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Increasing financial burden of revision total knee arthroplasty

Kayode O. Oduwole · Diarmuid C. Molony · Ray J. Walls · Simi P. Bashir · Kevin J. Mulhall

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Abstract We reviewed the peri-operative and financial data of patients who underwent revision total knee arthroplasty in our institution between 1997 and 2006. The aims were to compare difference in cost between aseptic and septic cases and to identify the sources of preventable cost increase in revision knee procedure. The study group comprised 117 women (65%) and 62 men (35%). The median age of patients decreased from 73 years (37–83 years) in 1997–2001 to 70 years (15–91 years) in 2002–2006, a decline of 4% ($P < 0.05$). The mean ASA scores also dropped from 3 to 2 between the two periods. Despite this, the mean total cost of revision knee procedure continued to increase. Patients undergoing revision arthroplasty because of infection had much higher ($P = 0.0001$) cost compared to their aseptic counterpart. Increase in the costs of investigations ($P < 0.05$) and implant ($P < 0.05$) was the major contributing factors. The cost of implants increased by 32–35% ($P < 0.05$) depending on implant selection. Changing demographics will increase the requirement for this surgery and thus increase its overall cost to society. Cost increases associated with unnecessary investigations, prolonged hospital stay and use of expensive implants should be avoided.

K. O. Oduwole (✉) · D. C. Molony · R. J. Walls · S. P. Bashir · K. J. Mulhall
Department of Orthopaedic Surgery,
Cappagh National Orthopaedic Hospital,
Finglas Dublin 11, Republic of Ireland
e-mail: odukayolajide@yahoo.com

Present Address:
K. O. Oduwole
Clinical Research Unit, Catherine McCauley Research Centre,
Mater Misericordiae University Hospital,
Dublin 7, Republic of Ireland

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Introduction

Total knee arthroplasty (TKA) has led to marked improvements in the quality of life for patients with end-stage arthritic conditions [5]. With increasing awareness and changing demographics, the incidence of total knee arthroplasty is increasing [10, 17]. As this number increases, a proportionate increase in the number of patients requiring revision surgery is expected. Revision total knee arthroplasty (TKA) consumes considerably more resources than primary TKA [8, 10]. The management of infected arthroplasty has been shown to require even more resources in terms of inpatient stay, microbiological investigation and multiple stage procedures than that of aseptic failure [4].

Previous study has projected that the economic burden of revision for infected TKA will exceed 50% of the inpatient resources available for revision by 2016. The hospital charges for aseptic revision were also projected to exceed 450% by the same period [11]. Because of the possible clinical and economic burden of such projection, the issues of cost in revision TKA cannot be overemphasised.

The current study investigated the trends in the cost of revision TKA between two 5-year periods in our institution. The purposes of the study were (1). To compare difference in cost between aseptic and infected reasons for revision TKA between the two periods and (2). To identify the causes of cost increase in revision TKA and examine whether these cost increase can be prevented. The study hypothesised that some of the cost factors are avoidable without compromising patient's care. Identification of the avoidable factors can enhance the optimal use of scarce

resources, improve patients' care and help the surgeons to better manage their clinical burden.

Patients and methods

Between 1997 and 2006, there were 3,322 primary TKA carried out in our institution. During the same period, a total of 189 patients underwent revision TKA for both aseptic and infective reasons. Complete peri-operative and financial data were available for 179 (95%) patients. The aseptic group included failures due to aseptic loosening, peri-prosthetic fractures and revision for other reasons such as instability or component failures. Patients' cohort was divided into 2 groups; the first group consisted of sixty patients who underwent revision TKA between 1997 and 2001. Clinical data included patient's demographics, diagnosis and American Society of Anaesthesiologists (ASA) grade. Overall cost was determined from the number of units of blood transfused, implant and instrumentation cost, number of bed-days, cost of investigations and other non surgical treatment e.g. medications. Results were compared with the results of the remaining 119 patients who underwent revision knee procedure at the same institution between 2002 and 2006.

