Cost of Joint Replacement Surgery for Osteoarthritis: The Patients' Perspective

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ABSTRACT. ***Objective.*** To address costs of total joint replacement surgery from the patients' perspective by determining patient out-of-pocket costs during the first year following joint replacement, and to explore whether health status presurgery or in the immediate 3 months postsurgery were determinants of costs. In light of the different outcomes experienced by patients with total knee replacement (TKR) and total hip replacement (THR), any differences in costs between the 2 groups were also explored.

Methods. Patients with osteoarthritis (OA) scheduled for primary unilateral TKR or THR surgery at 3 Sydney hospitals were approached. Patients completed questionnaires preoperatively to record expenses during the previous 3 months and health status immediately prior to surgery. Patients then maintained detailed prospective cost diaries and completed SF-36 and WOMAC Index every 3 months for the first postoperative year. Arthritis-specific cost information obtained in the diary included medications (prescription and nonprescription), visits to health professionals, tests (radiographs, scans, blood tests, etc), special equipment, alterations to house, and the use of private or community services.

Results. Ninety-eight TKR and 76 THR patients provided cost details for their first postoperative year. For both THR and TKR patients, out-of-pocket costs fell considerably over the first postoperative year, and during the year the proportion of patients who experienced no out-of-pocket costs increased, as did the proportion who made no use of health services such as medical tests or visits to health professionals. Regression analysis for THR patients showed that pension status, preoperative SF-36 Physical Component Score, and 3-month postoperative WOMAC Function were significant independent predictors of postoperative costs. Regression analysis for TKR patients showed that presurgery WOMAC Stiffness and pension status were significant independent predictors of postoperative costs, indicating that those with greater stiffness had greater postsurgery costs and those on a pension had lower costs.

Conclusion. OA patients undergoing THR and TKR have substantial out-of-pocket costs presurgery, which fall dramatically over the first postoperative year. Poorer presurgery health status predicted greater expenditure during the first postoperative year, which might be taken into consideration when patients are making a choice about the timing of joint surgery. (J Rheumatol 2002;1006–14)

Key Indexing Terms:
PATIENT COSTS
TOTAL KNEE REPLACEMENT
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Musculoskeletal disorders, of which osteoarthritis (OA) is the most common, incur significant economic costs[1]. Few reports concentrate on the economic effects of OA alone; however, this disease was reported to cost the Australian health system roughly $624 million in 1993-94 [all data given as Australian dollars], with increasing expenditure expected as the population ages[2]. The economic impact of arthritis was estimated at 2.5% of the gross national product in the US in 1992, 1.7% in Canada in 1994, and 1.1% in the UK in 1986[1].

Total hip (THR) and knee replacements (TKR) are commonly performed to relieve pain and improve function, particularly where the joint is affected by arthritis. Each year over one million THR are performed world-wide and the number of TKR is also rapidly approaching this[3]. While these are expensive procedures, costing in excess of $10 billion each year in the US alone[4], joint replacement is one of the most cost-effective procedures in the whole of medicine and surgery[3]. In terms of cost-effectiveness, the timing of the procedure in the progression of the disease may affect the outcome, as total joint replacement has been shown to be more cost-effective at 6 months postsurgery for patients who had poorer health status preoperatively than those in a better state[5].

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While both procedures improve patients' well being, patients who have undergone THR report a greater improvement in pain and function and more satisfaction with the outcome than patients undergoing TKR[6-9]. Outcome of the operation can influence costs incurred, so evaluation of health status, both general and disease-specific, should be undertaken in conjunction with analysis of expenditure. Studies have shown that a worse preoperative health status results in poorer postoperative function[8], but whether this affects postoperative costs is unknown.

The use of quality adjusted life years (QALY) in assessing the effectiveness of joint replacement allows comparison with other procedures. Modeling that has taken into account the progression of the disease and worsening function if the procedure is not performed, and the possibility of the need for revision of the prosthesis if the operation is performed, showed that THR may result in a cost saving or at least be cost-effective[10]. The cost-effectiveness of TKR compares favorably with coronary artery bypass and renal dialysis, 2 widely accepted procedures[11].

Many studies of the cost-effectiveness of joint replacement assess costs from the perspective of the health care system; however, costs to the individual are not so extensively studied. It is important to address these out-of-pocket costs, as they have a direct effect on the patient undergoing the procedure, and may provide additional information for individual decision making.

