MINI-SYMPOSIUM: REVISION HIP ARTHROPLASTY

(vi) Economics of revision total hip arthroplasty

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Summary
Total hip arthroplasty (THA) is a procedure which relieves pain, restores function and improves quality of life for patients with severe hip arthritis. The economics of total joint arthroplasty has become an increasingly important issue in the past decade, and will be more so in the future. If the number of patients treated with THA in the community increases as anticipated, so too will the requirement for revision of failed THA. Orthopaedic surgeons, medical administrators, and policy makers must work together to control costs while still maintaining high standards and quality outcomes for patients. This article examines issues relating to the economics of THA, including projections for the future burden of revision THA, the cost-effectiveness of revision THA, measures to improve survivorship of arthroplasties and the role of national arthroplasty registers in guiding decision-making based on evidence-based practice.

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Introduction

Total hip arthroplasty (THA) has revolutionized the care of patients with end-stage arthritic conditions of the hip, leading to marked improvements in health-related quality of life.1 The number of total hip replacements for arthritis is increasing as is the requirement for total hip replacement and hemiarthroplasty in hip fracture treatment.2 With the increased utilization of total hip replacement surgery, it is expected that the number of patients requiring revision total hip replacement will also grow.

The increasing wave of individuals with degenerative joint disease and the projected requirement for THA in the future are startling.2 Both healthcare providers and health administrators must co-operate to meet this challenge to provide THA to disabled patients, thus alleviating suffering, restoring function and improving quality of life. As a part of this initiative, health systems worldwide must ensure that any measures adopted to minimize arthroplasty expenditure are not to the detriment of excellent outcomes.

The aim of this article is to explore the economics surrounding revision THA particularly with regard to the financial burden which it will place upon health systems in the near future. Ultimately the ideal solution would be the avoidance of the need for revision total hip replacement by the implantation of durable primary THA’s and the avoidance of postoperative complications. A critical analysis of all facets of arthroplasty is necessary to improve outcomes and both clinical and economic research should be aimed at addressing this issue. The use of national arthroplasty registers will be important with respect to guiding future directions based upon evidence based decision-making.
Burden of hip arthroplasties

Recent data published by the American Academy of Orthopaedic Surgeons (AAOS) demonstrate the scope of the problem being faced with regard to THA. The number of primary total hip arthroplasties performed in the USA has increased from 134,000 in 1995 to 220,000 primary and 36,000 revision hip replacements in 2003, an appropriate revision rate of 14%. The AAOS projects that by the year 2030 the requirement for primary THA will increase to 274,000 and at the current rate of revision arthroplasties, the revision burden will be in the order of 45,700. Another potential source of revision surgery will be the number of hemiarthroplasties performed for the treatment of hip fracture, calculated to be 108,000 hemiarthroplasties in 2003 (Fig. 1).

Economic cost of primary and revision THA now and in the future

Revision total hip replacements are recognized as being both more expensive than primary procedures and associated with greater technical difficulties and inferior outcomes. The crude revision THA rates (proportion of hip replacement procedures that are revisions) for various countries are demonstrated in Table 1.

In 2003, the cost of primary THA in the USA was approximately $6.77 billion and the cost of revision THA was $1.66 billion, resulting in a total expenditure of $8.43 billion. Extrapolating from the current revision rate generates a revision burden of 45,700 revision THAs for 2030. The projected cost (at 2.5% inflation rate) of primary THA would be US$18.7 billion and a further US$4.01 billion for revision THAs. Thus the USA will be dealing with a US$22.7 billion dollar annual expenditure for primary and revision hip arthroplasty in 2030 (Fig. 2).

Crude revision rates for THR vary around the world. Sweden started in 1979 with a crude revision rate similar to what other countries report today, but through evidence-based surgical practice, now has the lowest rate worldwide with 7%. In the USA the revision rate for 2003 was 14%, decreased from a rate of 18% in 2002. Obviously the financial benefits of reducing this rate of revision are considerable.