The healthcare arrangement in Ireland involves both private and public funded healthcare system operating within same hospital setting. We used the cost for a semi-private patient as prescribed by one insurer (VHI Healthcare Ltd.) as the standard unit cost for inpatient stay and treatment fees. Baseline inpatient investigations included pre- and post-operative plain radiographs and blood tests. The cost of advanced radiological investigations such as bone scans and MRI performed was not included. This was done in order to exclude the effect of variation in diagnostic preference amongst the different consultants involved during the years of study. When more complex implant designs were required, the cost of the basic revision set of the implant was applied. Costs of IV antibiotic therapy and other medications were determined through pharmacy records. All revisions for suspected infection were carried out as a two-stage procedure, and the cumulative data were compiled as a single episode. All charges were adjusted for inflation.

Statistical analysis

Data were analysed using SPSS version 17. Median test was performed with Fisher's exact method for difference in ages of the patient cohorts between the two periods. We compared revision subgroup differences in LOS by Mann–Whitney test, while the two-sample t test was used to compare cost. A $P < 0.05$ was considered significant.

Results

The total study group comprised 117 women (65%) and 62 men (35%). There was a significant decrease ($P = 0.047$) in the median age of patients between 1997–2001 and 2002–2006(Table 1). The average ASA scores also dropped from 3 to 2 between the two periods.

Patients undergoing revision for infection had longer hospital stay and consumed more resources in both periods of study (Table 1). The median LOS for aseptic revisions decreased significantly ($P = 0.03$) between the two periods, but there was no significant difference ($P = 0.63$) in LOS for their infected counterpart (Table 1). The mean cost of aseptic revision was 14, 135 Euros in the first period while revision for infection was 19,964 Euros per patient. This represents a difference of 41% ($P = 0.11$). In the second period, patients undergoing revision arthroplasty because of infection had much higher ($P = 0.0001$) cost relative to patients undergoing surgery for aseptic reason (Table 1). The mean total cost increase between the two periods for infected revision approached a statistical significance ($P = 0.052$).

The number of revision surgeries performed as proportion of primary TKA procedures increased from 3 to 8% in the 10-year period.

Considering individual segments of cost for both revision subtypes, the mean in-hospital treatment costs (costs

Table 1 Patients' median age, length of stay and cost analysis of revision TKA per patient between 1997–2001 and 2002–2006

Periods	Revision subtype	Age (years)		LOS (days)		Mean cost of investigation (Euros)	Mean in-hospital treatment cost (Euros)	Mean cost of Implant (Euros)	Mean total cost per patient (Euros)
		Median	IR	Median	IR				
2002–2006	Infected ($N = 20$)	70	15–91	39	31–44	3,870	14,345	4,898	23,113 (12,180-33,853)
	Aseptic ($N = 99$)			15.5	11–19	2,980	5,627	6,567	15,174 (5,837–24,777)
1997–2001	Infected ($N = 8$)	73	37–83	34	27–46	3,482	11,132	5,351	19,965 (14,171–23,098)
	Aseptic ($N = 52$)			17	15–22	2,795	7,121	4,219	14,135 (1,114–31,071)

IR Interquarter range, *LOS* length of stay. In-hospital treatment cost included bed-cost, surgeon's fees and cost of medication (see Fig. 1)

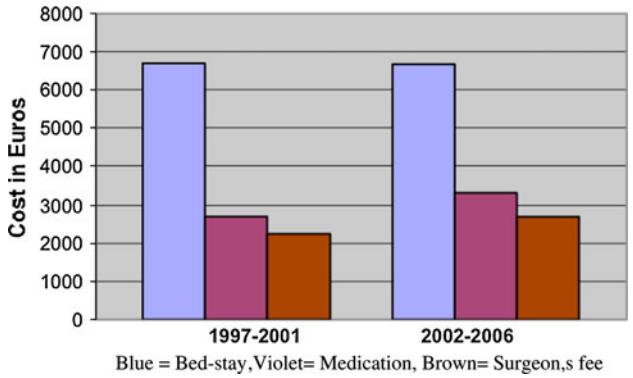

Fig. 1 Breakdown of in-hospital mean treatment cost segment for both revision subtypes between 1997–2001 and 2002–2006. *Blue* Bed-stay, *violet* Medication, *brown* Surgeon's fee

