Cost Drivers in Total Hip Arthroplasty: Effects of Procedure Volume and Implant Selling Price

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Abstract

Total hip arthroplasty (THA), though a highly effective procedure for patients with end-stage hip disease, has become increasingly costly, both because of increasing procedure volume and because of the introduction and widespread use of new technologies.

Data regarding procedure volume and procedure costs for THA were obtained from the National Inpatient Sample and other published sources for the years 1995 through 2005. Procedure volume increased 61% over the period studied. When adjusted for inflation, using the medical consumer price index, the average selling price of THA implants increased 24%. The selling price of THA implants as a percentage of total procedure costs increased from 29% to 60% during the period under study.

The increasing cost of THA in the United States is a result of both increased procedure volume and increased cost of THA implants. No long-term outcome studies related to use of new implant technologies are available, and short-term results have been similar to those obtained with previous generations of THA implants.

This study reinforces the need for a US total joint arthroplasty registry and for careful clinical and economic analyses of new technologies in orthopedics.

The economic burden of musculoskeletal disease in the United States was estimated to be $321.8 billion in 2003.[1] Arthritis is a particularly costly disease, primarily because of the growing number of patients older than 65. The total cost of any health care service may be attributed to the disease prevalence, the treatment prevalence, and the cost per treated case. In an analysis of health care spending for arthritis, an increase of $11 billion was estimated for the period 1987–2000, and 44% of the increase was attributed to the increased cost per treated case.[2] This finding supports the notion that, in many cases, increased healthcare spending may be attributable at least in part to the cost of new technologies.[3]

The Swedish Total Hip Replacement Register found aseptic loosening to be the main cause of total hip arthroplasty (THA) failure.[4] New formulations of polyethylene, including highly cross-linked polyethylene and "hard-on-hard" bearings (eg, alumina and zirconia ceramics and metal), have been offered as potential solutions to the problems associated with bearing surface articulation wear, with wear rates calculated well below the level hypothesized to induce osteolysis.[5-10] Short-term to midterm results for these new bearing surfaces have been excellent, though without clear superiority over conventional metal-on-ultra-high-molecular-weight-polyethylene and metal-bearing surfaces.[11-15] Despite lack of clear clinical superiority, these bearing surfaces are being used with increasing frequency in the United States with the hope that the revision burden will decrease.

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Increased use of these and other new technologies is one of the main cost drivers for THA in the United States. In light of recent projections regarding the burden of disease related to musculoskeletal care and the need for total joint arthroplasty, current trends of rising costs per case are unsustainable.[16]

The goal of this study was to investigate the independent contributions of procedure volume and implant cost as drivers of increased costs associated with THA.

Methods

Data were obtained from the Nationwide Inpatient Sample (NIS), the largest all-payer inpatient database in the United States.[17] The NIS is an annual, statistically valid Healthcare Cost and Utilization Project survey of approximately 1000 hospitals. It includes approximately 20% of the inpatient hospitalizations performed in the United States, regardless of payment source. The information collected covers more than 100 clinical and demographic variables, including primary diagnosis, primary proce-

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Am J Orthop. 2009;38(1):E1-E4.

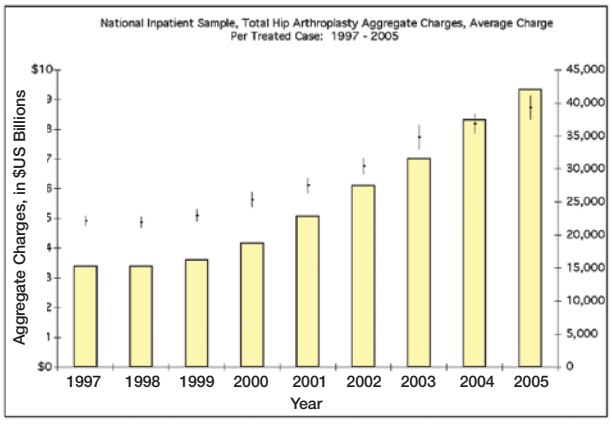

Figure 1. Aggregate charges, mean charge per treated case (95% CI), total hip arthroplasty, National Inpatient Sample, 1997–2005.

