Article

AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY

Foot & Ankle International®
1–11

DOI: 10.1177/1071100719856888
journals.sagepub.com/home/fai

Health and Quality of Life Outcomes Among Patients Undergoing Surgery for End-Stage Ankle Arthritis

Shanika Rajapakshe, MSc[1], Jason M. Sutherland, PhD[1], Kevin Wing, MD[2], Trafford Crump, PhD[3], Guiping Liu, PhD[1], Murray Penner, MD[2], Alastair Younger, MD[2], Andrea Veljkovic, MD[2], and Kate Redfern, MSc[4]

Abstract

Background: There is little research investigating which aspects of health-related quality of life change following ankle arthrodesis and total ankle replacement surgery. The objective of this study was to report on statistically and clinically relevant changes in multiple dimensions of health-related quality of life among patients undergoing ankle replacement or fusion surgery.

Methods: This study was based on a prospective sample of ankle arthrodesis and total ankle replacement patients. Participants complete the Ankle Osteoarthritis Scale, EuroQoL's EQ-5D-3L, the Patient Health Questionnaire–9, and the pain intensity, interference with enjoyment of life, and general activity pain instrument. Instruments were completed preoperatively and postoperatively. Multivariate regression models were used to measure the change in health-related quality of life outcomes, adjusting for demographic, clinical, and health service utilization.

Results: Participants achieved statistically significant improvements in health-related quality of life in each domain of measurement. The majority of participants reported clinically significant improvement in pain. Mild depressive symptoms were common, and clinically significant improvement in depression symptoms occurred in 22% of patients. Gains in health were more pronounced among participants reporting the worst preoperative health in all domains quality of life measured.

Conclusions: Pain showed a clinically important improvement among 64% of participants whereas 22% reported a clinically meaningful improvement in their depression symptoms postoperatively. Clinically significant gains in health-related quality of life were not experienced by all participants in all dimensions. Further research is warranted to better understand the failure of some patients to improve in dimensions of health studied.

Level of Evidence: Level III, comparative study.

Keywords: Ankle arthrodesis, minimally important difference, patient-reported outcomes, quality of life, total ankle replacement

Introduction

The objectives of surgery for end-stage ankle arthritis are to address the patient's activity-related pain and associated loss of ankle function and improve their overall health-related quality of life.[12,21] The 2 most common operative strategies are ankle arthrodesis (AA) and total ankle replacement (TAR).[23] There is a dearth of research regarding patients' perspectives of their AA or TAR surgery across multiple domains of physical and mental health.

To understand the patients' perspective of their AA or TAR surgery, all dimensions of health should be considered, not simply individual ankle function. Patient-reported

[1]Centre for Health Services and Policy Research, School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada
[2]Department of Orthopaedics, University of British Columbia, Vancouver, British Columbia, Canada
[3]Department of Surgery, University of Calgary, Calgary, Alberta, Canada
[4]Vancouver Coastal Health Authority, Vancouver, British Columbia, Canada

Corresponding Author:
Jason M. Sutherland, PhD, Centre for Health Services and Policy Research, School of Population and Public Health, University of British Columbia, 201-2206 East Mall, Vancouver, British Columbia V6T 1Z3, Canada.
Email: jason.sutherland@ubc.ca

outcomes (PROs) are increasingly being used to measure patients' self-reported health and quality of life.[34] PROs are questionnaires that ask patients about specific dimensions of their health-related quality of life,[3,19] including physical and mental health status,[18] symptom severity, and interference.[16]

PROs have been described as generic when they measure broad aspects of health, such as mental and physical health, or condition-specific when they measure condition- or anatomic-specific health. PROs have been reported extensively in the literature for measuring effectiveness of hip and knee arthroplasty, though their application is less common or standardized for measuring ankle function or effectiveness of ankle interventions.[9,10,27,40]

There is recent evidence of the value of incorporating PROs for measuring outcomes and health-related quality of life among AA and TAR patients. Croft et al investigated the relationship between self-reported ankle-related-health with the need for revision surgery,[11] whereas others report associations between preoperative PRO scores and hospitalization length of stay.[46,52] However, the existing research is limited by which domains of patient's health were measured and smaller sample sizes.[14,38] These are important limitations given reportedly high prevalence of depression and psychological distress in osteoarthritis and orthopedic patients.[24,49]

The goal of this study was to measure changes in health-related quality of life during the perioperative period attributable to AA or TAR surgery for end-stage ankle arthritis in a number of domains of health. This study adjusted for the use of community-delivered physiotherapy in operative outcomes.[44,56]

Methods

Patient Recruitment

This study was based on a cohort of prospectively enrolled participants scheduled for elective AA or TAR for operative treatment of end-stage ankle arthritis. The setting of the study was Vancouver Coastal Health (VCH) Authority, a geographically defined health delivery region in British Columbia, Canada, and home to more than 1 million residents. Prospective participants were identified after being scheduled for AA or TAR with one of 4 foot and ankle surgeons.

Eligible patients were community-dwelling, 19 years of age or older, able to respond to survey questions in English with or without assistance, and scheduled for surgery at least 14 days from being registered on the operative queue. Patients who were scheduled for revision of AA or TAR were not included. Eligible patients were contacted via phone by VCH to participate and were carried out independently to surgical appointments.

Participants were sent a survey package in the mail or a secure link to an online survey package preoperatively. Participants received up to 2 reminder telephone calls or emails to complete their survey package. The survey package included a checklist of common chronic health conditions, 4 PROs, and contact information of study personnel. Participants completed a second survey package 6 months postoperatively that included the same PROs. Data for this study were collected between September 2015 and October 2018. VCH Legal and Privacy Office completed a Privacy Impact Assessment and the University of British Columbia's Research Ethics Board approved this study.

Instruments

The EQ-5D-3L was used to evaluate general health.[18] This instrument is composed of 5 items, each corresponding to one of the following domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each item was ranked on a 3-level scale of no problems, some problems, and severe problems. Participants also rated their overall health using a continuous visual analog scale (VAS) ranging from 0 (Worst imaginable health state) to 100 (Best imaginable health state). The EQ-5D-3L has been used with orthopedics patients,[5,20,22] and has been used in studies evaluating ankle surgery patients.[25]

To investigate self-reported disability and pain severity attributable to end-stage ankle arthritis, participants completed the Ankle Osteoarthritis Scale (AOS).[31,55] The AOS is used widely in foot and ankle research and has generally performed well on advanced psychometric analysis.[12,16,42] This 18-item condition-specific instrument is divided into two 9-item subscales for pain and disability. To complete each item, patients placed a mark along a 100-mm horizontal line bounded on the left as "No pain/difficulty" and on the right as "Worst pain imaginable / So difficult unable." An overall score was calculated as the average of the 2 subscale scores.