In Australia, costs to the individual, particularly for medications, may be reduced if they receive a government pension or hold a means-tested Senior's Health Card under the Pharmaceutical Benefit Scheme. Under this "safety net," patients pay about $3.50 per prescription for items listed for subsidy on the Pharmaceutical Benefits Scheme, until they reach a certain level of out-of-pocket expenditure (currently $182.00), after which the total cost of their medications is covered by the health system. Those not covered by the "safety net" scheme pay about $22 per prescription until they reach a certain level of out-of-pocket expenditure (currently $669.70), after which they pay $3.50 per prescription, the same payment as the pensioner concession patients.

Initial peri- and postoperative costs of joint replacement are expected to be considerable, as the patient undergoes intensive treatment; however, these initial costs may be misleading when investigating the overall economic effect of joint replacement. Longer-term examination of costs is warranted, as health status has been shown to improve throughout the first postoperative year[9].

We investigated costs of total joint replacement surgery from the patients' perspective by determining patient out-of-pocket costs during the first year after joint replacement, and explored whether health status presurgery or in the immediate 3 months postsurgery were determinants of costs. In light of the different outcomes experienced by TKR and THR patients, any differences in costs between the 2 groups were also explored.

While out-of-pocket costs only represent a small component of the total overall costs of joint replacement surgery, they are crucial to the individual living with arthritis and are often overlooked. Increasingly the patients' perspective should be taken into account in medical decision making.

MATERIALS AND METHODS

Patients and questionnaires. All patients with a diagnosis of OA scheduled for primary unilateral TKR or THR at 3 Sydney hospitals during 1994 and 1995 were eligible to participate. Patients were informed that they would be required to complete questionnaires preoperatively to record expenses during the previous 3 months in a study-designed cost questionnaire. In addition, they would be required to complete health status questionnaires preoperatively [Western Ontario and McMaster University Osteoarthritis Index (WOMAC) and Short Form-36 (SF-36)], and maintain detailed prospective cost diaries for their first postoperative year at 3 month intervals.

As part of the preoperative questionnaires, in addition to arthritis related expenses incurred over the previous 3 months, general demographic information about the respondents was collected, including their date of birth, whether they lived alone or with others, whether they had other conditions or diseases in addition to their arthritis, and whether they had private health insurance or if they received a pension.

Cost diaries. Arthritis-specific cost information obtained in the diary and preoperative questionnaire related to medications (both prescription and nonprescription), visits to health professionals, tests (e.g., radiographs, blood tests, scans), special equipment, household alterations, and use of private and community services (including private home help, gardener, taxi service, hydrotherapy, meals on wheels, government subsidized home care, and community transport). Respondents were asked to prospectively record in the diaries all expenses they incurred due to arthritis in these sections. Where respondents were able to claim money from private health insurance funds or Medicare for the cost of visits to health professionals, they were asked to record both the amount they paid and the amount they claimed. The gap between these, or the amount they were "out-of-pocket," was used in the analyses reported here. To ascertain health service utilization, respondents were instructed to include visits, tests, and medications even if they were not charged or had paid at a reduced rate, i.e., through the government funded Medicare or pharmaceutical benefit scheme. Although they may not have been charged, these visits nevertheless would have associated transport costs and indirect costs in time lost from work or usual duties for the patients or their care-givers. Each diary was completed for 3 months, when it was returned to the research office and a new diary for the next 3 month period was sent. Four diaries were completed during the first postoperative year. Diaries commenced when the patient returned home from their hospital stay and as such do not include costs for the surgery, hospital stay, or inpatient rehabilitation.

The diaries were modeled on those used for another Australian cost-of-illness study for multiple sclerosis[12]. Cost diaries have been identified as a potentially useful method to collect these data[13]. To confirm that diaries were a valid means of collecting these data, in the initial phases of the study home visits were made to a random sample of respondents to compare their diary entries with actual receipts. To encourage completion of diaries, the research officer telephoned respondents twice during each diary period and sent newsletters and birthday cards.

If cost diaries and health status questionnaires were not completed for a 3 month period, with a maximum of 2 missing diaries, missing values were replaced by mean values for that component derived from joint, sex, and age group matched patients who completed the diary or questionnaire for that period. To determine whether mean values were appropriate to replace missing data, analyses were performed comparing the results

obtained when (a) the mean, (b) the upper 95% confidence limit, and (c) lower 95% confidence limits were used to replace missing data for each component. No significant differences were found when using each of these 3 figures to replace data, so mean values were used to replace missing data for the analyses reported here.

To reduce the number of dimensions on the SF-36 and reduce the role of chance in testing hypotheses relating to health outcomes, a method of gaining 2 summary scores without substantial loss of information from the 8 dimensions of the SF-36 has been developed[14,15]. Through the use of factor analysis, the 8 scales are combined into a Physical Component Scale (PCS) and Mental Component Scale (MCS) that have been shown to be reliable and valid[14,15]. The scales of Physical Functioning, Role Physical, Bodily Pain, and General Health correlate most highly with PCS, and Mental Health, Role Emotional, Vitality, and Social Functioning scales correlate most highly with MCS.