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![Figure 1](https://via.placeholder.com/150)

**Figure 1** Projected numbers of primary and revision THA. Comparison of 2003 versus 2030.

![Figure 2](https://via.placeholder.com/150)

**Figure 2** Cost of primary, revision and total cost of arthroplasty in the USA for 2003 and projected cost for 2030 (in US$ billions).

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**Table 1** Crude THA revision rates between countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Crude revision rate (%)</th>
<th>Year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>13</td>
<td>2004</td>
<td>National joint replacement registry&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Canada</td>
<td>13</td>
<td>2003</td>
<td>Canadian Joint replacement registry&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>England/Wales</td>
<td>9</td>
<td>2004</td>
<td>National joint registry&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>New Zealand</td>
<td>13</td>
<td>2004</td>
<td>NZ National joint register&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>Norway</td>
<td>12</td>
<td>2003</td>
<td>Norwegian arthroplasty register&lt;sup&gt;7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Scotland</td>
<td>14</td>
<td>2004</td>
<td>Scottish arthroplasty project&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sweden</td>
<td>7</td>
<td>2003</td>
<td>Swedish national hip arthroplasty register&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
<tr>
<td>USA</td>
<td>14</td>
<td>2003</td>
<td>American academy orthopedic surgeons&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Crude revision rate % = number of revisions/total number of primary and revision hip arthroplasties.
The AAOS has estimated the average cost of a revision THA in 2003 was $45,000 and a decrease in the revision rate from 14% to the current Swedish rate of 7% would therefore produce a yearly saving of $810 million in 2003 or a projected saving of $2 billion extrapolated for the year 2030.

Recent reductions in the cost of revision THA

Many changes in the management of arthroplasty patients have occurred over the past few decades and improved procedures have led to decreases in overall costs.10 Arthroplasty patients are often admitted on the day of surgery and now the average length of stay for primary THA is 4.5 days and for revision THA 5.4 days in the USA.11 Length of stay may decrease further for primary THA if inserted by minimally invasive techniques with improved anaesthesia, home support and accelerated rehabilitation.11,12 One recent study comparing outpatient THA (admission, surgery and discharge within 12 h) versus inpatient THA demonstrated $4000 less average hospital cost and $2500 reduction in the outpatient group per procedure.12

Surgeon remuneration has also decreased over the last decade as a percentage of the overall expenditure but implant costs still contribute substantially to the total.13 Currently the cost of alternate bearing surfaces (ceramic on ceramic, cross-linked poly-ethylenes or metal-on-metal articulations) are greater than a traditional metal on polyethylene bearing. This increased initial expenditure may produce potential long-term cost reductions if the low in vitro wear rates translate to improved in vivo survivorship.14 Many hospitals and health departments have a tendering process to negotiate contracts with the prosthesis suppliers in an attempt to control the cost of implants, leading to marked reductions in expenditures.15

Cost effectiveness of revision THA

Health economics and cost-effectiveness is becoming one of the most important issues in orthopaedics today. There is an increasing volume of literature about the economics of both hip and knee arthroplasty.16 This is demonstrated in the findings of one recent study which showed that in the 10 years from 1993 to 2002, there were 70 economic evaluations of THA published in the English literature compared to only 10 in the preceding decade.16

Health economists have categorized healthcare interventions into extremely cost effective (cost-to-utility < $20,000), moderately cost-effective (cost-to-utility of $20,000 to $100,000), and effective but costly (cost-to-utility > $100,000).17 Rorabeck et al.18 and Chang et al.19 demonstrated that the cost-to-utility gain for primary THA was superior to treating moderate hypertension, coronary artery bypass surgery or renal dialysis. By these criteria a revision THA costing even twice that of a primary replacement would still be classified as excellent in terms of cost-effectiveness.

