

## Two knees or not two knees?

### Patient costs and outcomes following bilateral and unilateral total knee joint replacement surgery for OA<sup>1</sup>

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#### Summary

**Aims:** This study aims to address medical and non-medical direct costs and health outcomes of bilateral and unilateral total knee replacement from the patients' perspective during the first year post-surgery.

**Methods:** Osteoarthritis patients undergoing primary unilateral total knee or bilateral total knee replacement (TKR) surgery at three Sydney hospitals were eligible. Patients completed questionnaires pre-operatively to record expenses during the previous three months and health status immediately prior to surgery. Patients then maintained detailed prospective cost diaries and completed SF-36 and WOMAC Index each three months for the first post-operative year.

**Results:** Pre-operatively, no significant differences in health status were found between patients undergoing unilateral TKR and bilateral TKR. Both unilateral and bilateral TKR patients showed improvements in pain, stiffness and function from pre-surgery to 12 months post-surgery. Patients who had bilateral TKR spent an average of 12.3 days in acute hospital and patients who had unilateral TKR 13.6 days. Totally uncemented prostheses were used in 6% of unilateral replacements and 48% of bilateral replacements. In hospital, patients who had bilateral TKR experienced significantly more complications, mainly thromboembolic, than patients who had unilateral TKR. Regression analysis showed that for every one point increase in the pre-operative SF-36 physical score (i.e. improving physical status) out-of-pocket costs decreased by 94%. Out-of-pocket costs for female patients were 3.3 times greater than for males.

**Conclusion:** Patients undergoing bilateral TKR and unilateral TKR had a similar length of stay in hospital and similar out-of-pocket expenditures. Bilateral replacement patients reported better physical function and general health with fewer health care visits one year post procedure. Patients requiring bilateral TKR have some additional information to aid their decision making. While their risk of peri-operative complications is higher, they have an excellent chance of good health outcomes at 12 months and are not going to be doubly 'out-of-pocket' for the experience.

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**Key words:** Bilateral knee arthroplasty, Patient costs, Osteoarthritis.

#### Introduction

With the pressure on health budgets increasing across the globe, there has been an emphasis on assessing the costs of procedures to health care systems. Total joint replacement is one procedure that has been investigated in light of an increasing number being performed worldwide each

year and has been estimated to accrue costs in excess of US\$10 billion annually in the United States<sup>1</sup>.

Total knee replacement (TKR) is widely accepted as an effective treatment for severe arthritis and has been shown to improve pain and restore function<sup>2</sup>. Simultaneous bilateral TKR, where both knees are replaced during the one operation, has been reported to be an extremely cost-effective procedure in patients with bilaterally symptomatic disease and decreases the cost of two unilateral procedures by 36%<sup>3</sup>. Bilateral TKR may be more advantageous for the patient in terms of decreased cost, total rehabilitation time, physical therapy requirements, anaesthesia time and hospital length of stay<sup>3</sup>.

While costs for the acute hospital stay are similar for simultaneous bilateral and unilateral procedures, rehabilitation needs have been shown to be greater amongst those

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with bilateral TKR<sup>4</sup> with approximately two times greater need for rehabilitation. In addition, other post-operative complications such as confusion, arrhythmias and a greater need for banked blood have been shown to occur in those undergoing bilateral procedures<sup>4</sup>.

While these factors are important from the view of the health system decision makers', data on the patients' views of bilateral replacement during the first post-operative year are limited. While patient out-of-pocket costs represent only 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 in the 'big picture'. The inclusion of patient costs for non-medical aspects of joint replacement, such as transport and housekeeping, gives a more detailed estimate of the costs of the procedure as these are not included in the costs to the health system. Increasingly the patients' perspective, including their costs, should be taken into account in medical decision making.

In Australia, the hospitalization cost of joint replacement is covered by the government-funded Medicare or private health insurance funds and is estimated to cost approximately AUS\$25,000 to AUS\$30,000 per patient. Medical practitioners' fees may be higher than the reimbursement and patients pay the gap out of their own pocket.

This study aims to address costs of TKR from the patients' perspective by determining the out-of-pocket expenditure and health service utilization for the first year post-surgery of patients undergoing bilateral TKR. To put these costs and outcomes into perspective, they have been compared with costs and outcomes of those undergoing unilateral TKR. Patient-centred health status measures were then used to assess outcome from the patient's perspective in the early post-operative period and one year later.

## Methods

All patients with a diagnosis of osteoarthritis (OA) scheduled for primary unilateral or simultaneous bilateral TKR at three Sydney hospitals, including public and private, during 1994 to 1998 were approached to participate. Patients were informed that they would be required to complete questionnaires to record expenses during the pre-operative three months in a study-designed Cost Questionnaire. In addition, they would be required to complete health status questionnaires pre-operatively (Western Ontario and MacMaster Universities Osteoarthritis Index [WOMAC] and Short Form-36 [SF-36]), and maintain detailed prospective Cost Diaries for their first post-operative year at three monthly intervals. Where patients consented, medical records were examined and data regarding length of stay, operation time, medications, complications and discharge destination were extracted.