Data analysis. Data were analyzed using Statistical Packages for the Social Sciences. As the cost data were not normally distributed (using Kolmogorov-Smirnov goodness of fit test), costs were log transformed for comparisons between groups. A stepwise method was used for regression analyses. Variables entered into the models were joint replacement group (0 = TKR, 1 = THR); age; sex (0 = male, 1 = female); years with arthritis; receive pension (0 = no, 1 = yes); have private health insurance (0 = no, 1 = yes); have comorbidities (0 = no, 1 = yes); live alone or with others; presurgery and 3 months postsurgery SF-36 PCS, MCS, WOMAC pain, stiffness and function.

RESULTS

Three hundred seventy-six patients were eligible to participate and of these, 49 were not able to be contacted preoperatively, so did not take part. Three hundred twenty-seven were approached, with 252 agreeing to participate (77%). Reasons for nonparticipation included not having time or not being interested in providing such detail, feeling too old or sick for such a commitment, and poor English skills. Of the 252 who agreed to participate, 174 (69%) provided a complete year of diaries, which represents 46% of the eligible population. This may limit generalizability of results; however, no significant differences were seen in the age or sex of nonparticipants compared with participants. Preoperative SF-36 scores were obtained from 43 nonparticipants who were scheduled for TKR. When these scores were compared with the preoperative scores of the TKR study participants who provided cost data, the only significant difference was in Role Physical, where people who participated in the study showed greater limitations in their daily work due to physical problems (mean Role Physical score for nonparticipants 32.95, and participants 18.13; 95% confidence interval of the difference 2.7, 26.9). For the THR group, preoperative SF-36 scores were obtained from 24 nonparticipants. These were compared with the scores from THR study participants and the only significant difference was in Physical Function, where those who did not participate in the study showed worse preoperative function (preoperative Physical Function score: nonparticipants 17.9, participants 28.4; 95% CI of the difference –17.7, –3.1).

Ninety-eight TKR and 76 THR patients provided 4 cost diaries for their first postoperative year (Table 1). TKR patients were significantly older than THR patients, had a longer duration of arthritis, and a greater proportion had comorbidities and received the aged pension.

No patient required revision of their prosthesis during the 12 month followup period. Six patients who underwent replacement of another joint during the 12 months were excluded from the analysis.

For both THR and TKR groups, the most commonly reported comorbidities were hypertension/cardiovascular disease and gastrointestinal and respiratory problems. Twenty-two patients reported admission to hospital in the 12 months postsurgery. For TKR, 8 patients required manipulation of the operated knee, 2 were admitted for an infected prosthesis, one had thrombosis, and 5 patients were admitted for arthritis related conditions not related to their primary replacement. For THR, 3 patients were admitted for thrombosis and 3 for arthritis related conditions not related to the THR.

Health status pre and postsurgery. Both TKR and THR resulted in significant improvement in health status when preoperative SF-36 and WOMAC scores were compared with 3 month postsurgery scores, with the exception of MCS for TKR patients, which remained unchanged. This improvement continued, with 12 month scores being significantly better than 3 month scores, again with the exception of MCS for TKR patients, which remained unchanged.

Preoperatively, no significant differences were found in SF-36 or WOMAC scores between THR and TKR patients. However, at both 3 and 12 months postsurgery, THR patients reported significantly better PCS (3 mo: THR 39.2, TKR 32.7, 95% CI of the difference –8.6, –4.3; 12 mo: THR 43.1, TKR 37.5, CI –8.5, –2.7), Pain (3 mo: THR 4.0, TKR 6.7, CI 1.6, 3.8; 12 mo: THR 3.0, TKR 5.5, CI 1.4, 3.7), Stiffness (3 mo: THR 2.6, TKR 3.6, CI 0.52, 1.5; 12 mo: THR 2.1, TKR 2.9, CI 0.2, 1.3), and Function (3 mo: THR 17.4, TKR 26.2, CI 5.2, 12.3; 12 mo: THR 13.4, TKR 23.0, CI 5.6, 13.7) than TKR patients. At both 3 and 12 months postsurgery, TKR patients reported better MCS (3 mo: TKR 47.3, THR 45.2, CI 0.2, 4.0; 12 mo: TKR 46.3, THR 44.4, CI 0.3, 3.6) than THR patients.

Utilization of services for which there may be no out-of-pocket costs. Analysis of out-of-pocket costs does not take into account the utilization of services for which the health system bears the cost. Table 2 shows the utilization of services by THR and TKR patients preoperatively and during the first postoperative year.