Twenty percent of orthopedic patients are estimated to suffer from symptoms of depression.[24,49] As depressed patients have worse postoperative outcomes[33,45] and require more lengthy follow-up,[28] the Patient Health Questionnaire–9 (PHQ-9) was used in this study to measure participants' self-reported symptoms of depression.[50] The instrument has been used in orthopedics,[4,49] administered to patients with ankle injuries,[7] and has seen increasing use with orthopedic patients.[51,52] This instrument measured functional impairment and symptoms due to depression. Participants responded to 9 items, each ranked on a 4-point Likert scale ranging from 0 (Not at all bothered) to 3 (Bothered nearly every day). A total score was calculated by summing the item scores. Scores greater than 10 were considered clinically significant depression, whereas scores above 15 and 20 corresponded to moderate and severe depression, respectively.[37]

Pain is an important indication for surgery and a major opportunity for postoperative improvement among orthopedic patients.[39] This study measured pain using the pain intensity (P), interference with enjoyment of life (E), and general (G) activity instrument.[36] Known as PEG, this 3-item instrument consists of 1 pain intensity item and 2 pain interference items. Items are scored on a scale of 0 (No pain/interference) to 10 (pain as bad as you can imagine/complete interference). The PEG instrument's total score is calculated as the average of the 3 items, and scores greater than 3 are indicative of high levels of pain.[43] The PEG has been validated in patients presenting with musculoskeletal pain in primary care[35,36] and is complementary to the ankle-specific questions in the AOS.

Analysis

Participants' PRO data were linked with their hospital discharge summary and outpatient rehabilitation clinic visits by VCH. An anonymized data set was made available to the study team for analyses. Participants' characteristics included age, sex, Charlson Comorbidity Index, representing their cumulative morbidity calculated from patients' hospital discharge summary (53), and a neighborhood-level indicator of socioeconomic status (SES). The analysis included an indicator representing patients' AA or TAR.

Age was summarized by 4 categories, 50 years of age and under, between 51 and 60, between 61 and 70, and over 70 years. SES was included in analyses because lower SES is associated with poorer postoperative outcomes, including increased pain and reduced physical function.[13,26] SES was determined from Canadian census data independent of this study, and shown categorized into 5 quintiles.[54] For presentation, a sixth quintile was included for patients with missing SES data.

As there is evidence of an association between delayed access to treatment and poorer outcomes,[6,48] the analysis included an integer variable representing the duration of patients' wait for surgery in weeks. This variable was defined by time between registration for surgery and surgery date. Wait time was summarized with 3 categories: 12 weeks or less, between 13 and 26 weeks, and greater than 26 weeks.

The analysis included a count of the number of participants' visits to publicly funded outpatient physiotherapy in the 180 days following discharge. There is research demonstrating the effectiveness of community-delivered rehabilitative services in hip and knee replacement patients for alleviating pain and optimizing recovery.[1,30,44] Physiotherapy is associated with improved short- and medium-term levels of physical function, pain, and range of motion.[1] In this study, privately paid rehabilitative services, which are thought to be common, were not observable and are a limitation of the results.

Demographic and clinical characteristics of participants, as well as utilization of publicly funded outpatient physiotherapy and wait time categories, are summarized by counts and percentages.

Each of the PROs were measured with continuously-valued variables. Means and standard deviations were calculated for the EQ-5D VAS, AOS, PEG, and PHQ-9 instruments, measuring health status, ankle-related quality of life, pain and depression, respectively. Unadjusted change in PRO values were reported, defined as the preoperative PRO value subtracted from the postoperative PRO value. The values were reported for the entire sample and for each demographic and clinical characteristic category. Differences between preoperative and postoperative values were measured using the paired *t* test, noting that no adjustment for multiple comparisons was used since the analyses was exploratory.

For each instrument and patient, an indicator variable was calculated representing whether the patients' change marked a clinically meaningful improvement, or achieved the change in PRO value that a patient would report to have been important or meaningful following surgery. This threshold was reported as the minimally important difference (MID).

This study assumed that the MID for the EQ-5D VAS is 7.0, noting that the MID for the EQ-5D VAS has been reported as 7.[47] A clinically significant change in the AOS was assumed to be the value of 28, derived using an anchor question-based approach.[8] For the PHQ-9, a clinically significant change was reported to be an MID value of 5 points or more.[41] For this study, a value of 5.0 was assumed to be the minimum change in PHQ-9 value that a patient would report the surgery to have been important or meaningful. This study assumed that a value of 1.0 is the change in PEG value that a patient would report the surgery to have been important or meaningful.[17]

For each instrument, the change in PRO value (postoperative score minus preoperative score) was adjusted for participant demographic and health services utilization characteristics by regressing the described predictors for each PRO instrument against participants' EQ-5D VAS, AOS, PEG, and PHQ-9 scores, respectively. The linear regression models included a term for preoperative PRO value as an explanatory variable. Although missing data for PROs was less than 1%, multiple imputation by chained equations with 100 imputations was used, which assumed that missing data was missing at random. All analysis was carried out in SAS, version 9.4.

Results

There were 190 patients eligible to participate. Among them, 46.7% participated and completed preoperative and postoperative PROs. This participation rate provided a

Table 1. Summary Statistics of Participant Demographic and Clinical Characteristics, EQ-5D VAS and AOS Scores, and Percentage Exceeding Instruments' MID Value.[a]