Arthritis-specific cost information obtained in the Diary and pre-operative questionnaire related to medications (both prescription and non-prescription), visits to health professionals, tests (for example radiographs, blood tests, scans), special equipment, household alterations, and use of private and community services. Respondents were asked to prospectively record in the diaries all expenses they incurred in these categories due to their arthritis. Where respondents were able to claim reimbursement 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. Respondents were also instructed to include visits, tests and medications even when they were not charged or had paid at a reduced rate, i.e. through the government-funded Medicare or Pharmaceutical Benefit Scheme Safety Net, in order to ensure complete records of health service utilization. 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 and/or their carers. Each Diary was completed for three months, when it was returned to the research office and a new diary for the next three month period was sent. Four diaries were completed during the first post-operative year. Diaries commenced when the patient returned home from their hospital stay and as such do not include costs of the surgery, hospital stay or inpatient rehabilitation.

The diaries were modeled on those used for an earlier Australian cost-of-illness study for multiple sclerosis<sup>5</sup>. Cost diaries have been identified as a potentially useful method to collect these data<sup>6</sup>, although a more recent study suggests that older adults and those with a chronic illness may underreport health service utilization<sup>7</sup>. To confirm that diaries were a valid means of collecting this data, in the initial phases of our study home visits were made to a random sample of respondents to compare their diary entries with actual receipts from Medicare statements, pharmacy statements, receipts from services such as housekeeping. There was high concordance and the study progressed. To encourage compliance and completion of diaries, the research officer telephoned respondents twice during each diary period and sent newsletters and birthday cards.

Where Cost Diaries and health status questionnaires were not completed for a 3 month period, with a maximum of two 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. In order 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 three figures to replace data, so mean values were used to replace missing data for the analyses reported here. Data were analysed using Statistical Packages for the Social Sciences. For descriptive purposes, mean costs are presented but as the cost data were not normally distributed (using Kolmogorov-Smirnov Goodness of Fit test), costs were log transformed for comparisons between groups. A backwards method was used for regression analysis whereby all relevant variables were entered into the model and were progressively omitted if they did not reach statistical significance. Variables significant in univariate analyses and which have been identified in the literature to be associated with outcomes of joint replacement were entered into a regression model, including type of replacement (unilateral or bilateral), age, sex, years with arthritis, pension status, private health insurance status, have comorbidities, live alone or with others, pre-surgery and 3 months post-surgery WOMAC scores and SF-36 Physical Component Score (PCS) and Mental Component Score (MCS).

## Results

One hundred and ninety eight patients undergoing unilateral TKR and 139 patients undergoing bilateral TKR

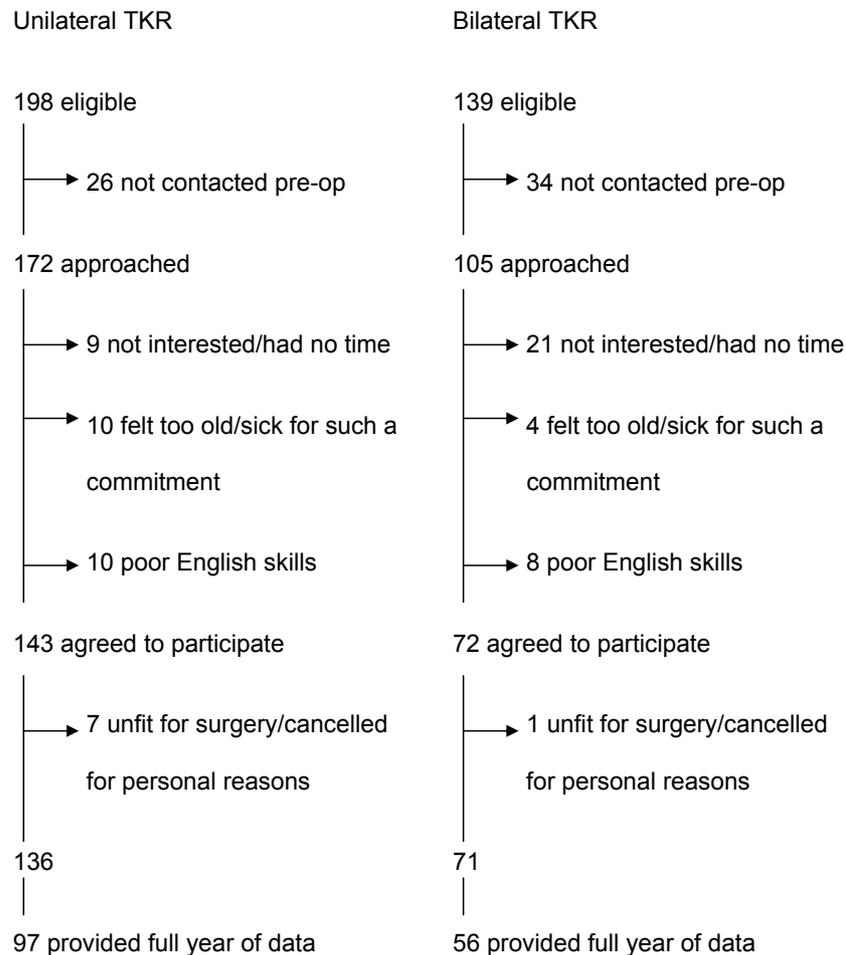


Fig. 1. Response rate and reasons for non-participation.

were eligible to participate. Ninety-seven patients undergoing unilateral TKR and 56 patients undergoing bilateral TKR provided cost details for the full year. Fig. 1 outlines the number of patients in each category and indicates the reasons patients did not participate.