As with out-of-pocket costs, for both THR and TKR, the use of services, particularly physiotherapy, decreases over the year. Figure 1 shows the proportion of patients who had no visits to health professionals at each time point. For both THR and TKR patients, the proportion with no visits increased throughout the year, with 21% of THR and 15% of TKR patients having no visits in the first 3 months postsurgery. By 12 months postsurgery, 63% of THR and 54% of TKR patients did not require the services of health professionals.

Table 1. Patient demographics.

	TKR	THR	Significance Chi-square, p
N	98	76	
% Female	53	46	0.841, 0.359
Mean age, yrs (SD)	70.4 (7.00)	63.3 (11.7)	t_{172}= 4.963, 0.000
Mean duration of arthritis, yrs (SD)	16.3 (12.3)	11.0 (9.6)	t_{169}= 3.069, 0.003
Comorbidities, %	91	71	12.738, 0.000
Receive pension, %	63	45	5.506, 0.019
Private health insurance, %	57	69	2.437, 0.119
Live alone, %	25	24	0.071, 0.790
Cemented prosthesis, %	81.5	37.3	
Part cemented prosthesis, %	12.3	16.9	

Table 2. Utilization of health services.

	3 Mo Presurgery Mean visits, n (range)	1–3 Mo Postsurgery Mean Visits, n (range)	9–12 Mo Postsurgery Mean Visits, n (range)
Knee replacements			
Surgeon	1.0 (0–6)	0.9 (0–4)	0.3 (0–4)
General practitioner	1.9 (0–10)	1.5 (0–12)	0.8 (0–9)
Physiotherapist	0.9 (0–24)	6.4 (0–40)	0.6 (0–21)
Radiographs	0.9 (0–6)	0.4 (0–3)	0.2 (0–2)
Blood tests	0.5 (0–10)	0.6 (0–21)	0.8 (0–3)
Community services	1.5 (0–66)	3.1 (0–36)	1.2 (0–27)
Hip replacements			
Surgeon	0.8 (0–2)	1.1 (0–3)	0.4 (0–3)
General practitioner	2.2 (0–20)	1.2 (0–24)	0.3 (0–3)
Physiotherapist	2.1 (0–80)	1.1 (0–10)	0.0 (0–1)
Radiographs	0.9 (0–6)	0.4 (0–2)	0.3 (0–3)
Blood tests	0.3 (0–6)	0.8 (0–19)	0.1 (0–3)
Community services	0.3 (0–12)	0.8 (0–27)	0.1 (0–4)

Expenditures. Overall mean out-of-pocket expenditures for both TKR and THR are shown in Table 3 and Figure 2. For both THR and TKR groups, the average out-of-pocket expenditure decreased during the postoperative year. For TKR, a mean reduction of $178.24 (95% CI $15.80, $340.69) was seen from the first 3 month to the 9 to 12 month postsurgery period. For THR this reduction in expenditure was $200.10 (95% CI $73,10, $327.09).

Overall out-of-pocket costs were not distributed normally among respondents. For TKR respondents, the mean annual expenditure was $661 (standard deviation $1172, 95% CI $426.30, $896.45), median $322, and costs ranged from $0 to $7559. Six respondents were considered to be outliers. For THR, 5 respondents were considered to be outliers. One THR respondent undertook major household renovations costing nearly $100,000. When this respondent is included, mean total expenditure for THR respondents was $1911 (SD $11,993, 95% CI –$0, $4651.77),