			EQ-5D VAS				AOS			
Characteristic	n	%	Preoperative Mean (SD)	Postoperative Mean (SD)	Difference *P* Value	Percentage Exceeding MID	Preoperative Mean (SD)	Postoperative Mean (SD)	Difference *P* Value	Percentage Exceeding MID
Overall	89	100.0	65.4 (18.8)	72 (16.2)	.003	42.7	60.5 (19.7)	31.7 (20.2)	<.001	45.5
Age group										
≤50 y	16	18.0	57.1 (17.1)	74.0 (16.0)	.002	56.3	66.3 (17.8)	43.6 (20.2)	.005	25.0
51-60 y	32	36.0	65.9 (16.3)	67.7 (16.1)	.645	37.5	64.5 (16.2)	28.9 (19.0)	<.001	71.4
61-70 y	26	29.2	69.0 (18.7)	76.3 (14.6)	.077	38.5	48.9 (24.6)	30.0 (21.6)	.049	21.4
>70 y	15	16.9	66.9 (24.5)	71.5 (18.5)	.309	46.7	67.1 (10.8)	27.3 (19.6)	.001	62.5
Sex										
Female	54	60.7	66.2 (18.3)	71.6 (16.8)	.058	40.7	65.8 (13.3)	39.6 (20.8)	<.001	33.3
Male	35	39.3	64.2 (19.6)	72.5 (15.4)	.019	45.7	56.9 (22.7)	27.1 (18.8)	<.001	53.9
Charlson Comorbidity Index										
0	79	88.8	66.9 (17.9)	72.6 (16.3)	.016	41.8	60.6 (18.7)	32.7 (20.6)	<.001	44.4
≥1	10	11.2	53.7 (22.4)	67.6 (15.2)	.047	50.0	60.0 (26.1)	27.2 (19.1)	.038	50.0
SES										
1 (highest)	13	14.6	71.5 (15.8)	70.0 (15.3)	.759	23.1	69.0 (14.6)	35.7 (14.9)	.001	57.1
2	20	22.5	68.9 (19.2)	70.8 (16.4)	.887	40.0	55.9 (16.0)	30.5 (23.2)	.018	33.3
3	17	19.1	59.1 (21.3)	72.8 (15.1)	.003	70.6	64.1 (21.6)	31.6 (20.6)	<.001	66.7
4	11	12.4	62.1 (22.9)	68.7 (24.3)	.212	36.4	66.9 (20.0)	49.1 (27.3)	.120	0.0
5 (lowest)	14	15.7	67.9 (18.2)	77.8 (11.8)	.070	35.7	61.5 (16.3)	6.2 (6.1)	.229	66.7
Missing	14	15.7	63.0 (14.3)	71.1 (15.6)	.156	42.9	55.0 (24.5)	30.6 (17.8)	.013	41.7
Surgery flag										
AA	61	68.5	65.7 (18.3)	71.7 (16.6)	.030	37.7	61.6 (18.3)	31.2 (19.7)	<.001	56.7
TAR	28	31.5	64.9 (20.2)	72.7 (15.5)	.031	53.6	58.1 (23.3)	33.2 (22.7)	.027	21.4
Wait time, wk										
0-12	34	38.2	68.5 (14.3)	73.6 (14.5)	.076	32.4	53.2 (21.4)	32.0 (16.5)	.001	43.8
13-26	19	21.3	60.1 (24.1)	68.9 (20.4)	.081	52.6	67.4 (20.1)	37.9 (15.8)	.009	40.0
>26	36	40.4	65.4 (19.0)	72.2 (15.3)	.080	47.2	63.1 (17.1)	27.7 (25.9)	<.001	50.0
Community physiotherapy visits										
0	81	91.0	65.6 (17.9)	73.0 (15.8)	.001	44.4	60.1 (19.9)	30.5 (19.8)	< .001	23.5
≥1	8	9.0	63.4 (27.1)	61.9 (17.3)	.845	25.0	66.3 (20.4)	45.0 (24.4)	.343	12.5

Abbreviations: AA, ankle arthrodesis; AOS, Ankle Osteoarthritis Scale; MID, minimally important difference; SD, standard deviation; SES, socioeconomic status; TAR, total ankle replacement; VAS, visual analog scale.
[a]Physiotherapy visits are within 180 days of discharge.

sample of 89 participants who underwent AA or TAR. Participants were, on average, 2 years older than nonparticipants (statistics not shown). No other differences were observed between participants and nonparticipants. Descriptive statistics of the characteristics of the sample are provided in Table 1.

Most participants were female (60.7%) and did not have other chronic health conditions (88.8%) reported on their hospital discharge. AA was more common (68.5%). Participants were distributed evenly across age groups and SES categories. The majority of patients waited for their surgery more than 26 weeks. Only 9% of participants received publicly funded physiotherapy in the 180 days following their surgery.

As shown in Table 1, the average gain in EQ-5D VAS score was 6.6 points, a statistically significant improvement. Many of the sample's subgroups had a statistically significant gain in VAS score. However, women participants older than 50 years and participants who received publicly funded physiotherapy did not achieve statistically significant gains in VAS score. Among all participants, 42% had a gain in the VAS score that exceeded the MID. Although participants from both operative groups had statistically significant changes in VAS score on average, 53.6% of the TAR group experienced a gain in score greater than the MID compared to 37.7% in the AA group.

Among participants, the average gain in the AOS score was 28.8, a statistically significant change. Analysis found that 45.5% of participants had a change in the AOS score that exceeded the instrument's MID of 28.0; the largest improvements were among participants with the highest preoperative values (worst health). Improvements in AOS values found that only 25% of the youngest participants' gain in AOS scores exceeded the MID.

The results shown in Table 2 for pain (the PEG instrument) demonstrate that all subgroups of participants reported lower levels of pain postoperatively, with the exception of the 9% of participants receiving publicly funded physiotherapy services. Among all participants, the majority (64%) reported a change in pain that exceeded the

Table 2. Summary Statistics of Participant Demographic and Clinical Characteristics, PEG and PHQ-9 Scores, and Percentage Exceeding Instruments' MID Value.[a]