of bed-stay, surgeon's fees and medications) rose by 10% ($P = 0.3$) between the first and second period of study (Fig. 1). The mean investigation and implant cost increased by 8% ($P = 0.01$) and 20% ($P = 0.04$), respectively.

The generic cost of revision implants increased by 32–35% (3119–4371 and 4216–5800 Euro $P < 0.05$) between 1999 and 2006 depending on implant selection.

Discussion

The most important sources of cost increase in revision TKA over the 10-year period were from inpatient investigation and cost of implant. There was a significant increase in cost of inpatient investigation ($P = 0.01$) despite a decrease in their median age ($P = 0.04$) and improvement in ASA grade. Improvement in morbidity should have reduced the cost of inpatient treatment and investigation [9, 18].

The cost of revision for infection at both time points was higher than that for aseptic reasons [4, 7]. We believe that some of these cost increase could be avoided. A lot of resources were utilised on repetitive investigations especially in suspected infections. No preoperative investigation have been found accurate for diagnosing infection [3], but clinical findings and use of simple tests such as C-reactive protein, ESR [2, 3] and knee aspiration may yield predictable results [3]. The use of valid and reliable preoperative systems of measuring bone loss on plain radiographs can facilitate cost-effective surgical planning [14] rather than expensive radiological investigations.

Both the generic and the mean total cost of implant also increased significantly between the two periods ($P = 0.03$ and $P = 0.04$, respectively). Cost of implant represents a major component of the overall cost in revision TKA [6, 13]. In our institution, the pattern of implant use changed towards the more modern and expensive designs during the second period of the study. Substantial amount can be saved by controlling the variable costs of these implants and supplies [1, 16]. We also recommend the use of implants with documented long-term low failure rates which often cost less [15].

The charges analysed in the present study included many but not all possible charges associated with revision TKA. The charges did not include preoperative procedures such aspiration of the knee or procedures performed post-operatively such as manipulation under anaesthesia. Also, professional costs such as that of the surgeon's assistant, theatre staff and nursing care were not included. The cost or charge as presented in this study is therefore a conservative estimate of the overall cost associated with revision TKA.

Our study was limited by small numbers in the infected group. The average lengths of stay in this study are high when compared to other studies [12]. This may be partly explained by changing trends in intravenous versus oral antibiotic regimes policy in our institution. New protocols designed to reduce the length of hospital stay such as one-stage revision for infected TKA where appropriate are been reviewed.

Despite these limitations, some trends have been noted. We have shown an increasing rate of revision TKA surgery and attendant cost. Revision for aseptic reason cost a minimum of 15,174 euros while revision for infection will require at least 23,113 euros. Hospitals or privately insured individuals are not fully reimbursed for these fees. This cost increase will therefore have direct economic impact on the patients (private patients due to increased insurance premium; public patients on long waiting list for revision due to cost containment measures by Health Administrators) especially during the current economic climate. Whether these cost increase justified the benefits of performing a revision knee procedure is beyond the scope of this paper.

With increasing life expectancy and indications for primary arthroplasty, more patients are coming to revision surgery. The financial burden associated with cost increase will have direct impact on patients especially in the current economic climate when the optimisation of limited resource is crucial.

Conclusion

We noted a marked rise in the cost of revision TKA as observed by other authors [12]. This cost increase is more remarkable in revisions performed for suspected infection. The two major factors responsible as identified in this study are preventable. Diagnostic procedures should be standardised and also cost-effectiveness when appropriate should be considered. Effective measures also need to be

undertaken to reduce resultant costs from prolonged hospital stay and variable cost of implants.

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