No significant difference was seen in the proportion of males and females amongst study participants and non-participants and those who withdrew without providing post-operative data within replacement type. For patients undergoing unilateral TKR, non-participants, however, were significantly older than participants (73 vs 71 years,  $P=0.038$ ). No difference in age was seen for patients undergoing bilateral TKR. Pre-operative SF-36 and WOMAC scores were available from patients who agreed to participate in the study and then did not provide post-operative data. For the patients undergoing unilateral TKR, no significant difference was seen for any of the three WOMAC scores or eight SF-36 scores between those who provided post-operative data and those who did not. However, patients undergoing bilateral TKR who did not provide post-operative data reported worse WOMAC pain while there was no difference in WOMAC stiffness or function or the eight SF-36 scores.

No patients required revision of their prostheses during the 12-month follow-up period. Three patients who underwent hip replacement during the 12 months were excluded from the analysis.

Cost data were obtained from 97 patients who had primary unilateral TKR and 56 patients who had simultaneous bilateral TKR. Details of these patients are shown in Table 1. Patients who had unilateral TKR were significantly older than patients who had bilateral TKR (71 vs 68 yrs,  $P=0.001$ ). A significantly greater proportion of patients who had bilateral TKR than patients who had unilateral TKR went to a rehabilitation facility post-acute hospital stay (55% vs 33%,  $P=0.007$ ) and a greater proportion reported having private health insurance (86% vs 59%,  $P=0.001$ ). The post-operative regimen was similar in each patient. Mobilization commenced when the drains were removed (usually day two or three post-surgery) and continuous passive motion devices were employed intermittently when necessary whilst in hospital. Significantly more patients who had unilateral TKR received a cemented or partly cemented prosthesis (94% vs 54%,  $P<0.0001$ ). Pre-operative rating of pain in the knees was available from 62 patients undergoing unilateral TKR. The pain reported by these patients was significantly worse in the operated knee than the other knee ( $p<0.0001$ ).

#### HEALTH STATUS

Pre-operatively, no significant differences were found between patients undergoing unilateral TKR and patients undergoing bilateral TKR in WOMAC pain, stiffness or

Table I  
Details of study patients

	Unilateral TKR	Bilateral TKR	Significance	
n	97	56	—	—
Age in years (range)	70.9 (55-87)	67.8 (50-82)	$P=0.011$	**
% Female	53.6	48.2	$P=0.520$	—
Length of stay in days (range)	13.8 (5-28) (N=65)	12.4 (6-29) (N=52)	$P=0.060$	—
% to rehabilitation	33.0	55.4	$P=0.007$	**
% receiving pension	63.9	48.2	$P=0.058$	—
% with private health insurance	58.8	85.7	$P=0.001$	**
% reporting co-morbidities	71.1	62.5	$P=0.270$	—
% with post-op admission related to TKR	12.4	5.4	$P=0.160$	—
% live alone	26.0	14.3	$P=0.090$	—

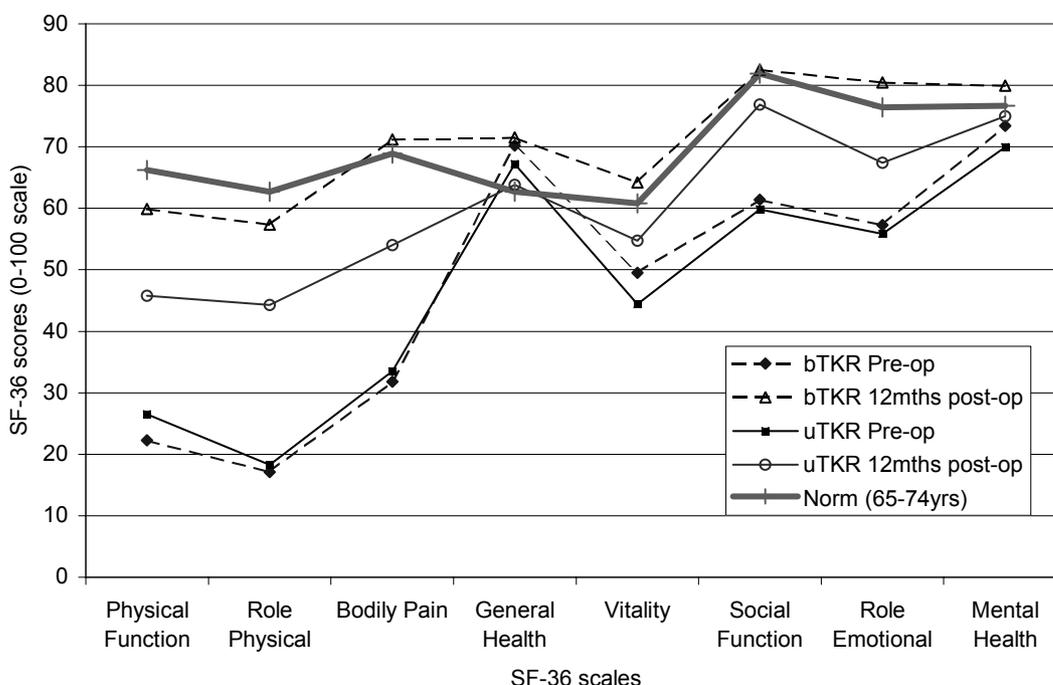


Fig. 2. Pre-operative and 12-month post-operative SF-36 scores for bilateral and unilateral TKR respondents and Australian population (65–74 years).

