

# The mortality, morbidity and cost benefits of elective total knee arthroplasty in the nonagenarian population

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**Abstract** With the increasing life expectancy, a greater number of elderly patients are being referred to an orthopaedic department to have elective total knee arthroplasty (TKA). Total knee arthroplasty should be considered in the very elderly only after carefully balancing the benefits of surgery against the risks of surgery. The aim of this study was to analyse the mortality, morbidity and cost benefits of elective TKA in a cohort group of the nonagenarian population. Between 1990 and 2006, 42 patients  $\geq 90$  years of age had TKA surgery. Patient's notes were retrospectively analysed. A cost-benefit analysis was carried out by comparing the surgical costs against nursing home placement. The mean age at surgery was 90.4 years (range: 90–90.6). There was one major and 11 minor postoperative complications with no immediate or late postoperative deaths. The Knee Society Scores improved from 25 points (range: 8–44) to 81 points (range: 60–95), and the WOMAC Scores improved from 62 points (range: 54–73) to 41 points (range: 34–46) ( $p < 0.002$ ). The calculated cost-benefit savings for 42 patients at 5 years after TKA was estimated to be £2,746,839. Total knee arthroplasty in the nonagenarian population is safe, beneficial and cost-effective.

**Résumé** L'augmentation de la durée de vie fait qu'une population de plus en plus âgée présente les conditions pour

bénéficier d'une prothèse totale du genou. La prothèse totale du genou doit être considérée dans cette population en comparant les bénéfices de la chirurgie et les risques de celle-ci. Le but de cette étude est d'analyser la mortalité, la morbidité, le rapport coût/bénéfice après prothèse totale du genou dans une cohorte de patients nonagénaires. Entre 1990 et 2006, 42 patients d'âge supérieur ou égal à 90 ans ont bénéficié d'une chirurgie par arthroplastie totale du genou. L'analyse de ces patients a été rétrospective. Le rapport coût/bénéfice a été réalisé en comparant le coût chirurgical versus, le coût du nursing à domicile. La moyenne d'âge a été de 90,4 ans (de 90 à 90,6). Ces patients ont présenté une seule complication majeure et 11 complications mineures sans décès post-opératoire. Le score de la Knee Society a été amélioré en passant de 25 points (8 à 44) à 81 points (60 à 95) et le score Womac a été amélioré de 62 points (54 à 73) à 41 points (34 à 46) ( $p < 0.002$ ). Le rapport coût/bénéfice de ces 42 patients à 5 ans de l'utilisation de la prothèse a été estimé à 2.746.839£. La prothèse totale du genou dans une population de nonagénaire est une intervention sûre et qui permet un rapport coût/bénéfice positif pour la société.

## Introduction

The number of elderly persons – the geriatric population – in the UK has risen markedly over the last ten decades, with significant effects on the health and social services. With advances in medicine and better socio-economic care, more people are reaching their ninth or tenth decade of life. It is estimated that the number of people over 75 years of age is around 14% in the UK and continuing to rise [6].

The majority of this ageing population will develop osteoarthritis and consequently require joint arthroplasty

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surgery, such as total knee arthroplasty (TKA). Age alone may not be the deciding factor for surgery, as elderly patients may have other associated comorbidity factors that make the decision for surgery difficult [2]. Consequently the benefits of TKA, such as an improvement in pain relief and mobility, have to be carefully balanced against the risks associated with the surgery [13]. There may also be other socio-economic benefits for both the patient and society that have to be taken into consideration before a decision for surgery is taken.

## Objective

The aim of this study was to analyse the mortality, morbidity and cost benefits of TKA in a cohort group of the nonagenarian population.

## Patient and methods

Between 1990 and 2006, all patients  $\geq 90$  years of age who underwent TKA were identified from hospital-computerised database records. The medical records and radiographs of each patient were pulled from the file and reviewed individually. Case notes were analysed for patient demographics, comorbidity factors, domiciliary status and mobility status.

Inclusion criteria included all patients with severe knee osteoarthritis requiring TKA; exclusion criteria included inflammatory arthropathy or a need for revision arthroplasty, but in reality there were no patients who fitted these criteria. Clinical evaluations were made for the Knee Society Score and WOMAC (Western Ontario and McMaster Universities) Score.