			PEG				PHQ-9			
Characteristic	n	%	Preoperative Mean (SD)	Postoperative Mean (SD)	Difference *P* Value	Percentage Exceeding MID	Preoperative Mean (SD)	Postoperative Mean (SD)	Difference *P* Value	Percentage Exceeding MID
Overall	89	100.0	5.8 (2.5)	3.5 (2.5)	<.001	64.0	6.1 (5.7)	4.4 (4.4)	.002	22.5
Age group										
≤50 y	16	18.0	6.1 (2.7)	3.4 (2.6)	.001	62.5	8.6 (6.9)	5.1 (5.3)	.034	25.0
51-60 y	32	36.0	6.0 (2.4)	3.9 (2.3)	<.001	59.4	6.3 (5.3)	5.1 (4.8)	.247	28.1
61-70 y	26	29.2	5.6 (2.4)	3.1 (2.7)	.001	73.1	4.5 (5.0)	3.8 (3.1)	.390	11.5
>70 y	15	16.9	5.5 (3.0)	3.6 (2.5)	.012	60.0	6.1 (5.6)	3.4 (4.3)	.008	26.7
Sex										
Female	54	60.7	5.8 (2.4)	3.6 (2.4)	<.001	57.4	6.2 (5.6)	4.9 (4.8)	.056	20.4
Male	35	39.3	5.8 (2.8)	3.4 (2.6)	<.001	74.3	6.0 (5.9)	3.8 (3.6)	.008	25.7
Charlson Comorbidity Index										
0	79	88.8	5.7 (2.5)	3.5 (2.5)	<.001	60.8	6.0 (5.6)	4.5 (4.4)	.010	20.3
≥1	10	11.2	7.2 (2.6)	4.1 (2.5)	.014	90.0	7.3 (6.1)	4.3 (4.1)	.033	40.0
SES										
1 (highest)	13	14.6	5.5 (3.0)	3.7 (2.4)	.009	61.5	5.4 (6.5)	3.7 (3.8)	.265	38.5
2	20	22.5	5.3 (2.4)	3.6 (2.3)	.023	55.0	7.4 (6.0)	4.2 (4.3)	.014	30.0
3	17	19.1	6.5 (2.2)	3.8 (2.4)	<.001	76.5	7.6 (4.9)	4.8 (3.7)	.005	23.5
4	11	12.4	6.4 (2.3)	3.5 (2.8)	.003	63.6	5.3 (3.7)	5.3 (4.9)	1.000	0.0
5 (lowest)	14	15.7	5.4 (3.0)	3.1 (3.3)	.033	50.0	4.7 (5.8)	3.8 (5.3)	.423	21.4
Missing	14	15.7	6.1 (2.5)	3.4 (2.1)	.004	78.6	5.4 (6.5)	5.1 (4.8)	.871	14.3
Surgery flag										
AA	61	68.5	5.8 (2.6)	3.5 (2.5)	<.001	63.9	6.2 (5.9)	4.8 (4.7)	.039	21.3
TAR	28	31.5	6.0 (2.5)	3.6 (2.6)	<.001	64.3	6.1 (5.1)	3.7 (3.7)	.014	25.0
Wait time, wk										
0-12	34	38.2	5.5 (2.6)	3.3 (2.2)	<.001	67.7	5.7 (5.5)	4.4 (5.0)	.108	23.5
13-26	19	21.3	6.4 (2.6)	4.1 (2.5)	.002	63.2	6.9 (7.2)	4.8 (4.2)	.138	26.3
>26	36	40.4	5.8 (2.5)	3.5 (2.8)	<.001	61.1	6.1 (5.0)	4.3 (3.9)	.027	19.4
Community physiotherapy visits										
0	81	91.0	5.9 (2.6)	3.4 (2.5)	<.001	66.7	6.1 (5.7)	4.2 (4.2)	.001	23.5
≥1	8	9.0	5.5 (2.6)	4.8 (2.3)	.470	37.5	6.6 (6.0)	6.8 (6.0)	.951	12.5

Abbreviations: AA, ankle arthrodesis; MID, minimally important difference; PEG, pain intensity (P), interference with enjoyment of life (E), and general (G) activity instrument; PHQ-9, Patient Health Questionnaire–9; SD, standard deviation; SES, socioeconomic status; TAR, total ankle replacement.
[a]Physiotherapy visits are within 180 days of discharge.

MID of the PEG instrument. Improvements in pain were more pronounced among males than females, with 74% of males reporting improvement in pain that exceeded the MID.

Among participants, the average change in the PHQ-9 depression score was 1.7 points, a statistically significant improvement, though only 22% of participants' gain in PHQ-9 score exceeded the MID of 5 points.

Table 3 demonstrates that the 2 important indicators of gain in health are participants' preoperative overall health status (EQ-5D VAS) and ankle-specific health (AOS) scores, confirming that participants with the worst preoperative health experienced the largest gains. The number of publicly funded outpatient physiotherapy visits was negatively associated with changes to the VAS score, a finding that bears additional research.

The results of Table 4 demonstrated that the most significant factor associated with improvement in pain (the PEG instrument) and depression (the PHQ-9 instrument) was participants' preoperative status. Participants with the worst pain or depression experienced the largest improvements. Demographic factors did not appear to be associated with gain in health.

Figure 1 summarizes the changes of participants' scores on the 4 instruments with the MID for each overlaid on the figures to illustrate the distance between the instruments' preoperative values with postoperative values and MID. The figure illustrates that, on average, the mean change in pain (PEG) exceeded the MID by a significant margin. The mean change of the AOS and VAS scores marginally exceeded the MID. The mean change of depression (PHQ-9) did not exceed the MID.

Figure 2 shows a scatterplot of participants' PEG pain and PHQ-9 depression scores preoperatively and postoperatively. Participants in the upper right quadrant, of both panels, had high pain and clinically significant depression. Ideally, participants would move from their preoperative point to the lower left quadrant. The scatterplots illustrate that PEG pain values tended to decrease whereas PHQ-9 values tended not to decrease as markedly.

Table 3. Regression Analysis Results for Change in EQ-5D VAS and AOS Scores.

	EQ-5D VAS		AOS	
Regression Variable	Coefficient (SE)	*P* Value	Coefficient (SE)	*P* Value
Intercept	46.342 (9.194)	<.001	12.001 (19.239)	.533
Number of outpatient physiotherapy visits	–1.336 (0.605)	.027	1.370 (0.960)	.153
Preoperative PRO score	–0.625 (0.097)	<.001	–0.378 (0.171)	.027
Age group				
≤50 y	Reference group		Reference group	
51-60 y	–8.567 (4.855)	.078	–8.203 (9.583)	.392
61-70 y	–2.447 (5.285)	.643	14.088 (11.719)	.230
>70 y	–3.167 (5.817)	.586	–11.822 (12.132)	.330
Sex				
Female	Reference group		Reference group	
Male	1.838 (3.582)	.608	–11.645 (7.625)	.127
Charlson Comorbidity Index				
0	Reference group		Reference group	
≥1	2.019 (5.582)	.718	–5.500 (9.953)	.581
SES				
1 (highest)	Reference group		Reference group	
2	1.175 (5.738)	.838	–11.176 (12.768)	.382
3	8.258 (5.762)	.152	–11.547 (11.670)	.323
4	2.596 (6.477)	.689	3.641 (16.361)	.824
5 (lowest)	8.559 (5.919)	.148	–26.003 (16.550)	.117
Missing	3.508 (5.952)	.556	–8.197 (11.723)	.485
Type of surgery				
AA	Reference group		Reference group	
TAR	2.167 (3.635)	.551	2.667 (9.070)	.769
Wait time, wk	0.022 (0.075)	.774	–0.091 (0.146)	.533

Abbreviations: AA, ankle arthrodesis; AOS, Ankle Osteoarthritis Scale; MID, minimally important difference; PRO, patient-reported outcome; SD, standard deviation; SE, standard error; SES, socioeconomic status; TAR, total ankle replacement; VAS, visual analog scale.
[a]For the EQ-5D VAS, positive coefficients correspond to an improvement in a patient's self-reported health. For the AOS, negative regression coefficient values correspond to improvements in self-reported health.

Discussion

The results of this study demonstrate that AA or TAR surgery significantly impacted some, but not all, dimensions of self-reported health-related quality of life. Specifically, the majority of participants experienced clinically meaningful pain relief. Almost one-half of participants' change in ankle-related quality of life and overall health status exceeded the MID.