function or the eight scales of the SF-36. From pre-surgery to 12 months post-surgery patients who had unilateral TKR reported a reduction in WOMAC pain scores of 48%, stiffness reduced by 33% and function improved by 39%. Patients who had bilateral TKR reported a 73% reduction in WOMAC pain, a 53% reduction in stiffness and a 63% improvement in function from pre-surgery to post-surgery. Patients who had unilateral TKR reported significant improvements in all SF-36 scales from pre-surgery to 12 months post-surgery (all  $P$ -values  $<0.05$ ). Similarly, patients who had bilateral TKR reported significant improvements in all SF-36 scales, with the exception of General Health which was high pre-surgery (all  $P$ -values  $<0.001$ ).

SF-36 scores for the first post-operative year for TKR patients as well as Australian population norms for the 65–74 year age group<sup>8</sup> are shown in Fig. 2 and WOMAC scores are shown in Fig. 3.

When the potential confounders of replacement type, age, gender, home/rehabilitation, live alone/with others were entered into regression models for WOMAC scores at 12 months post-surgery, the results demonstrated that

patients who had bilateral TKR reported better WOMAC pain, stiffness and function (pain:  $\beta=-2.57$ ,  $P=0.0001$ ; stiffness:  $\beta=-0.909$ ,  $P=0.0014$ ; function:  $\beta=-10.388$ ,  $P<0.0001$ ).

HOSPITALIZATION

Medical records of 65 (67%) patients who had unilateral TKR and 52 (93%) patients who had bilateral TKR were reviewed. Patients who had bilateral TKR spent an average of 12.4 days (range, 6 to 29 days) in acute hospital and patients who had unilateral TKR 13.8 days (range, 5–28) ( $P=0.06$ ). The operation time for bilateral TKR was significantly longer than unilateral TKR (130 mins vs 113 mins,  $P<0.0001$ ). Only six percent of unilateral TKR were totally uncemented while 46% of bilateral TKR were.

In hospital, patients who had bilateral TKR experienced significantly more complications than patients who had unilateral TKR ( $\chi^2=19.16$ ,  $P<0.0001$ ). Complications mainly consisted of thromboembolic events which were experienced by 29% of bilateral TKR patients compared with 6% of unilateral TKR patients. Ten percent of patients who had