Postoperative complications were defined as either major or minor and included any adverse medical or surgical event occurring following surgery. Discharge locations were recorded as home or nursing home.

Postoperative follow-up consisted of outpatient clinic review at 6 weeks. In view of the advanced age of these patients and their difficulties with attending follow-up, further review was only undertaken if there was a specific clinical need to do so. At the time of this study in January 2006, all patients still alive were followed-up by a telephone conversation with the patient themselves, first-degree relatives or attending family doctors.

All patients were treated by a group of 12 surgeons at the one teaching hospital. The surgical technique varied only slightly with the individual surgeon. Intra-operatively, all patients had a thigh tourniquet applied with a medial parapatellar approach to the knee joint. In all cases, cement was used for both the femoral and tibial components.

Routine pre-operative tests (chest radiograph, electrocardiography, full blood count, urea and electrolyte, liver function tests) were considered to be an adequate evaluation for 41 patients. Prior to surgery, only one patient required special investigation (echocardiogram).

The cost for the operation per patient, including the number days stayed in the hospital, were obtained from the hospital finance department. Nursing home costs were obtained from the Department of Social Services, Aberdeen Council (UK).

*Statistical analysis* The paired sample *t*-test using statistical package SPSS ver. 12 (SPSS, Chicago, Ill.) was used for all analyses.

## Results

A total of 42 patients were treated with TKA during this study period. The mean age at surgery was 90.4 years (range: 90–90.6 years). Most patients had significant pre-operative comorbidity factors (Table 1), and the mean American Society of Anesthesiologists Physical Status (ASA) Score was 2.2 (range: 2–3), with 33 patients having an ASA of 2 and nine patients with an ASA of 3. TKA was performed under spinal anaesthesia in 28 cases and general anaesthesia in 12 cases; two patients had failed spinal anaesthesia and were converted to general anaesthesia.

## Complications

There was one major and 11 minor post-operative complications with no immediate or late postoperative deaths. The major complication was a significant cerebral vascular accident (stroke) 3 days postoperatively in one patient which required the patient to be transferred to the acute stroke unit. This patient eventually made a good recovery

**Table 1** Pre-operative comorbidity of patients referred for total knee arthroplasty (TKA)

Comorbidity <sup>a</sup>	Frequency of disease ( <i>n</i> )
Ischemic heart disease	7
Atrial fibrillation	5
Hypertension	4
Myocardial infarction	3
COAD	2
Congestive cardiac failure	2
Deep vein thrombosis/PE	2
Chronic anaemia	1

<sup>a</sup> COAD, Chronic obstructive airway disease; PE, pulmonary embolism

**Table 2** Comparison of pre-operative and postoperative benefits ( $n=42$ ) at the 6-week outpatient clinical follow-up

Function	Pre-operative (%)	Postoperative (%)
Complains of pain ( $n$ )	42 (100%)	None
Knee Society Score	25	81
WOMAC Score	62	41
Domiciliary status ( $n$ )		
Living at home	30 (71%)	18 (43%)
Living at home with help	12 (29%)	13 (31%)
In Nursing home	None	11 (26%)
Use of Walking aids ( $n$ )		
None	18 (43%)	12 (29%)
Walking stick	15 (36%)	19 (45%)
Zimmer frame	9 (21%)	10 (24%)
Wheelchair	None	1 (2%)
Ability to go shopping ( $n$ )	21 (50%)	19 (45%)
Ability to travel and socialise ( $n$ )	17 (40%)	8 (19%)

with no residual neurological deficit and was discharged back home 3 months following surgery.

Nine patients had minor complications, including confusion (five patients), urinary retention (three patients), urinary infection (two patients) and atrial fibrillation (one patient). However, none of these patients suffered severe morbidity from any of these complications.

The mean hospital stay of this group was 11 days (range: 9–15 days). Twelve patients were discharged directly to home, whilst 30 required further rehabilitation for an average period of 5.8 weeks (range: 3–12 weeks) in the community hospital.

Patients were followed up for 6 weeks postoperatively and thereafter if clinically indicated. At the time of the study, the mean follow-up period from the time of surgery was 7.5 years for the whole group.