Unpublished data from our hospital supports the cost-effectiveness of revision THA. We derived a dollar value for each 10-point WOMAC improvement comparing the pre- and postoperative status of 1264 primary and 133 revision hip replacement patients, using the local health department funding allocation.20 In our institution, US$1383 were spent for every ten-point increase in the WOMAC score for patients undergoing a primary THA as compared to US$2458 for each ten-point increase in patients undergoing a revision total hip replacement (Table 2).

The ratio of cost per 10-point improvement in WOMAC scores comparing revision to primary arthroplasty was 1.78. Thus revision hip arthroplasty is approximately 56% as cost-effective as a primary procedure at our hospital but is still rated as good or excellent.

It should also be remembered that revision THA allows the majority of patients to maintain community independence, sparing some of the cost to society of permanent residential care for those individuals.

Importance of national arthroplasty registers

National arthroplasty registers are now effective in Australia, Canada, Denmark, England/Wales, Hungary, New Zealand, Norway, Romania, Scotland, and Sweden generally funded by government sources. National joint registries have the power to provide accurate and timely data about the types and number of specific prostheses being implanted, and which prostheses are being removed. In a national arthroplasty register the endpoint taken for failure is implant failure (or both components or removal of prosthesis). It is desirable to identify the early failure of newer implants so that they can be promptly withdrawn from use. The continual collection of this data by joint registries allows more rapid recognition of problems than would otherwise occur through the conventional orthopaedic literature, and ensures that adverse outcomes come to light without signs.

The Swedish Hip Registry9 was established in 1979 with the aim that individual hospitals would be able to compare their own arthroplasty outcomes to those of the rest of the nation. Those with poorer outcomes would then be able to identify improved practices and implement them for the benefit of their own patients. There is no question that the Swedish Registry has been a resounding success.

### Table 2 Cost of 10-point WOMAC improvement in primary and revision THA.

<table>
<thead>
<tr>
<th>Funding allocation (US$)</th>
<th>Primary THA</th>
<th>Revision THA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in WOMAC score</td>
<td>53</td>
<td>36</td>
</tr>
<tr>
<td>Cost (US$) per 10-point WOMAC improvement</td>
<td>$1383</td>
<td>$2458</td>
</tr>
</tbody>
</table>
The effect of the Registry in improving the quality of hip replacement in Sweden has been well documented. In the 1980s the Registry identified the benefits of modern cementing techniques in hip arthroplasty. The dissemination of this information led to a change in practice. As a result, the use of a distal femoral cement restrictor increased from 30% in 1982 to more than 95% in 1987. The crude rate of revision hip replacements in Sweden has halved over the last 20 years and is currently 7%. The implementation of techniques gained from the feedback of yearly outcome data has decreased the revision rates of their cemented implants. The Swedish Hip Registry has prompted a reduction in the number of implant types used, with 78% of cemented operations utilizing one of five designs all of which have documented long-term success. In this way the Registry has influenced both surgical technique and prosthesis type, leading to improvement of outcomes nationally.

Arthroplasty registers are powerful tools that provide timely data to guide surgeons toward evidence-based surgical practice for the benefit of their patients. They should reduce the burden of revision THA surgery to society.

### Funding allocation (instruments) and true cost of revision THA

In the 1980s, health policy changed in many countries to a prospective system of payments based on the International Classification of Disease (ICD-9) and diagnostic-related groups (DRGs) in an attempt to reduce expenditure. The code for revision THA is represented by ICD-9 81.53 or DRG 545. Any excess between the true cost of the procedure and the DRG allocation is suffered as a loss by the hospital. Hospitals were initially able to cover lost revenue from individual cases by cost-shifting payments from third party providers. The increase in Health Maintenance Organizations (HMO) soon made this impossible. As a result, hospitals have adopted many of the measures previously discussed, streamlining procedures and reducing costs.