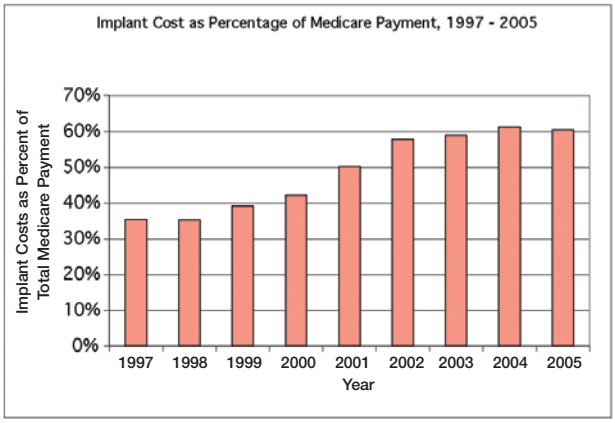

Figure 2. Total hip arthroplasty implant average selling price as percentage of Medicare payment, Orthopedic Research Network, 1995–2005.

dure, age, sex, and payer type. For this analysis, *ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification)* procedure code 81.51 (primary THA) was used as the primary procedure code. Demographic information, including mean age, mean length of stay (LOS), inpatient mortality, aggregate charges, and procedure prevalence by age group, was obtained.

Data on THA device costs were obtained from the Orthopedic Research Network (ORN) for the period 1995–2005.[18,19] ORN is a group of 45 hospitals, both academic and community-based, that collects cost and volume data for orthopedic procedures performed in each independent hospital system. Mean costs of THA implants (excluding revision surgeries) were collected and pooled. Mean costs of THA implants for the Medicare-only population (age, >64 years) were also collected and pooled. In addition, the Medicare payments for these groups were collected. The cost of implants for each period was adjusted for inflation using the medical component of the consumer price index (mCPI) and 2005 as the index year. For example, the mCPI in 1995 was 220.5. The mCPI in 2005 was 323.2. Therefore, 1 US dollar ($) spent on medical care in 2005

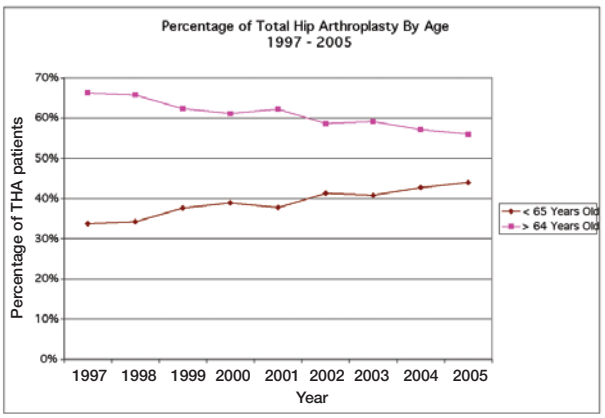

Figure 3. Distribution of total hip arthroplasty (THA) patients by age, National Inpatient Sample, 1997–2005.

cost $0.68 in 1995 (220.5/323.2 = 0.68). Thus, an implant value of $6466 in 2005 would have been valued at $2297.78 in 1995. This conversion was used for all implant costs.

Results

NIS data showed a 61% increase in total number of primary THAs, from 144,918 (in 1995) to 237,645 (in 2005). For the same period, mean LOS decreased from 6.0 days to 4.0 days; inpatient mortality decreased from 0.55% to 0.22%; and aggregate charges for THAs increased 146%, from $3,388,830,117 to $9,350,753,890 (Figure 1). Mean charge per treated case rose from $22,138 (95% CI, $21,418, $22,858) to $39,348 (95% CI, $37,527, $41,168), an increase of 78%. The percentage of older-than-64 patients who underwent THA fell from 66% to 56%; conversely, the percentage of younger-than-65 patients who underwent THA rose from 34% to 44%.

Using ORN data, we found an increase of 92%, from $3368 (in 1997) to $6466 (in 2005), in the average selling price (ASP) of the implanted device in THAs for all reported patients. After an inflation adjustment for the 2005 dollar, this represented a 24% increase. ORN data also showed that the ASP of THA implants fell between 1997 and 1998 but increased 43% since 1998 when adjusted for inflation. When these same data sets were limited to Medicare patients, the ASP of the implanted device in THAs increased from $2773 to $6102, an increase of 120%. After an inflation adjustment for the 2005 dollar, this represented a 33% increase. For the same period, the percentage of the implant cost as a portion of Medicare payment increased from 29% to 60% (Figure 2).

According to ORN data, the percentage of ceramic-on-ceramic and metal-on-metal implants increased from 1% of all THAs in 1999 to 16% in 2005.[19] Also, the cemented femur/polyethylene liner, as recommended by the National Institutes of Health Consensus Panel, accounted for less than 1% of THAs. Highly cross-linked polyethylene acetabular liners have grown to account for 66% of all liners, whereas standard ultra-high-molecular-weight polyethylene has fallen from more than 90% in 1999 to 18% in

2005. NIS data showed that the percentage of THA patients younger than 65 increased 10% between 1997 and 2005 (Figure 3).