This study found that within the constellation of physical and mental impairments associated with end-stage ankle arthritis, mild depressive symptoms were common, particularly in the younger age group. Unexpectedly, 22% of patients achieved clinically important gains in their depressive symptoms by the 6-month postoperative time point. A small number of patients indicated clinically significant levels of depression both preoperatively and postoperatively. As the current clinical recommendations are for simultaneous treatment of pain and depression to optimize outcomes,[2] screening for depression in the perioperative period and providing referrals to mental health resources may be warranted to improve mental health outcomes.

This study found that in each dimension of health surveyed, participants with the poorest preoperative health experienced the greatest improvements in health. A finding that supports the notion that when a surgeon and patient arrive at a mutually agreeable decision to proceed with reconstruction of their end-stage ankle arthritis, the most severely affected patients benefit the most across multiple dimensions of health and could be triaged appropriately.

Notably, the adjusted results showed that participants who had more publicly funded outpatient physiotherapy visits had smaller improvements in EQ-5D VAS scores measuring overall health status. This finding may be an artifact of participants having poorer prognosis being referred to outpatient physiotherapy at higher rates, though there were few participants who received publicly funded outpatient physiotherapy and limited the study's ability to measure relationships between publicly funded outpatient physiotherapy and demographic characteristics or clinical variables.

Table 4. Regression Analysis Results for Change in PEG and PHQ-9 Values.[a]

	PEG		PHQ-9	
Regression Variable	Coefficient (SE)	*P* Value	Coefficient (SE)	*P* Value
Intercept	1.701 (1.204)	.162	1.403 (1.708)	.412
Number of outpatient physiotherapy visits	0.137 (0.099)	.169	0.242 (0.149)	.104
Preoperative PRO score	–0.622 (0.107)	<.001	–0.548 (0.074)	<.001
Age group				
≤50 y	Reference group		Reference group	
51-60 y	0.377 (0.777)	.629	1.437 (1.234)	.244
61-70 y	–0.250 (0.825)	.762	1.348 (1.337)	.313
>70 y	–0.044 (0.936)	.963	–0.221 (1.455)	.879
Sex				
Female	Reference group		Reference group	
Male	–0.131 (0.575)	.820	–1.526 (0.894)	.088
Charlson Comorbidity Index				
0	Reference group		Reference group	
≥1	–0.179 (0.897)	.843	–0.640 (1.329)	.630
SES				
1 (highest)	Reference group		Reference group	
2	–0.086 (0.913)	.925	–0.646 (1.383)	.640
3	–0.457 (0.939)	.628	–0.031 (1.434)	.983
4	–0.739 (1.058)	.487	1.303 (1.576)	.409
5 (lowest)	–0.544 (0.972)	.577	0.323 (1.462)	.825
Missing	–0.526 (0.975)	.591	1.660 (1.462)	.256
Type of surgery				
AA	Reference group		Reference group	
TAR	0.036 (0.588)	.951	–1.115 (0.888)	.209
Wait time, wk	–0.004 (0.012)	.711	–0.004 (0.018)	.833

Abbreviations: AA, ankle arthrodesis; PEG, pain intensity (P), interference with enjoyment of life (E), and general (G) activity instrument; PHQ-9, Patient Health Questionnaire–9; PRO, patient-reported outcome; SE, standard error; SES, socioeconomic status; TAR, total ankle replacement.
[a]For the PEG and PHQ-9 instrument values, negative regression coefficient values correspond to improvements in self-reported health.

Even though a plurality of participants waited more than 26 weeks for their surgery, this study found no evidence of a relationship between the wait for surgery and gain in health after adjustment for patient-level and health service utilization characteristics. This finding was unexpected, given the relationship between delayed access to surgery and poorer outcomes for knee arthroplasties and hallux valgus procedures.[15,53]

Aspects of this study align with previous research; the overall mean change in AOS scores of 28.8 was similar to those reported by others.[12,14,38] Interestingly, this study found clinically important improvements in self-reported depressive symptoms among 22% of patients, a finding that is not concordant with previous research,[32] and provides some support for mild depressive symptoms not being a contraindication to surgery for end-stage ankle arthritis.

There are a number of important limitations to this study's findings. Participants were recruited from a single surgical clinic in a metropolitan region and, although this study found no significant differences between participants and nonparticipants, there may be unobserved participation bias. In addition, this study measured the change in PROs 6 months after surgery; other studies have suggested different follow-up durations. Also, this study investigated primary AA and TAR surgeries and may not be reflective of revision surgeries.

Importantly, the EQ-5D VAS, PEG, and PHQ-9 instruments, measuring health status, pain, and depression, respectively, are generic instruments, not specific to the symptomatology of foot and ankle conditions. Generic instruments have typically been thought to be less responsive to operative interventions, likely based on the observation that patient responses may well be influenced by other important conditions outside the ankle undergoing operative reconstruction. Although these instruments have been validated in broad samples of patients, the MID values used in this study may not be appropriate for patients undergoing AA and TAR surgery.[29] This limitation suggests that additional research on the MID establish whether the value is robust among AA and TAR surgeries and whether the