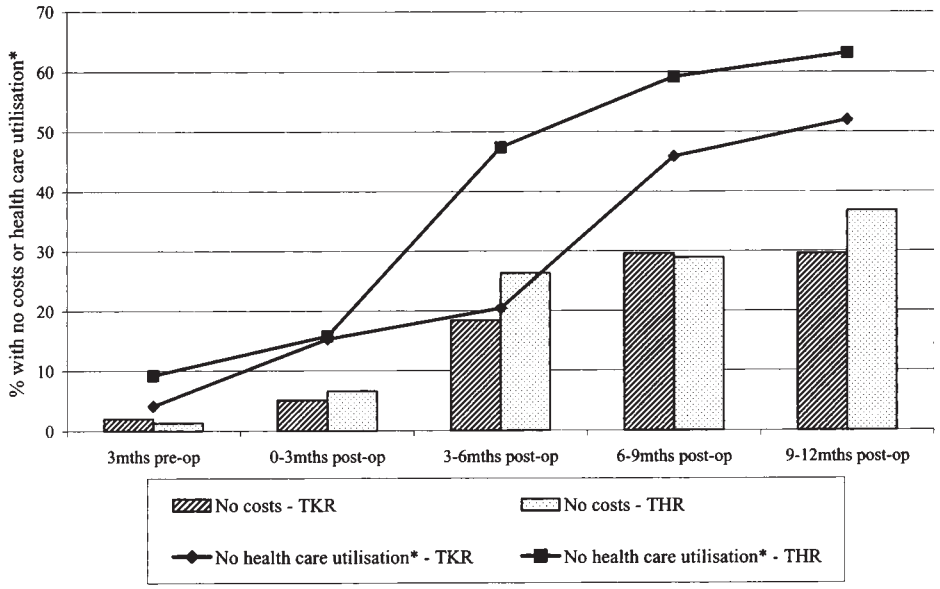

Figure 1. Proportion of patients with no out-of-pocket costs or health care use presurgery and one year postsurgery. *Patients did not require visits to health professionals, hospitalization, or medical tests for arthritis related conditions.

Table 3. Mean proportion of total out-of-pocket expenditure spent on individual components.

	3 Mo Pre–op	3 Mo Post–op	6 Mo Post–op	9 Mo Post–op	12 Mo Post–op
Knee replacements					
Mean amount spent ($)	378.628	306.44	103.49	123.71	128.19
SD	1012.96	787.60	297.17	295.53	319.73
95% CI for mean	174.46, 582.78	148.53, 464.34	43.91, 163.07	64.46, 182.96	64.09, 192.30
Median amount spent ($)	131.81	179.30	42.05	29.17	19.95
% who spent $0	2.0	5.1	18.4	29.6	29.6
% of total mean expenditure					
Prescription medications	4.8	8.5	12.0	9.4	7.4
Nonprescription medications	6.3	4.5	9.3	6.5	8.0
Health professional visits	6.2	21.6	18.4	26.9	14.1
Tests	1.0	1.0	0.2	0.5	0.3
Special equipment	16.2	20.3	6.9	17.0	31.9
Alterations to house	43.8	6.6	1.9	3.7	5.4
Community services	1.7	4.8	11.5	7.5	7.3
Private services	16.3	32.7	39.7	28.3	25.6
Hospitalization	3.8	0	0	0	0
Hip replacements					
Mean amount spent ($)	319.41	268.14	197.49	60.85	68.05
SD	559.74	543.84	568.37	95.40	126.27
95% CI for mean	190.63, 448.20	143.87, 392.42	67.61, 327.37	39.05, 82.65	39.19, 96.90
Median amount spent ($)	131.20	142.56	25.03	25.92	32.55
% who spent $0	1.3	6.6	26.3	28.9	36.8
% of total mean expenditure					
Prescription medications	7.9	5.2	2.7	12.0	11.8
Nonprescription medications	17.3	4.1	3.0	17.2	14.6
Health professional visits	9.0	11.4	4.4	15.5	10.7
Tests	1.8	3.2	1.2	1.9	1.3
Special Equipment	14.3	30.1	7.8	12.6	25.2
Alterations to house	7.3	22.9	48.0	0	0
Community services	0.2	2.3	2.4	7.2	3.4
Private services	33.8	21.1	30.4	33.6	33.0
Hospitalization	8.4	0	0	0	0

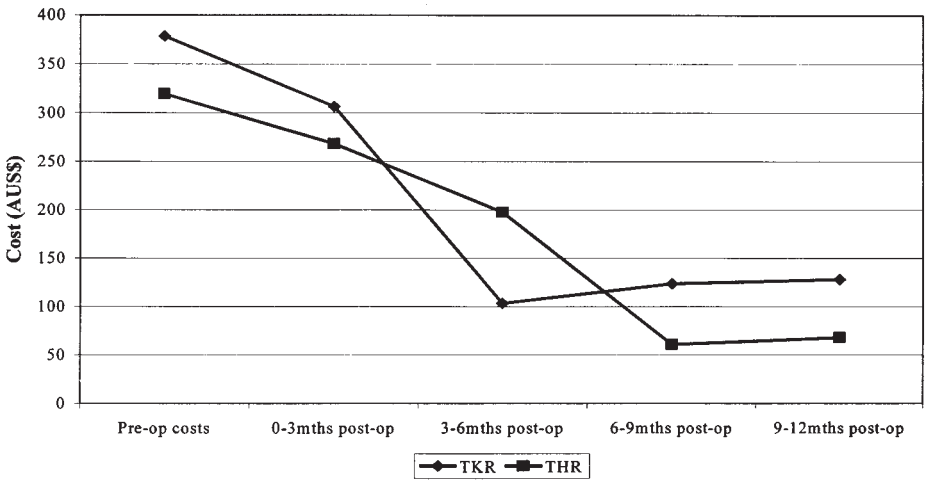

Figure 2. Out-of-pocket costs presurgery and one year postsurgery.

median $274, with costs ranging from $0 to $104,801. If this respondent with extreme costs is excluded, mean annual expenditure for THR was $539 (SD $908, 95% CI $330.17, $748.27) median $273, and ranged from $0 to $6084.