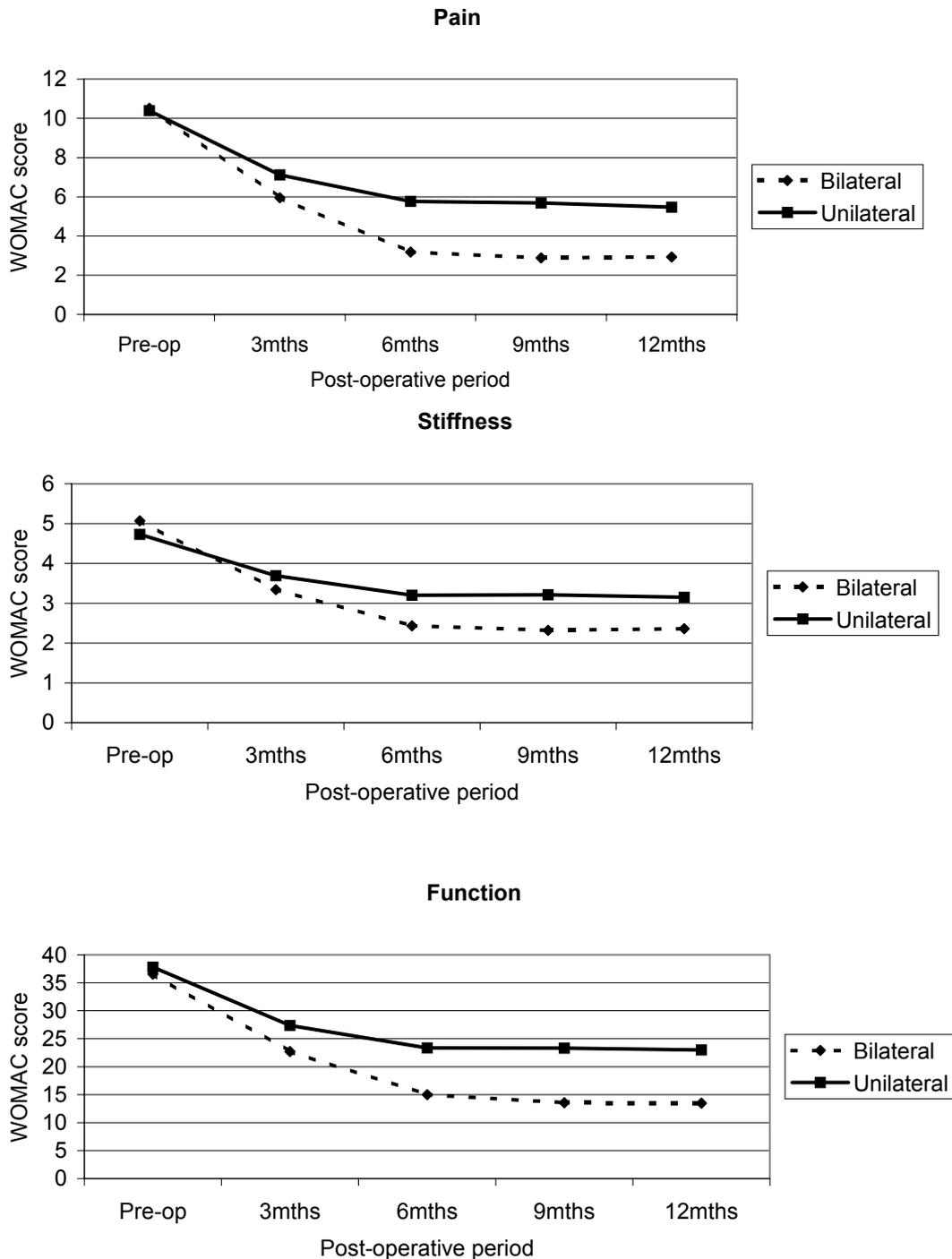


Fig. 3. WOMAC scores for TKR patients pre- and post-surgery (higher score=worse health status).

bilateral TKR experienced short-term confusion compared with 3% of patients who had unilateral TKR. Significantly more patients who had bilateral TKR than patients who had unilateral TKR were discharged to a rehabilitation facility (55% vs 33%,  $P=0.007$ ). Bilateral TKR patients also required greater use of blood transfusions, of both banked (1.17 units vs 0.16 units,  $P<0.0001$ ) and autologous blood (2.0 units vs 0.44 units,  $P<0.0001$ ). No deaths among any of these patients occurred during the hospital stay, and one patient who had unilateral TKR died within the 12-month follow-up period (cause unknown).

Patients recorded in the study diaries if they were readmitted to hospital for an arthritis-related disorder. During the first year post-surgery, 12 (12%) patients who had unilateral TKR and 3 (5%) patients who had bilateral TKR were readmitted to hospital for a condition related to their knee replacement, predominantly for manipulation of the joint under anaesthesia due to poor range of motion. Of the nine manipulations performed, one surgeon accounted for five, with three other surgeons performing the remainder. There was no significant difference in WOMAC pain, stiffness or function for

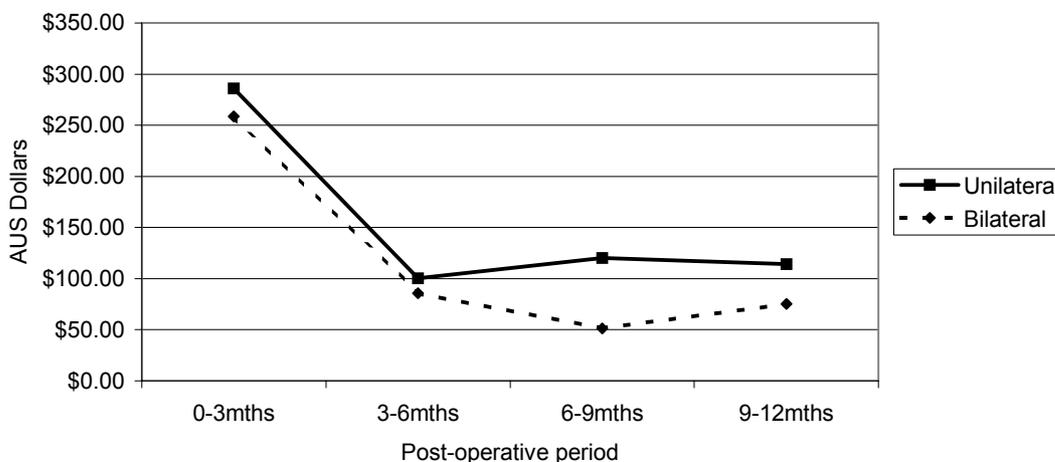


Fig. 4. Out-of-pocket expenses during the first twelve months post-surgery.

patients of this one surgeon compared to the others combined.

OUT OF POCKET COSTS

Overall out-of-pocket costs were not normally distributed amongst respondents. For patients who had unilateral TKR, the mean annual expenditure was AUS\$621 (standard deviation AUS\$1,185, 95% Confidence interval (CI) AUS\$382, AUS\$860) and costs ranged from AUS\$0 to AUS\$7,559. Six respondents were considered to be outliers. For patients who had bilateral TKR, the mean annual expenditure was AUS\$471 (sd AUS\$587, 95% CI AUS\$313, AUS\$628) and costs ranged from AUS\$0 to AUS\$3,160. Six patients who had bilateral TKR were considered to be outliers. The expenses during each three month period are shown in Fig. 4. No significant difference between patients who had bilateral TKR and patients who had unilateral TKR was seen for overall one year log transformed costs or for any of the component costs recorded in the diaries, such as medications, visits, tests and services.

