frac{(21-10)}{20}\right] \times 100 = 55$$

Where lowest possible score = 10 and possible raw score range = 20