### Survival period

As of the last telephone review in January 2006, 23 patients were alive (55%), and 19 had died. The mean age of the 23 patients still living was 94.3 years (range: 92–100 years), with a mean survival from surgery of 58 months. For the 19 patients who had died, the mean age at death was 94.3 years

**Table 3** Cost-benefit 5-year analysis for TKA versus nursing home placement<sup>a</sup>

Year	Number of patients still living	Number of patients who had died	Number of patients placed in a nursing home	Estimated nursing home cost (£)
1	36	6	None	$36 \times 26,000 = 936,000$
2	32	4	None	$32 \times 26,000 = 832,000$
3	26	6	2	$24 \times 26,000 = 624,000$
4	26	0	5	$21 \times 26,000 = 546,000$
5	24	2	4	$20 \times 26,000 = 520,000$
			Total cost	$= 3,458,000$

<sup>a</sup> Estimated saving in 5 years is £2,746,839 = £3,458,000 (estimated nursing home cost) – £711,161 (cost of surgery for 42 patients)

(range: 93–97 years), with a mean survival from surgery of 35 months. The mean survival of the whole group of 42 patients from the time of surgery was 3.9 years (range: 0.7–10 years).

### Pain relief and functional improvement

The Knee Society Scores improved significantly ( $p < 0.001$ ) from a pre-operative mean of 25 points (range: 8–44) to 81 points (range: 60–95) at the last clinical follow-up. The Knee Pain Score improved from 33 (range: 15–45) to 47 (range: 45–50) ( $p < 0.001$ ). The WOMAC Scores improved significantly ( $p < 0.002$ ) from a pre-operative mean of 62 points (range: 54–73) to 41 points (range: 34–46) at the last clinical follow-up (Table 2).

### Domiciliary status and mobility after surgery

At the time of this study, 19 of the living patients were independent and managing their own shopping; the remaining three patients had been admitted to a nursing home – one due to terminal cancer and the other two due to other social problems. Of the 19 patients who died, 12 had been independent and living at home up to their death, while the other seven patients had been admitted to a nursing home or community hospitals before their death. All patients admitted to a nursing home, however, had been living in their own home until at least 2 years after their surgery (Table 3).

### Cost-benefit analysis

For the purpose of this study, the cost benefits of the TKA surgery were compared against the cost of nursing home placement. The average cost of TKA surgery per patient, inclusive of hospital stay (acute and rehabilitation stay), medical staff costs and infrastructure was £16,932; consequently, the total cost of surgery for 42 patients was £711,161 ( $42 \times £16,932$ ). The cost of nursing home placement per patient per year was calculated to be £26,000. It was assumed that without TKA patients would have been admitted into nursing home care within a year of their outpatient clinic appointment, as they would not be mobile

enough to care for themselves. Hence, at 5-years postsurgery, the total estimated accumulated cost for nursing home placement would have been £3,458,000. The overall cost benefit of performing the TKA at 5 years postsurgery is therefore £2,746,839 (total nursing home cost – total cost of TKA) (Table 3).

## Discussion

There are a reasonable – although by no means large – number of studies that have reported on the morbidity and mortality of TKA in the very elderly [1, 3, 9, 10, 12, 15]. Our study has found similar results of improved pain relief, mobility and better quality of life after TKA in the very elderly. Herrick et al. also suggested other medical benefits, such as improved cardiovascular function, due to the improved mobility of patients after joint replacement [8]. However, we are uncertain if this applies to our group of patients.

In this study, there was one major postoperative complication, while nine patients suffered minor postoperative complications. Boettcher reported a higher risk of postoperative bleeding in their very elderly patients after TKA due to increased tissue fragility in these patients [4]. There have also been reports of increased wound breakdown for the same reason. However, we did not experience any such complications with our cohort group of patients.

The most prevalent complication in the elderly after TKA is postoperative confusion [1, 9, 12]. It is a routine practice in our institute to administer opioids through PCA (patient-controlled analgesia) as a protocol for postoperative pain relief. We suggest that the postoperative confusion experienced by our patients could be explained as secondary to these analgesics drugs [5], although there may be other causes [14], including urinary infection. However, none of the patients had long-term sequelae from these complications, and this manifestation of confusion resolved within 36–48 hours after the surgery with no serious consequences.