Table II shows the mean amount spent on each of the component costs recorded in the study diaries and the proportion of the total cost contributed by each component. Over the year after discharge from the acute hospital or

Table II  
Mean out-of-pocket amount spent by patients during first post-operative year (AUS\$)

	Unilateral TKR \$ (%)*	Bilateral TKR \$ (%)*
Prescription medications	55.58 (8.9)	68.72 (14.6)
Non-prescription medications	37.97 (6.1)	41.51 (8.8)
Visits to health professionals	125.81 (20.3)	128.26 (27.2)
Tests	4.14 (0.7)	5.36 (1.1)
Equipment	120.42 (19.4)	81.79 (17.4)
Alterations to home	31.76 (5.1)	41.63 (8.8)
Services	245.03 (39.5)	103.30 (21.9)
Total cost (range)	621.01 (\$0-\$7,559)	470.75 (\$0-\$3,160)

\* Percent of total out-of-pocket cost.

rehabilitation facility, patients who had bilateral TKR and patients who had unilateral TKR spent a similar amount on visits to health professionals, with patients who had bilateral TKR spending an average of AUS\$128 and patients who had unilateral TKR AUS\$126. The greatest proportion of the total annual out of pocket cost spent by patients who had bilateral TKR was on visits to health professionals (27% of total cost) and by patients who had unilateral TKR on services (39% of total cost).

UTILIZATION OF HEALTH SERVICES

As there may be no out-of-pocket costs to patients if visits to health professionals or medical tests are covered by the health care system, utilization of services may be considered an indication of need. The number of visits to general practitioner, surgeon, and physiotherapist as well as the number of medical tests undertaken are shown in Table III. Patients who had unilateral TKR made significantly more visits to their surgeon and underwent more x-rays than patients who had bilateral TKR for arthritis-related conditions during the first post-operative year and used more community services. The total number of visits to health professionals during the post-operative year are shown in Fig. 5.

When comparing the number of visits to health professionals during the post-operative year between those who went to a rehabilitation facility and those who went directly home, no significant differences were seen for either the unilateral TKR or bilateral TKR patients. People who went home did not have significantly more visits to physiotherapists, general practitioners or surgeons than

Table III  
Utilization of health services – mean number (and range) of visits and tests during first post-operative year

	Unilateral TKR	Bilateral TKR	Significance
General practitioner	4.13 (0-23)	2.84 (0-20)	P=0.080 -
Surgeon	2.18 (0-10)	1.38 (0-5)	P=0.002 **
Physiotherapist	10.31 (0-67)	6.41 (0-60)	P=0.077 -
X-rays	1.04 (0-6)	0.32 (0-3)	P<0.001 **
Blood tests	0.93 (0-23)	0.80 (0-8)	P=0.785 -
Community services	7.80 (0-64)	2.70 (0-30)	P=0.005 **

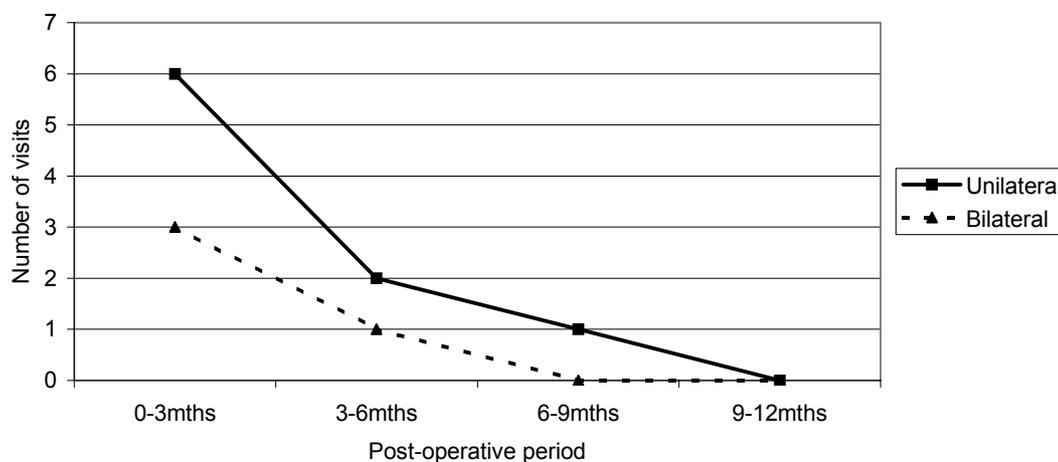


Fig. 5. Median number of visits to health professionals during the first post-operative year.

those who received additional treatment in an inpatient rehabilitation facility.

#### REGRESSION ANALYSIS-COSTS FOR THE FIRST POST-OPERATIVE YEAR

The variables entered into the regression model to determine significant independent predictors of patients' out-of-pocket medical and non-medical costs over the first post-operative year are shown in Table IV.

Pre-operative SF-36 PCS and gender were the significant independent predictors of post-operative log-transformed costs ( $\beta = -0.063$ ,  $P = 0.002$  and  $\beta = 1.182$ ,  $P < 0.0001$ , respectively). Thus, for every one point decrease in the pre-operative SF-36 physical score (i.e. worsening physical status) costs increased by 94%. Out-of-pocket costs for female patients were 3.3 times higher than for males.