Several studies have demonstrated that the average cost of a complicated revision THA surgery now lies between $30,000 and $52,000. Often these procedures require significant bone grafting as well as more costly modular revision implants. Crowe demonstrated that despite improvements in length of stay, use of clinical pathways, and negotiated discounts on implants, the hospital loss at their institution for each revision hip replacement procedure averaged $5402. Concerns have been raised that DRG reimbursements are now so low as to prevent hip arthroplasty. Other workers have questioned whether the surgical fee is so low as to make revision total hip replacement economically non-viable for surgeons. The Medicare reimbursement to surgeons for reconstructive hip surgery decreased 35% from 1991 to 2004 while the reimbursement to hospitals increased by 16%. It has even been suggested that tertiary referral hospitals may need to start limiting referrals of patients with failed THA who are in need of revision surgery.

Grouping all revision THA under one DRG 545 code is unrealistic. An expansion of the basic DRGs, known as the All-Patient Refined, Diagnostic-Related Groups Severity of Illness (APR-DRG SOI), is a weighted index reflecting patient baseline medical health ranging from one (lowest severity of illness) to 4 (highest severity of illness). Adoption of this refined DRG or a similar instrument allows categorization of the complexity of revision surgery to be taken into account.

### Methods of decreasing revision THA rates

The ultimate goal is to avoid the requirement for revision THA. The implantation of a durable primary THA with the minimal of complications is the main aim. Katz demonstrated that 12% of all primary THAs and 49% of revision THAs in the US Medicare population are performed at centres where ten or fewer of these procedures were undertaken each year. Significantly, 52% of primary and 77% of revision THA were performed by surgeons who carry out ten or fewer of these operations annually. Their study demonstrated lower complication rates and mortality for high-volume surgeons (those performing greater than 50 primary THAs or 10 revision THAs per year). Because certain complications such as deep infection or recurrent dislocation often necessitate early revision surgery, the reduction in these complications will have a beneficial effect upon the requirement for revision.

Further work needs to be undertaken to elucidate exactly how the higher volume hospitals and surgeons achieve these results as the reasons are likely to be multifactorial. Adoption of similar practices may lead to improvements in outcomes globally at smaller centres. Functional outcomes 3 years after THA are not better when undertaken in busier units by surgeons with a greater turnover of procedures, despite the fact that early complication rates are lower.

Technological improvements in materials also have the potential to decrease the revision rate in future if the theoretical advantages of contemporary bearing surfaces with very low wear rates translate to improved prosthetic longevity.

Surgeons should base their choice of implant on best current data and be critical before adopting a new hip prosthesis. Ideally, the introduction of different materials and implants should be on a prospective, controlled basis beginning with a selected few centres to confirm safety before widespread acceptance. Evidence-based decision-making should be the primary guide, if we are to avoid failures from the implementation of unproven, if novel, implants.

### Summary

Revision THA is a cost-effective procedure which has been shown to improve quality of life, reduce pain and improve function for patients with failed primary arthroplasties. The increasingly aged population requires more primary arthroplasty than ever before and the need for revision THA is likely to increase as a result, leading to a greater financial burden for society. Health systems and surgeons must work to minimize this expenditure while ensuring that excellent outcomes are maintained. Reducing the rate of revision THAs by the implantation of durable primaries and the reduction in complications will be the most important long-term solution. The use of arthroplasty registers is a crucial part of this process. Evidence-based decision-making and
the careful introduction of new technology in a prospective controlled fashion will assist toward better and changed practice.

Practice points

- Revision THA is a cost-effective procedure by health economic standards
- Hip arthroplasty cost the USA $8 billion in 2003, with projection for $23 billion for 2030
- Halving revision THA rates would currently save the USA almost US$ 1 billion per year
- Evidence-based medicine has the potential to reduce revision THA rates markedly
- National arthroplasty registers have great potential in this regard

Research directions

- Comprehensive healthcare cost analyses in the literature
- Epidemiologically-based estimation of future arthroplasty requirements
- Technological improvements (improved fixation, reduced wear)
- Biological improvements (antimicrobial surface coatings, bone stimulating proteins, bisphosphonates to reduce stress shielding or osteolysis)
- Worldwide adoption of national arthroplasty registers

References