The length of the hospital stay was found to be prolonged in this cohort group of patients. Although the average acute hospital stay was only 11 days, we experienced a larger number of our patients requiring a longer rehabilitation period. Our records suggest that the lack of social support, which frequently accompanies ageing, seems to account for most of the postoperative rehabilitation requirements [9, 15].

Postoperative pain score had significantly improved compared to preoperative scores, with both the Knee Society Score and WOMAC score significantly improving after surgery. It was interesting to note that TKA had not reduced the use of walking aids by patients after surgery (Table 2). By the time elderly patients undergo TKA, they often have been using walking aids for many years, due to

joint pain and unsteadiness; consequently joint replacement surgery may not necessarily decrease this requirement despite improved pain-free mobility.

The cost-effectiveness versus patient benefits in medical care can be challenged in any study. However, in the past, the majority of patients in the elderly group were in nursing homes with joint contractures that are not a common problem today. Due to the socio-cultural set-up in Britain, many of the elderly tend to live independently, necessitating the ability to be mobile to carry on with their daily activities. Mobility that is restricted due to treatable conditions, such as osteoarthritis of the knee, may be improved by interventions such as TKA. As such, mobile patients would be able to self care and remain in their own familiar environment with their partners, taking care of each other [8].

This study showed that all patients eventually went back to their previous domiciliary status after surgery and that a majority of these patients were still living independently at the time of this study. The patients at home were mobile and self caring and hence required no social input. At 5 years postsurgery only 11 patients required nursing home placement and 24 patients were still living independently. The total cost benefit savings at 5 years postsurgery was estimated to be £2,746,839 (Table 3). The financial costing used in these calculations was only minimal, and no account was taken of the extra skilled care that might have been required for patients in a nursing home, due to a lack of mobility, without surgical treatment.

Many authors have indicated the cost-effectiveness of TKA in patients over 60 years of age, but the average expected survival period of younger patients after surgery is more than 10 years [11]. Patients aged 90 or over have a limited expected survival period, which was shown in this study to be an average of 3.9 years. The cost benefit of TKA has then to be calculated for a shorter period of their surviving life. Boettcher showed similar results in his study of very elderly patients undergoing total hip arthroplasty and concluded that it was cost beneficial to have the surgery compared to nursing home placement [4]. Some authors may argue that the cost benefits of TKA shown in this study can be challenged, as we assumed that the patients would have required nursing home admission without the surgery. However, it has been shown that 15% of all patient admissions to nursing homes are due to immobility secondary to joint arthritis [7]. All our patients had severe knee osteoarthritis pre-operatively, and the majority of them would have required nursing home placement or increased home care help within a year without the TKA. The cost of surgery per patient was calculated to be £16,932 and the cost of nursing home placement per patient per year to be £26,000. This means that if nursing home placement was delayed even for only 1 year, there was a minimum of £9,680 saved per patient by

this surgical procedure. In countries like the UK, where the government finances social care, such as nursing homes and home help, the acceptable use of mobility-restoring surgery would have a direct bearing on the economy.

The results of this study are characterised by the drawbacks of any retrospective study. There may have been an element of selection bias, as every surgeon may have had different thresholds for surgery. Only patients who were considered the most fit would have been referred for an orthopaedic consultation and subsequently offered surgery. However, based on the results of this study, it is evident that TKA has the potential to offer a better quality of life and is cost beneficial, both to the patient and society. Although only a small group of nonagenarians currently require TKA (average of 2.8 patients per year), the estimated saving is significant.

Given the context of current expenditures in medicine, it could be questioned whether the risk benefit or cost benefit ratio warrants funding for knee replacement in the very aged population. The results of this study show that apart TKA offering relief from pain and a better quality of life, there are also potential cost benefits. However, we believe severe preoperative pain is the primary indication for joint replacement, and the relief of pain should be the main indication for surgery. We also believe our study has further highlighted some important aspects that may be taken into account during the decision-making process and will act as a stimulus for further discussion and debate. With an increasing ageing population, in the future there may be a role for a sub-specialty in surgery for managing patients belonging to the very elderly group.

## Conclusion

Total knee arthroplasty is safe and beneficial in the nonagenarian population. It offers significant pain relief and a better quality of life, and the procedure is cost-beneficial.

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