For each of the time periods, no significant differences were found in mean total expenditure between TKR and THR. As shown in Table 4, however, looking at mean component costs, for some time periods TKR patients spent significantly more on prescription medications and community services than THR patients, while THR patients spent significantly more on tests during the 3 month recording at 12 months postsurgery.

For both THR and TKR patients, the proportion who did not have any arthritis related expenditure increased from presurgery to 12 months postsurgery. By one year postsurgery, 30% of TKR patients and 37% of THR patients had no expenses in the 9 to 12 month period compared to only 2% and 1%, respectively, preoperatively (Figure 1).

Component costs. Table 3 shows the proportion of total expenditure for each of the components recorded in the cost diaries.

For TKR, alterations to the house made up 44% of total preoperative expenditure. For the postoperative period, private services, visits, and special equipment constituted considerable proportions.

For THR, the major presurgery expenditure was for private services, which contributed to one-third of the total preoperative costs. Nonprescription medications contributed to 17% of the total cost. Postoperatively, private services, including home care, gardening assistance, and private transport services such as taxis continued to remain a considerable proportion of expenditure.

Preoperative health status and postoperative costs: TKR. Overall costs were significantly correlated with preoperative SF-36 PCS (r = –0.210, p = 0.038), WOMAC Stiffness (r = 0.314, p = 0.002), and WOMAC Function (r = 0.252, p = 0.012). People with worse physical status presurgery spent more over the year postsurgery.

Presurgery pain was significantly positively correlated with costs for equipment, community services, and private services. Preoperative stiffness was significantly positively correlated with costs for prescription medications, community services, and private services. Preoperative function was significantly positively correlated with cost for equipment, alterations, and community and private services.

Preoperative health status and postoperative costs: THR. Overall costs for the year postsurgery were significantly correlated with preoperative SF-36 PCS (r = –0.337, p = 0.003) and WOMAC Pain (r = 0.297, p = 0.009) and Function scores (r = 0.290, p = 0.011), indicating that people with worse physical function presurgery spent more during the first year postsurgery.

Preoperative SF-36 MCS was significantly positively correlated with cost for equipment, suggesting that people with better mental status spent more on equipment during the postsurgery year. Baseline SF-36 PCS and WOMAC pain were significantly correlated with costs for nonprescription medications and alterations to the home. Presurgery WOMAC Pain was also significantly correlated with cost of prescription medications. Preoperative WOMAC Stiffness was significantly correlated with cost for prescription medications, and preoperative WOMAC Function was significantly correlated with cost for equipment and alterations to the home.

Postoperative health status and postoperative costs: TKR. Overall out-of-pocket costs were not significantly correlated with 3 month postoperative health status of the TKR patients; however, some individual component costs were correlated with postoperative outcomes.

Costs for prescription medications were significantly correlated with PCS, MCS, Pain, Stiffness, and Function, indicating that people with worse function spent more on prescription medications. Similarly, expenditures on nonprescription medications were significantly correlated with 3 month postsurgery PCS.

Postoperative health status and postoperative costs: THR. Overall costs for the first year post hip surgery were significantly correlated with 3 month postsurgery PCS, Pain, Stiffness, and Function, indicating that those with a poorer health status incurred greater out-of-pocket expenditure.

Significant correlations were found between costs for prescription and nonprescription medications and alterations to the home and PCS, Pain, Stiffness, and Function at 3 months postsurgery. Similarly significant correlations were

Table 4. Areas where there are differences in costs between TKR and THR: mean cost and difference.

	TKR Mean $ (SD)	THR Mean $(SD)	95% CI of Difference	p
Prescription medications				
3 mo postsurgery	26.15 (32.74)	14.05 (26.68)	2.98, 21.23	0.010
6 mo postsurgery	12.38 (19.22)	5.15 (10.05)	2.43, 12.02	0.003
Community services				
12 mo postsurgery	9.29 (32.51)	0 (0)	1.92, 16.65	0.014
Tests				
12 mo postsurgery	1.54 (11.75)	7.06 (22.39)	–10.71, –0.32	0.038

found between equipment and PCS, Stiffness, and Function at 3 months. A significant positive correlation was found between tests and MCS, suggesting that people with better mental function spent more on tests such as radiographs, scans, and blood tests.