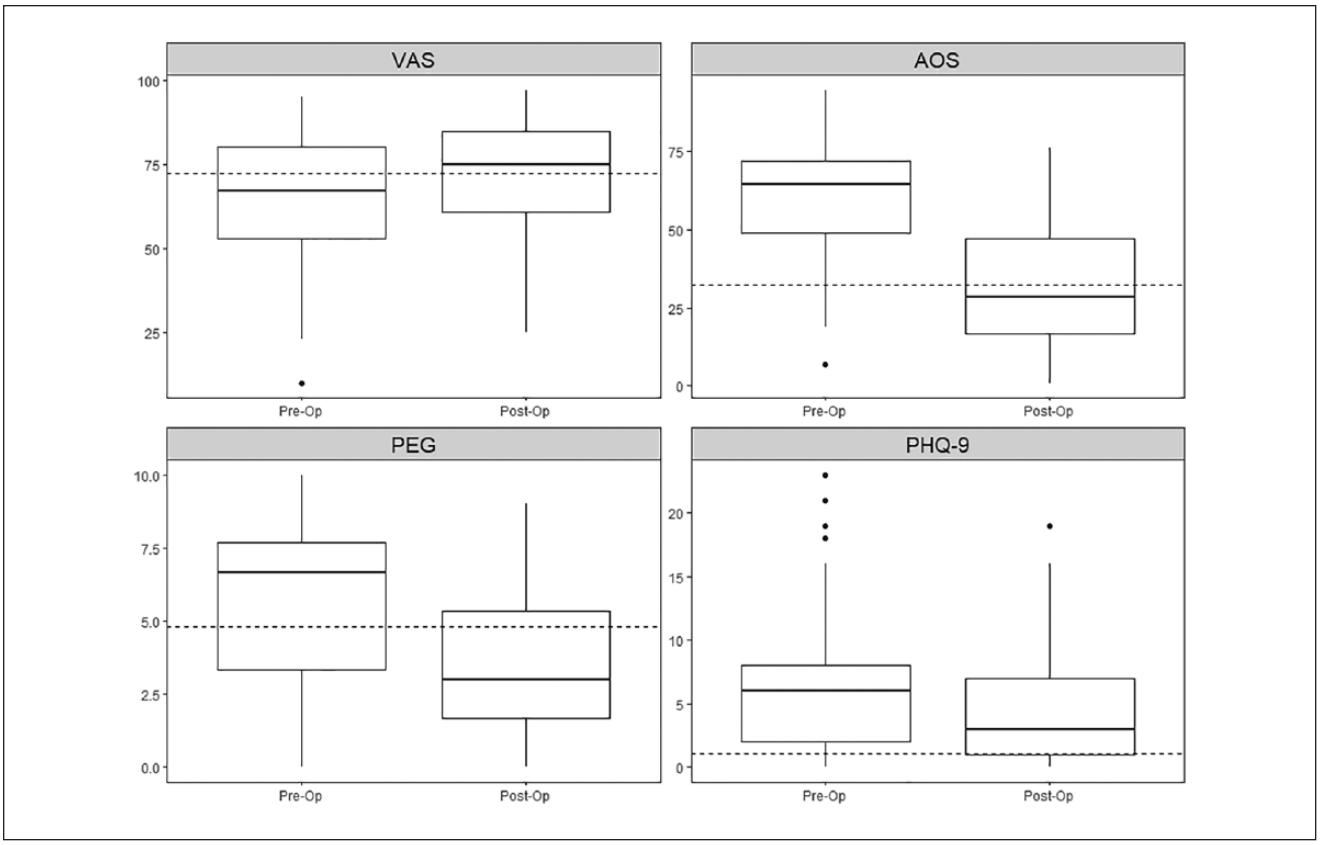

Figure 1. Boxplots of preoperative and postoperative health status (EQ-5D) VAS, ankle-related quality of life (AOS), pain (PEG), and depression (PHQ-9) values compared with horizontal dashed lines of the MID. For the VAS, the dashed line represents the MID value relative to the mean preoperative score, and postoperative values above this line indicate improvements that exceed the MID. For the AOS, PEG, and PHQ-9, the scale is reversed, and the dashed line represents the MID relative to the mean preoperative score for each instrument. Postoperative values below the dashed line indicate improvements in health that exceed the MID. Each instrument has a different maximum value: 100 for the VAS and AOS, 30 for the PEG, and 27 for the PHQ-9. AOS, Ankle Outcomes Score; MID, minimally important difference; PEG, pain intensity (P), interference with enjoyment of life (E), and general (G) activity instrument; PHQ-9, Patient Health Questionnaire–9; MID, minimally important difference; VAS, visual analog scale.

values are robust among subgroups. Also, the findings regarding a potential relationship between postoperative outcomes and physiotherapy are limited to this study's use of observable publicly funded occurrences, and likely significantly underrepresent the totality of participants' physiotherapy utilization. The reported lack of association between wait for surgery and failure to see expected improvement postoperatively may be limited by the small sample size and associated lack of power to detect such an association.

This study highlights the multiple dimensions of health inherent to the human condition, and that although a single PRO score can help quantify the patient's perspective in a given dimension, use of multiple and appropriate PROs representing multiple dimensions of health is likely warranted to be important. Although computer adaptive testing offers one elegant solution moving forward, further investigation is still required to better understand which questions, and in which clinical scenarios, for specific dimensions of health best capture the ankle patient's perspective.

This study found that AA and TAR surgery was statistically and clinically effective in improving ankle-related symptoms and pain interference. However, although gains in other dimensions of health and depression symptoms were present, gains in these aspects of health-related quality of life were smaller. Gains in health were significantly enhanced among participants reporting the poorest preoperative health. This study has significant implications to postoperative care and discharge planning instructions for AA and TAR patients.

Conclusion

Among participants, there was a clinically important improvement in pain scores among 64% of the participants. Also, 22% of the participants reported a clinically

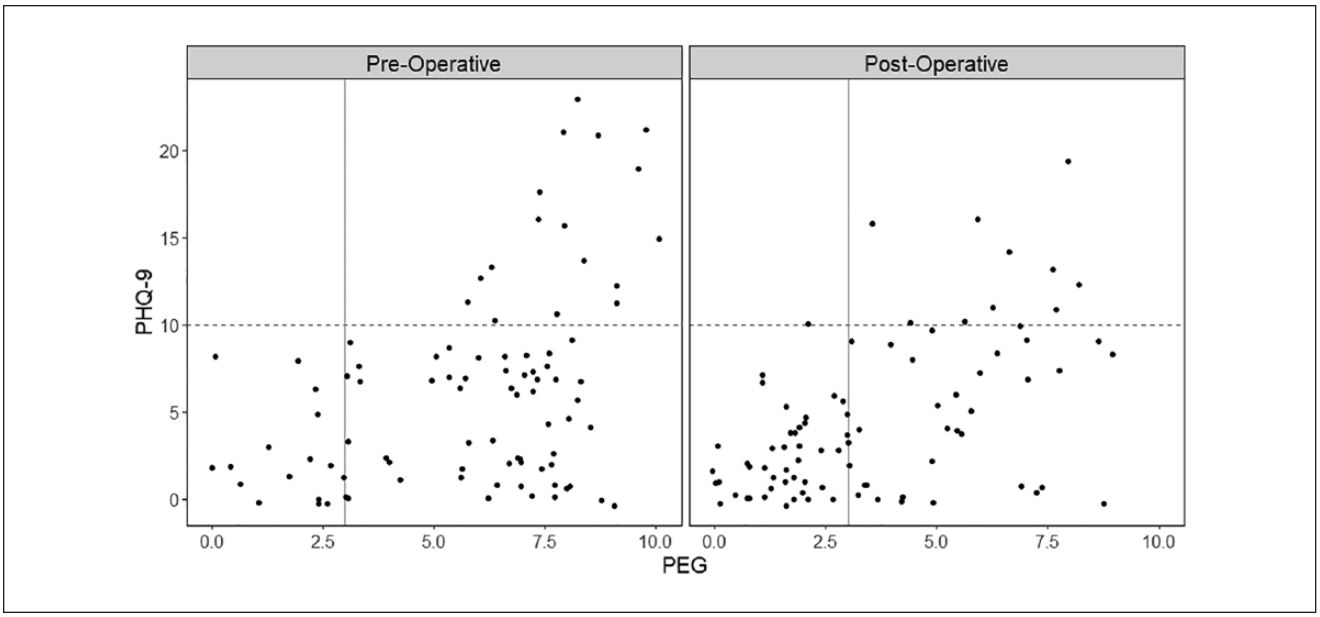

Figure 2. Preoperative and postoperative pain (PEG) and depression (PHQ-9) values. The vertical line indicates the threshold for high levels of pain (PEG values greater than 3). The horizontal line indicates the threshold for clinically significant depression (PHQ-9 scores greater than 10). PEG, pain intensity (P), interference with enjoyment of life (E), and general (G) activity instrument; PHQ-9, Patient Health Questionnaire–9.

meaningful improvement in their depression symptoms postoperatively, though clinically significant gains in health-related quality of life were not experienced by all participants in all dimensions.