## Discussion

Hospitalization costs associated with TKR have been previously studied, however they are only one component of costs. Costs to the patients themselves can

be significant and in this study, post-operative visits to therapists are included in the patient diaries and as a result costs incurred for these services can be considered which gives a more complete picture of the costs involved. Studies which consider only hospitalization costs do not consider these costs to both the patient and health system. Rather than receiving treatment as an inpatient, patients who had unilateral TKR made more visits to physiotherapists, surgeon and general practitioners as outpatients than patients who had bilateral TKR, but with no significant difference in out-of-pocket costs for these services. The significant difference in the number of visits to an orthopaedic surgeon between patients who had unilateral TKR and patients who had bilateral TKR may be a reflection of the surgeon's practice rather than an indication of need. The cost for the initial post-operative visit to surgeons is often included in the overall cost of the operation or may be covered by Medicare. Similarly, visits to general practitioners may be covered by Medicare and as such patients may have no or little out of pocket cost as the cost is passed on to the health system. Public hospitals commonly run physiotherapy clinics for outpatients, the costs for which are covered by the health system. The costs for private physiotherapy visits are initially paid by the patient, but may be claimed from private health insurance if the patient is covered for such visits. Within each of the groups (bilateral and unilateral), people who went home from the acute hospital rather than to a rehabilitation facility did not have significantly more post-operative visits to physiotherapists.

Other costs considered in this study included medications, assistive equipment and services that may be required post-surgery. In all of the component costs as recorded in the study Diaries, there was little difference in out-of-pocket costs between patients who had bilateral TKR and patients who had unilateral TKR, with services, such as home help and transport, contributing a considerable proportion of total out-of-pocket cost.

Although this paper contrasts costs and outcomes between OA patients undergoing unilateral and bilateral TKR it must be kept in mind that this is an observational study not an experimental one. It is not feasible to perform a randomized trial in this setting and the two groups are not directly comparable pre-surgery. None of the patients undergoing unilateral TKR included here required replacement of their other knee within the twelve month follow-up

Table IV

Regression model-significant independent predictors of overall out-of-pocket costs for the first post-operative year

Final model variables*	Co-efficient	$e^{\beta}$	Significance	Adjusted R <sup>2</sup>
Sex	1.182	3.261	0.000	0.179
Pre-surgery PCS	-0.063	0.939	0.002	-
Age at operation	-0.034	0.967	0.057	-

\*Dependent variable: Overall out-of-pocket costs for first post-operative year

Variables entered into the model: Type of replacement (1=unilateral, 2=bilateral), age, sex (0=male, 1=female), years with arthritis, pension (1=yes, 2=no), private health insurance (1=yes, 2=no), comorbidities (1=yes, 2=no), home situation (0=live with others, 1=lives alone), pre-operative WOMAC pain, stiffness and function, 3 month post-operative WOMAC pain, stiffness and function, pre-operative PCS and MCS, 3 month post-operative PCS and MCS

period suggesting that they did not suffer from severe bilateral knee osteoarthritis as did those undergoing bilateral TKR or their age limited them from undergoing a second TKR. However, the two groups did not differ in WOMAC or SF-36 scores pre-surgery suggesting they had similar levels of pain, function and general health pre-surgery. The bilateral TKR group was younger, less likely to receive a pension, more likely to have private health insurance, and were more likely to live with others, any of which may influence their costs over the post-operative year.

Patients were recruited from several surgeons who operated at three large Sydney metropolitan hospitals both in the public and private systems. It should be noted that a higher proportion of patients in this study had private health insurance than the general Australian population.

As shown in other studies, more patients undergoing bilateral TKR were discharged to an inpatient rehabilitation facility after their acute hospital stay. As previously reported<sup>4</sup> there may be an expectation amongst surgeons, physiotherapists and patients that intensive treatment is required by people having both knees replaced prior to their return home. It is not known from this study whether the better function shown by the patients who had bilateral TKR compared with the patients who had unilateral TKR at one year post surgery can be attributed to the initial intensive rehabilitation treatment.

It appears that patients who had bilateral TKR had more in-hospital complications, such as an increased rate of thromboembolic and cardiovascular disorders, which would increase the hospitalization cost of these procedures. A greater proportion of patients undergoing bilateral TKR experienced cardiovascular problems than patients having unilateral TKR and this pattern has been shown in previous studies<sup>4</sup>. No deaths occurred amongst these patients with complications. It must be noted that at one hospital where a large proportion of patients underwent bilateral TKR, it was practice to routinely scan for deep vein thrombosis (DVT) so a larger number may have been detected. Previous studies have not found increased occurrence of DVT when comparing patients who had bilateral TKR with patients who had unilateral TKR<sup>9,10</sup>. In addition to a possible increased occurrence of complications, patients who had bilateral TKR required approximately twice as many units of transfused blood. The greater use of uncemented prostheses, which results in an increased area of raw bleeding bone surfaces intraoperatively, may explain the greater rate of transfusions amongst the bilateral group. The increased use of transfusions may be associated with the possibility of potential problems in the form of blood-borne diseases, however there is an increasing practice to undergo autologous transfusion which reduces infection risk.

Fewer patients who underwent unilateral TKR went to a rehabilitation hospital, but more had re-admissions to hospital for joint-related conditions, commonly manipulation of the joint. This places an additional cost on the health care system that may not be considered in studies comparing only the hospitalization cost of bilateral and unilateral procedures.