Regression analysis — costs for first postoperative year. The variables entered into the regression model to determine significant independent predictors of patients' out-of-pocket costs over the first postoperative year are shown in Table 5. Three regression models were assessed: one for TKR patients, one for THR patients, and one with TKR and THR combined. All models included the same variables, with the exception of "Group" (THR or TKR), which was excluded in the separate TKR and THR models.

Preoperative WOMAC Stiffness and pension status were the significant independent predictors of postoperative log transformed costs for TKR patients (ß = 0.362, p = 0.001 and ß = –0.670, p = 0.028, respectively; adjusted R^2 = 0.126). Thus, for every one-point increase in the preoperative Stiffness score (i.e., worsening stiffness) median out-of-pocket costs increased by 144%. For those patients on a pension, median cost was 50% less than for those who did not receive a pension.

For THR patients, pension status, preoperative SF-36 PCS, and 3 month postoperative WOMAC Function were the significant independent predictors of postoperative log transformed costs (ß = –0.885, p = 0.012, ß = –0.069, p = 0.009, and ß = 0.048, p = 0.002, respectively; adjusted R^2 = 0.246). For THR patients on a pension, median cost was 59% less than for those who did not receive a pension. For every one-point decrease in preoperative physical component score (i.e., worsening physical status), median cost increases by 93%. For each one point increase in postoperative function score (i.e., worsening function), median cost increases by 104%.

For the combined hip and knee model, significant independent predictors of log transformed costs were not receiving a pension, being female, and having poorer preoperative WOMAC Function scores and worse 3 month postoperative physical status as measured by the SF-36 (Table 5). The median cost of those people with private health insurance is 156% higher than the cost for those without insurance, and women spend 167% more than men. Patients on a pension have a median cost 43% lower than those who do not receive a pension. For each one-point increase in preoperative function score (i.e., worsening function), median cost increases by 103%, and for every one-point decrease in postoperative physical component score (i.e., worsening physical status), median cost increases by 96%.

DISCUSSION

This is the first economic evaluation of total joint replacement surgery that focuses on the patients' perspective. Out-of-pocket costs incurred by patients undergoing TKR and THR are substantial during the initial postoperative period and decrease considerably over the first 12 months after surgery. There is an increasing awareness that patient-centered outcomes are important for decision making, particularly where the procedure involved is an elective one intended to improve quality of life rather than prolong life. In addition to improved function and reduced pain, these decreased costs may assist a patient in their consideration for undertaking surgery.

The economic burden of OA has many components when a societal perspective is taken[1], including direct medical and nonmedical costs and indirect costs, and intangibles of pain and loss of quality of life. Gabriel, *et al*[16,17] found that patients with OA incurred significantly more expenditure than nonarthritics in both medical and nonmedical costs.

Table 5. Regression model — significant independent predictors of overall log transformed costs for the first year postsurgery.

Final Model Variables	Coefficient	e^{β}	Significance	95% CI	Adjusted R^2
Combined hip and knee model					
Private health insurance (0 = no, 1 = yes)	0.433	1.557	0.092	–0.073, 0.958	0.184
Preoperative Function	0.028	1.028	0.003	0.009, 0.046	
Postoperative PCS	–0.040	0.961	0.008	–0.069, –0.011	
Sex (0 = male, 1 = female)	0.517	1.677	0.025	0.067, 0.967	
Pension (0 = no, 1 = yes)	– 0.556	0.573	0.030	–1.057, –0.055	
Knee only model					
Preoperative Stiffness	0.362	1.436	0.001	0.162, 0.562	0.126
Pension (0 = no, 1 = yes)	–0.670	0.512	0.028	–1.265, –0.075	
Hip only model					
Pension (0 = no, 1 = yes)	–0.885	0.413	0.012	–1.572, –0.197	0.246
Preoperative PCS	–0.069	0.933	0.009	–0.121, –0.018	
Postoperative Function	0.048	1.049	0.002	0.018, 0.078	

Variables entered into the model: Group (0 = knee, 1 = hip), age, sex, years with arthritis, private health insurance (0 = no, 1 = yes), receive pension (0 = no, 1 = yes), comorbidities (0 = no, 1 = yes), home situation (0 = live with others, 1 = lives alone), preoperative PCS, MCS, Pain, Stiffness and Function and 3 month postoperative PCS, MCS, Pain, Stiffness and Function.

Nonmedical costs considered in that study included services such as housekeeping, medical equipment such as bathroom aids and walking sticks, and alterations to the home. Our study suggests that these costs will decline after surgery. The utilization of private services such as home help, gardeners and taxi services, constituted a considerable proportion of out-of-pocket expenditure for both THR and TKR in our study. The cost of private services is not subsidized, so expenditure on these services is likely to be influenced by the ability to pay for them rather than a need for such services. However, the expenditure on these nonmedical items also decreases over the first year after TKR or THR.