Acknowledgments

This study was funded by the Canadian Institutes for Health Research (CIHR) and in-kind support of Vancouver Coastal Health (VCH) Authority. The second author is a Scholar of the Michael Smith Foundation for Health Research (MSFHR). CIHR, VCH and MSFHR had no role in developing the methods, data analyses, interpreting the results or manuscript preparation.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was funded by the Canadian Institutes for Health Research and in-kind support of Vancouver Coastal Health Authority.

ORCID iD

Jason M. Sutherland, PhD, https://orcid.org/0000-0002-1857-2432

References

1. Artz N, Elvers KT, Lowe CM, Sackley C, Jepson P, Beswick AD. Effectiveness of physiotherapy exercise following total knee replacement: systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2015;16(1):15.
2. Bair MJ, Robinson RL, Katon W, Kroenke K. Depression and pain comorbidity: a literature review. *JAMA Intern Med*. 2003;163(20):2433-2445.
3. Basch E. Patient-reported outcomes—harnessing patients' voices to improve clinical care. *N Engl J Med*. 2017;376(2):105-108.
4. Becher S, Smith M, Ziran B. Orthopaedic trauma patients and depression: a prospective cohort. *J Orthop Trauma*. 2014;28(10):e242-e246.
5. Benson T, Williams DH, Potts HWW. Performance of EQ-5D, howRu and Oxford hip & knee scores in assessing the outcome of hip and knee replacements. *BMC Health Serv Res*. 2016;16(1):512.
6. Braybrooke J, Ahn H, Gallant A, et al. The impact of surgical wait time on patient-based outcomes in posterior lumbar spinal surgery. *Eur Spine J*. 2007;16(11):1832-1839.
7. Briet JP, Houwert RM, Hageman MGJS, Hietbrink F, Ring DC, Verleisdonk EJJM. Factors associated with pain intensity and physical limitations after lateral ankle sprains. *Injury*. 2016;47(11):2565-2569.
8. Coe MP, Sutherland JM, Penner MJ, Younger A, Wing KJ. Minimal clinically important difference and the effect of clinical variables on the Ankle Osteoarthritis Scale in surgically treated end-stage ankle arthritis. *J Bone Joint Surg Am*. 2015;97(10):818-823.

9. Conti MS, Jones MT, Savenkov O, Deland JT, Ellis SJ. Outcomes of reconstruction of the stage II adult-acquired flatfoot deformity in older patients. *Foot Ankle Int*. 2018;39(9):1019-1027.
10. Cooke MW, Marsh JL, Clark M, et al. Treatment of severe ankle sprain: a pragmatic randomised controlled trial comparing the clinical effectiveness and cost-effectiveness of three types of mechanical ankle support with tubular bandage. The CAST trial. *Health Technol Assess*. 2009;13(13):iii, ix-x, 1-121.
11. Croft S, Wing KJ, Daniels TR, et al. Association of ankle arthritis score with need for revision surgery. *Foot Ankle Int*. 2017;38(9):939-943.
12. Daniels TR, Younger ASE, Penner M, et al. Intermediate-term results of total ankle replacement and ankle arthrodesis: a COFAS multicenter study. *J Bone Joint Surg Am*. 2014;96(2):135-142.
13. D'Apuzzo MR, Villa JM, Alcerro JC, Rossi MD, Lavernia CJ. Total joint arthroplasty: a granular analysis of outcomes in the economically disadvantaged patient. *J Arthroplasty*. 2016;31(9)(suppl):41-44.
14. Desai SJ, Glazebrook M, Penner MJ, et al. Quality of life in bilateral vs. unilateral end-stage ankle arthritis and outcomes of bilateral vs. unilateral total ankle replacement. *J Bone Joint Surg Am*. 2017;99(2):133-140.
15. Desmeules F, Dionne CE, Belzile E, Bourbonnais R, Fremont P. The burden of wait for knee replacement surgery: effects on pain, function and health-related quality of life at the time of surgery. *Rheumatology*. 2010;49(5):945-954.
16. Domsic RT, Saltzman CL. Ankle Osteoarthritis Scale. *Foot Ankle Int*. 1998;19(7):466-471.
17. Dworkin RH, Turk DC, Wyrwich KW, et al. Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. *J Pain*. 2008;9(2):105-121.
18. EuroQoL Group. EuroQol—a new facility for the measurement of health-related quality of life. *Health Policy (New York)*. 1990;16(3):199-208.
19. Garratt A. Patient reported outcome measures in trials. *BMJ*. 2009;338:a2597.
20. Giesinger JM, Hamilton DF, Jost B, Behrend H, Giesinger K. WOMAC, EQ-5D and Knee Society Score thresholds for treatment success after total knee arthroplasty. *J Arthroplasty*. 2015;30(12):2154-2158.
21. Glazebrook M, Daniels T, Younger A, et al. Comparison of health-related quality of life between patients with end-stage ankle and hip arthrosis. *J Bone Joint Surg Am*. 2008;90(3):499-505.
22. Grobet C, Marks M, Tecklenburg L, Audige L. Application and measurement properties of EQ-5D to measure quality of life in patients with upper extremity orthopaedic disorders: a systematic literature review. *Arch Orthop Trauma Surg*. 2018;138(7):953-961.
23. Haddad SL, Coetzee JC, Estok R, Fahrbach K, Banel D, Nalysnyk L. Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis. A systematic review of the literature. *J Bone Joint Surg Am*. 2007;89(9):1899-1905.
24. Hanusch BC, O'Connor DB, Ions P, Scott A, Gregg PJ. Effects of psychological distress and perceptions of illness on recovery from total knee replacement. *Bone Joint J*. 2014;96-B(2):210-216.
25. Henricson A, Kamrad I, Rosengren B, Carlsson Å. Bilateral arthrodesis of the ankle joint: self-reported outcomes in 35 patients from the Swedish Ankle Registry. *J Foot Ankle Surg*. 2016;55(6):1195-1198.
26. Hollowell J, Grocott MPW, Hardy R, Haddad FS, Mythen MG, Raine R. Major elective joint replacement surgery: socioeconomic variations in surgical risk, postoperative morbidity and length of stay. *J Eval Clin Pract*. 2010;16(3):529-538.
27. Hunt KJ, Alexander I, Baumhauer J, et al. The Orthopaedic Foot and Ankle Outcomes Research (OFAR) network: feasibility of a multicenter network for patient outcomes assessment in foot and ankle. *Foot Ankle Int*. 2014;35(9):847-854.
28. Johansen H, Finès P. Acute care hospital days and mental diagnoses. *Health Rep*. 2012;23(4):61-65.
29. Johnston BC, Ebrahim S, Carrasco-Labra A, et al. Minimally important difference estimates and methods: a protocol. *BMJ Open*. 2015;5(10):e007953.
30. Joice MG, Bhowmick S, Amanatullah DF. Perioperative physiotherapy in total knee arthroplasty. *Orthopedics*. 2017;40(5):e765-e773.
31. Jull A, Parag V, Walker N, Rodgers A. Responsiveness of generic and disease-specific health-related quality of life instruments to venous ulcer healing. *Wound Repair Regen*. 2010;18(1):26-30.
32. Kennedy S, Barske H, Wing K, Penner M, Daniels T, Glazebrook M. SF-36 Mental Component Summary (MCS) score does not predict functional outcome after surgery for end-stage ankle arthritis. *J Bone Joint Surg Am*. 2015:1702-1707.
33. Kerper LF, Spies CD, Buspavanich P, et al. Preoperative depression and hospital length of stay in surgical patients. *Minerva Anestesiol*. 2014;80(9):984-991.
34. Kim S, Duncan PW, Groban L, Segal H, Abbot RM, Williamson JD. Patient-Reported Outcome Measures (PROM) as a preoperative assessment tool. *J Anesth Perioper Med*. 2017;4(6):274-281.
35. Krebs EE, Bair MJ, Damush TM, Tu W, Wu J, Kroenke K. Comparative responsiveness of pain outcome measures among primary care patients with musculoskeletal pain. *Med Care*. 2010;48(11):1007-1014.
36. Krebs EE, Lorenz KA, Bair MJ, et al. Development and initial validation of the PEG, a three-item scale assessing pain intensity and interference. *J Gen Intern Med*. 2009;24(6):733-738.
37. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med*. 2001;16(9):606-613.
38. Lachman JR, Ramos JA, Adams SB, Nunley JA, Easley ME, DeOrio JK. Patient-reported outcomes before and after primary and revision total ankle arthroplasty. *Foot Ankle Int*. 2019;40(1):34-41.
39. Lindberg MF, Miaskowski C, Rustøen T, Rosseland LA, Paul SM, Lerdal A. Preoperative pain, symptoms, and psy-