Discussion

THA is among the most safe, efficacious, and cost-effective procedures performed in orthopedic surgery. Originally, THA was performed only in elderly patients and in patients with limited activity levels, and the goal was to relieve pain. The results with first-generation THA devices (eg, Charnley low-friction arthroplasties) have been reported, with 20-year survival rates ranging from 77% to 81% using revision surgery as the endpoint.[20,21] Advances in THA technology have allowed expansion of the indications for THA to include younger, more physically demanding patients seeking "high-performance hips." Such prostheses include hard-on-hard bearing surfaces, which have seen increasing use within the orthopedic community but without clear evidence of their long-term clinical superiority relative to conventional bearing surfaces.

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Validated NIS data showed that total THA charges have increased because of the increased number of treated cases and the increased cost per treated case. Our data showed that there was a significant increase in THA implant cost in both the all-payer and Medicare populations. Also, THA implants now account for a much larger percentage of the overall Medicare reimbursement for THA. Hard-on-hard (eg, ceramic-on-ceramic, metal-on-metal) bearings accounted for only 16% of the THAs in the 2005 ORN data. Therefore, hard-on-hard bearing use alone does not explain the substantial increase in THA implant costs, and one may assume that conventional implants have seen significant ASP increases as well.

Bozic and colleagues[22] evaluated the economics of alternative bearing technologies and found that the cost-effectiveness of a hard-on-hard bearing surface is related to the cost of the prosthesis and the age of the patient in whom it is implanted. A $2000 cost increase would be considered a cost saving over the lifetime of a 55-year-old patient if there were a corresponding decrease in revisions of 19% at 20 years. Conversely, there was no situation in which an alternative bearing surface could be cost-saving for a 75-year-old patient. The implication is that hard-on-hard bearing surfaces are not appropriate for all patients who undergo THA. Again, long-term follow-up of current devices is needed to more clearly define appropriate use given their cost and the projected increases in the volume of THAs performed in the United States.

In 2005, an estimated 237,645 primary THAs were performed in the United States. Based on use and changing population demographics, Kurtz and colleagues[16] estimated that demand for primary THA in the United States will grow to 453,000 in 2030, a increase of 226%. For the same period, the number of revision THAs was estimated to increase 237%, from 41,000 to 98,000. This growth has been fueled by an increase in the prevalence of primary THAs, due in part to advances in THA technologies, including alternative bearing surfaces. With increased THA incidence will come an increase in revision burden. New implant technologies offer the promise of reducing the revision burden in the United States through increased implant survivorship. The development of hard-on-hard bearing surfaces is intended to reduce wear rates and therefore increase implant longevity. However, results from short-term studies have shown no difference in overall implant survival rates with newer bearing surfaces. Furthermore, it is unclear whether the scarcity of resources within the health care system will be able to sustain the expected future demand in both primary and revision THAs.

The growth in both procedure volume and total episode-of-care costs has caught the attention of both payers and health care policymakers. NIS and ORN data suggest that both procedure volume and cost per treated case are significant drivers of the total cost of care associated with THA. ORN data suggest that the cost of the THA implant is a major driver of total THA cost for the Medicare population in particular.

Our study limitations derive from the ORN data, which represent only a small sample of US hospitals and have not yet been validated in a larger population representative of all US hospitals. However, our data are consistent with data from other independent groups, which have reported similar trends in THA implant costs over the same period. It should be noted that device vendors have aggressively sought to block attempts to increase transparency of information related to implant costs.[23]

We believe that, despite their shortcomings, these data are important with respect to THA cost drivers in the United States, and they emphasize the need for a national THA implant registry for evaluation and comparison of the performance of THA implants—as exists in most other developed countries.[4,24-27] Although randomized clinical trials are often considered the gold standard in clinical research, they are logistically and economically impractical, and their results are often clinically irrelevant by the time they are published many years after the introduction of a new device. A device registry would prospectively collect data regarding implant use, clinical outcomes, revision rates, and costs. These data would provide orthopedic surgeons, patients, hospitals, payers, and health care policymakers with information that can be useful in clinical and health care policymaking. They would enable the orthopedic community to evaluate the results of new technologies, compare use by region and patient demograph-

ics, and allow for identification of defective prostheses and the patients who have received them. Similar device registries have been shown to dramatically reduce revision rates and costs in other developed countries.[4,28] Furthermore, increased transparency of information related to the clinical outcomes and costs associated with THA implants will lead to improved quality and efficiency of THAs, ensuring access to these life-altering procedures for future generations of patients with hip disease.

Authors' Disclosure Statement

Dr. Kelly reports no actual or potential conflict of interest in relation to this article. Dr. Bozic wishes to note that he is a paid consultant to Integrated Healthcare Association.

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This paper will be judged for the Resident Writer's Award.