Because of the greater gains in health status reported by THR patients, it has been recommended that patients with THR and TKR should be evaluated as 2 separate groups when assessing the effect of the operation[7].

More postoperative complications were seen in the TKR group than the THR group, which is reflected in poorer outcomes for TKR. In view of the differences seen in age, duration of arthritis, pension status, and the better outcome reported by THR patients, it is interesting to see no significant difference in overall out-of-pocket expenditure between THR and TKR patients. In addition, although a higher proportion of the TKR patients reported having comorbidities, the presence of other illnesses was not an independent predictor of arthritis related expenditure. TKR patients spent significantly more on prescription medications at all time periods than THR patients, in spite of a higher proportion of TKR patients receiving the pension and therefore receiving prescription medications at a reduced price. Future analyses of the number and type of medications purchased may provide an explanation for this difference in costs.

Poorer preoperative functional status has been shown to be associated with a worse outcome at 6 months postsurgery[8]. Here, both preoperative and 3 month postoperative physical status were found to be predictors of out-of-pocket expenditure. People with poorer physical status had greater out-of-pocket expenditure over the postoperative year, with assistive equipment and alterations to the home being the major components. Expenditure over the 12 months postsurgery on prescription and nonprescription medications was significantly correlated with health status at 3 months postsurgery. While a direct cause and effect cannot be concluded from this observational study, the results suggest that earlier surgery or more aggressive attention to physical function and health status pre- and immediately postoperatively may improve outcomes and reduce costs from the patients' perspective.

Three regression models were presented, one for TKR, one for THR, and one with TKR and THR combined. The combined model included type of replacement (hip or knee) as a potential predictor of out-of-pocket costs. Possibly due to improved power of calculations, different predictors were shown in each of the models, and interestingly, the joint itself was not a predictor in the combined model.

While indirect costs, such as income lost as a result of absence from work, remain an important determinant of total costs of joint replacement, the calculation of these costs is complex and there is a lack of methodological consensus, particularly where patients are no longer in the workforce. As a result, indirect costs were not included in this analysis. The age group included here most likely includes those in retirement, and difficulties exist in valuing the time spent at nonpaid work and changes in productivity. Although direct out-of-pocket expenses related to health services utilization were low in this Australian population, where services are subsidized by the government, there will be associated direct nonmedical costs related to travel and parking that have not been gathered, and indirect costs related to time lost from work or usual duties for the patient and/or caregiver, and these will also decline.

Preoperative arthritis related expenditures were obtained by a retrospective questionnaire. In the majority of cases these were completed by the research assistant in the patient's home, where receipts and personal diary records were often available. However, it is acknowledged that patients may have some difficulty accurately recalling when they made their preoperative purchases. Postoperative data, on the other hand, were self-reported in prospective cost diaries. The prospective nature of the diaries, where respondents were encouraged to record expenses as they were incurred, reduces the effect of recall bias. The regular contact by the research team also served to encourage respondents to maintain their diaries. Goossens and colleagues[13] found no difference in results when comparing diaries for short periods (2 weeks every 2 months) with diaries covering a whole year, and it was concluded that the diary can be successfully adopted in longterm studies and is a valid instrument to measure direct medical costs[13]. While the observation of declining costs over the postoperative year may be due to reduced compliance over time, this would seem unlikely, given that the respondents completed other detailed health outcome questionnaires at the same time, and thus the declining costs should reflect the reduction in expenditure following joint replacement surgery.

Data reported here represent the costs incurred by half of the eligible population of patients scheduled for joint replacement at the participating hospitals, which may be a limitation to the generalizability of the results. Few differences were seen between study participants and nonparticipants where preoperative SF-36 data were available and there was no difference in age or sex. There is no evidence that these nonparticipants would have any important difference in costs or outcome from their procedure as their hospital treatment and followup by the surgeon was not determined by their study participation.

The value of our results is strengthened by the inclusion

of patients from a range of surgeons operating in both the public and private systems at several hospitals. The detailed prospective collection of data gives a clear picture of the costs of joint replacement that are borne by the patients themselves.

In addition to the well recognized improvements in pain and physical function after total hip and knee joint replacement surgery, patients with OA can look forward to reduced out-of-pocket expenditure and substantial savings in time and money spent on visits to health professionals in the first postoperative year. OA patients with poorer preoperative health status had greater out-of-pocket expenditure and health care utilization during the first postoperative year. These data provide important additional information that can be taken into consideration when making a choice about the timing of and preparation for joint surgery.

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