chological factors related to higher acute pain trajectories during hospitalization for total knee arthroplasty. *PLoS One*. 2016;11(9):e0161681.
40. Loveday DT, Barr LV, Loizou CL, Barton G, Smith G. A comparative prospective cohort health economic analysis comparing ankle fusion, isolated great toe fusion and hallux valgus surgery. *Foot Ankle Surg*. 2018;24(1):54-59.
41. Lowe B, Unitzer J, Callahan CM, Perkins AJ, Kroenke K. Monitoring depression treatment outcomes with the Patient Health Questionnaire-9. *Med Care*. 2004;42(12): 1194-1201.
42. Madeley NJ, Wing KJ, Topliss C, Penner MJ, Glazebrook MA, Younger AS. Responsiveness and validity of the SF-36, Ankle Osteoarthritis Scale, AOFAS Ankle Hindfoot Score, and Foot Function Index in end stage ankle arthritis. *Foot Ankle Int*. 2012;33(1):57-63.
43. Miller K, Combs S, van Puymbroeck M, et al. Fatigue and pain: relationships with physical performance and patient beliefs after stroke. *Top Stroke Rehabil*. 2013;20(4): 347-355.
44. Minns Lowe CJ, Barker KL, Dewey ME, Sackley CM. Effectiveness of physiotherapy exercise following hip arthroplasty for osteoarthritis: a systematic review of clinical trials. *BMC Musculoskelet Disord*. 2009;10(1):98.
45. Moussavi S, Chatterji S, Verdes E, Tandon A, Patel V, Ustun B. Depression, chronic diseases, and decrements in health: results from the World Health Surveys. *Lancet*. 2007;370(9590):851-858.
46. Pakzad H, Thevendran G, Penner MJ, Qian H, Younger A. Factors associated with longer length of hospital stay after primary elective ankle surgery for end-stage ankle arthritis. *J Bone Joint Surg Am*. 2014;96(1):32-39.
47. Pickard AS, Neary MP, Cella D. Estimation of minimally important differences in EQ-5D utility and VAS scores in cancer. *Health Qual Life Outcomes*. 2010;8(1):4.
48. Quon JA, Sobolev BG, Levy AR, et al. The effect of waiting time on pain intensity after elective surgical lumbar discectomy. *Spine J*. 2013;13(12):1736-1748.
49. Rosemann T, Backenstrass M, Joest K, Rosemann A, Szecsenyi J, Laux G. Predictors of depression in a sample of 1,021 primary care patients with osteoarthritis. *Arthritis Rheum*. 2007;57(3):415-422.
50. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *JAMA*. 1999;282(18):1737-1744.
51. Sutherland JM, Crump RT, Chan A, Liu G, Yue E, Bair M. Health of patients on the waiting list: opportunity to improve health in Canada? *Health Policy (New York)*. 2016;120(7):749-757.
52. Sutherland JM, Rajapakshe S, Younger A, et al. Do preoperative patient-reported outcomes predict hospital length of stay for surgically-treated end-stage ankle osteoarthritis patients [published online ahead of print February 2, 2019]? *Foot Ankle Surg*. doi:10.1016/j.fas.2019.01.008.
53. Sutherland JM, Wing K, Penner M, et al. Quantifying patient-reported disability and health while waiting for bunion surgery. *Foot Ankle Int*. 2018 39(9):1047-1055.
54. Vincent K, Sutherland JM. *A Review of Methods for Deriving an Index for Socioeconomic Status in British Columbia*. Vancouver: UBC Centre for Health Services and Policy Reseach; 2013.
55. Wacker ME, Jörres RA, Karch A, et al. Assessing health-related quality of life in COPD: comparing generic and disease-specific instruments with focus on comorbidities. *BMC Pulm Med*. 2016;16(1):70.
56. Wylde V, Artz N, Marques E, et al. Effectiveness and cost-effectiveness of outpatient physiotherapy after knee replacement for osteoarthritis: study protocol for a randomised controlled trial. *Trials*. 2016;17(1):289.