TKR restores function and relieves arthritic pain. After the procedure, patients undergoing bilateral TKR report significantly better physical and social function, less pain and better general and mental health than patients undergoing unilateral TKR. Both patients who had bilateral TKR and patients who had unilateral TKR improved post-operatively so at 12 months post-surgery they reported health status

that was similar to that of their age-matched peers in the Australian population. Using the knee-specific Hospital for Special Surgery scores to assess function, Worland<sup>8</sup> found no significant difference in knee function between the bilateral TKR and unilateral TKR patients at an average follow-up time of two years.

This analysis of patient costs adjusted for the difference in age between the bilateral TKR and unilateral TKR groups, however the fact that the patients undergoing unilateral TKR were significantly older than those undergoing bilateral TKR may account for some of the difference in health outcomes. Similarly, the presence of non-cemented prostheses in the younger patients who had bilateral TKR may also contribute to the difference in outcome. It is important to note that both groups improved significantly from their pre-operative health status with the patients undergoing bilateral TKR post-operatively attaining levels similar to their age-matched peers in the Australian population.

It should be noted that this study did not include the patient out-of-pocket costs associated with the procedure itself, the Diaries commenced when the patients returned home from hospital. For the majority of patients, the hospitalization costs were primarily covered by Medicare or a private health fund, however for private patients, additional expenses may be incurred for surgeon's fees and physiotherapy. As such, the patient costs reported here may be an underestimate of the true cost experienced by patients. It has been suggested that self-report of health care utilization may not give accurate information, with a considerable proportion of study subjects under-reporting visits to medical practitioners when compared with Health Maintenance Organisation records<sup>7</sup>. In the study reported here, the use of prospective diaries with regular reminders from research staff may reduce problems with recall. The availability of Medicare statements and pharmacy printouts of prescription medication also improves the accuracy of self-report in these diaries.

In addition to data concerning costs to the health care system, data from the patient's viewpoint which includes non-medical expenditure is important when considering the impact of such major surgery as elective TKR. Patients' out-of-pocket costs have been shown to decrease dramatically during the first post-operative year and are significantly lower than pre-operative expenditure. This reduction in expenditure is accompanied by a significant improvement in pain, function and health which are also important from the patients' point of view. This study assesses the often overlooked patient costs and includes non-medical expenditure such as transport and housekeeping. Patients should be aware of all aspects of the recovery process associated with TKR, which includes costs as well as health status.

## Conclusion

Patients undergoing bilateral TKR had a similar length of stay in hospital and similar out-of-pocket expenditures to those undergoing unilateral TKR, and while a greater proportion of patients undergoing bilateral TKR experienced thromboembolic disorders during their acute hospital stay these did not result in an increased rate of readmission to hospital during the post-operative year. In fact, patients who had bilateral TKR reported better physical function and general health with fewer health care visits during the year after the procedure.

Patients requiring bilateral TKR have some additional information to aid their decision-making. While their risk of peri-operative complications is higher, they have an excellent chance of good health outcomes at 12 months and are not going to be doubly 'out-of-pocket' for the experience.

## References

1. Lavernia CJ, Drakeford MK, Tsao AK, Gittelsohn A, Krackow KA, Hungerford DS. Revision and primary hip and knee arthroplasty: a cost analysis. *Clinical Orthopaedics* 1995;311:136–41.
2. Bachmeier CJM, March LM, Cross MJ, Lapsley HM, Tribe KL, Courtenay BG, *et al.* A comparison of outcomes in osteoarthritis patients undergoing total hip and knee replacement surgery. *Osteoarthritis and Cartilage* 2001;9:137–46.
3. Reuben JD, Meyers SJ, Cox DD, Elliot M, Watson M, Shim SD. Cost comparison between bilateral simultaneous, staged, and unilateral total joint arthroplasty. *The Journal of Arthroplasty* 1998;13:172–9.
4. Lane GJ, Hozack WJ, Shah S, Rothman RH, Booth RE, Eng K, *et al.* Simultaneous bilateral versus unilateral total knee arthroplasty; Outcomes analysis. *Clinical Orthopaedics and Related Research* 1997;345:106–12.
5. Black DA, Grant C, Lapsley HM, Rawson GK. The service and social needs for people with multiple sclerosis in New South Wales, Australia. *Journal of Rehabilitation* 1994;60:60–5.
6. Goossens ME, Rutten-van Molken MP, Vlaeyen JW, van der Linden SM. The cost diary: A method to measure direct and indirect costs in cost-effectiveness research. *Clinical Journal of Epidemiology* 2000;53:688–95.
7. Cronan TA, Walen HR. Accuracy of self-reported healthcare use in patients with osteoarthritis. *Journal of Rheumatology* 2002;29:2181–4.
8. Australian Bureau of Statistics (1997) National Health Survey: Summary of results, Australia 1995 Catalogue No. 4364.0
9. Worland RL, Jessup DE, Clelland C. Simultaneous bilateral total knee replacement versus unilateral replacement. *American Journal of Orthopaedics* 1996;25:292–5.
10. Morrey BF, Adams RA, Ilstrup DM, Bryan RS. Complications and mortality associated with bilateral or unilateral total knee arthroplasty. *Journal of Bone and Joint Surgery* 1987;69A:484–8.