Revision and Primary Hip and Knee Arthroplasty

A Cost Analysis

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The cost of health care in the United States has been rising steadily during the past 10 years. Total joint arthroplasty, a commonly performed orthopaedic procedure, accounts for approximately $10 billion dollars per year. The objective of this study was to perform a clinician-oriented cost analysis of primary and revision hip and knee arthroplasty. Twenty-five consecutive cases each of total knee arthroplasty, total hip arthroplasty, revision total knee arthroplasty, and revision total hip arthroplasty were analyzed. The length of stay and number of minutes spent in the operating room were significantly higher for the patients with revision hip surgery than for the other groups. The total charges for the prosthesis in the 4 groups exceeded 40% of the total charges for the procedure. Primary hip and knee surgery had similar billed costs, and work for revision hip surgery has a significantly higher billed cost than physician's work. The implant selection process by an orthopaedic surgeon performing arthroplasty of the hip and knee needs to include economic aspects.

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Health care resources in the United States currently are undergoing the most thorough scrutiny in history. The annual cost of health care has increased steadily during the past 10 years. In 1992, it was approximately 15% of the gross national product.[2] In an effort to control these costs, several commonly performed surgical procedures have been targeted. Total joint arthroplasty is the subject of this inquiry.

More than 400,000 primary hip and knee arthroplasties are performed in the United States each year.[1] Their actual total cost has been estimated to range between $20,000 to $35,000 per procedure.[3,4,5,6] The yearly cost of these procedures can be conservatively estimated to exceed $10 billion per year. In 1984, the Medicare prospective payment system was introduced in an effort to control these costs.[7] The diagnostic-related groups allocation in 1990 for an uncomplicated total hip arthroplasty was $8500.[3,4] These costs exclude surgical and anesthesia fees. The Health Care Finance Administration recently has developed a resource-based relative value scale that addresses surgeon fees.

TABLE 1. Medicare Surgical Fee Reimbursement for Total Joint Arthroplasty

Procedure	Estimated 1992	Estimated 1996
Knee arthroplasty	$2009	$1529
Revision knee arthroplasty	$2436	$1825
Hip arthroplasty	$1889	$1477
Revision hip arthroplasty	$2460	$1933

In the new fee schedule, reimbursement for joint replacement surgery will be reduced by >30% during the next 5 years.[1] Table 1 shows this projected reimbursement.

Clinicians can be effective in directing hospital cost-saving measures for patients undergoing total hip arthroplasty.[8] Clinicians who are fully involved in the day-to-day care of patients can help determine where cost reductions can be most effective with minimal impact in quality of care and outcome. The objective of this study was to perform a clinician-oriented, detailed cost analysis of primary and revision hip and knee arthroplasties.

MATERIALS AND METHODS

Patients from the Division of Arthritis Surgery at Johns Hopkins University who underwent primary and revision total hip and knee arthroplasties at the Good Samaritan Hospital were studied. The surgical procedures were performed by the senior authors (KAK, DSH) from 1987 to 1990. The Porous Coated Anatomic primary total hip replacement system was used in all patients. One thousand one hundred fourteen surgeries were performed in that period. A stratified sample was taken to obtain 25 consecutive cases in each of the following categories: total knee arthroplasty, total hip arthroplasty, revision total knee arthroplasty, and revision total hip arthroplasty. One hundred consecutive cases with complete financial and clinical records were available for this study. One patient was excluded because bilateral arthroplasties had been done, and 1 was excluded because of a posting error in the operating room charges. The following distribution was studied: 24 primary total knee arthroplasties, 24 revision total knee arthroplasties, 25 primary total hip arthroplasties, and 25 revision total hip arthroplasties. Any reoperation on a previously replaced knee or hip was considered a revision procedure regardless of the number of components exchanged, because the number of components replaced does not affect the hospital diagnostic-related groups reimbursement.

Detailed demographic information was recorded from each patient's chart. Age, diagnosis, gender, side, length of stay, complications, and components revised (in revision surgery) were recorded (Table 2). The total number of minutes spent in the operating room was recorded also. This total included anesthesia and surgical time. The total time was recorded because in most circumstances the operating surgeon was present with the patient in the operating room throughout the induction and accompanied the patient to the recovery room.

Detailed, itemized, and billed charges were obtained from the hospital billing department. These included charges for room and nursing care, laboratory studies, radiographs, physical and occupational therapy, operating-room expenses, prostheses, and administrative hospital charges.

The surgical fees billed for each patient also were obtained from the physicians' billing office. Dollar amounts were converted to 1991 dollars, using the consumer price index as well as the services index to adjust for inflation. Table 3 presents some of the billed charges for the 4 groups. Total charges were calculated by adding the total hospital charges to the billed surgeon's fee and did not include professional anesthesia fees.

Analysis of covariance was used to compare the effect of the surgical procedure, gender, age, and diagnosis on the cost. Bonferroni/Dunn T tests were performed to test for differences between the adjusted means. A p value of <0.05 was considered significant. A linear regression model was used to assess the effects of age, gender, and diagnosis in the economic outcome.

RESULTS

The patient groups studied were not statistically different by age, gender, or diagnosis. Lengths of stay were 12 and 23 days for

TABLE 2. Demographic Characteristics of the 4 Groups

Variable	Primary Total Knee Replacement	Revision Total Knee Replacement	Primary Total Hip Replacement	Revision Total Hip Replacement
Age in years (mean ± sd)	60 ± 2.3	68 ± 2.1	58 ± 3.5	58 ± 2.7
Gender				
Female	13	17	10	10
Male	11	7	15	15
Diagnosis				
Inflammatory Arthritis	5	4	9	8
Osteoarthritis	19	20	16	17

patients who underwent primary and revision hip arthroplasties. The hospital stay for a patient who underwent primary total knee arthroplasty averaged 12 days, as compared with 17 days for patients who underwent knee revision arthroplasty (Fig 1). Patients who underwent revision hip surgery stayed an average of 10 additional days in the hospital when compared with patients who had primary hip surgery, and an average of an additional 7 days when compared with patients who had revision knee surgery. These lengths of stay were typical for 1987.

Figure 2 shows the number of minutes spent in the operating room for the 4 groups. As can be expected, revision surgery took significantly longer than primary surgery. Of interest was that the number of minutes spent in the operating room for revision hip surgery was more than double that of primary knee or hip surgery ($p < 0.001$). The amount of time spent in the operating room was not different for patients who underwent primary hip and primary knee arthroplasties. Revision knee surgery took longer than primary hip and knee surgeries, but less than revision hip surgery. These data show that patients undergoing revision hip surgery stayed longer in the hospital and required more minutes in the operating room when compared with other groups ($p < 0.0001$) (Figs 1, 2).

Surgeons' fees for the 4 procedures followed a different trend. No statistical difference was found among the billed costs of primary procedures (Table 3). Revision knee and hip surgeries also were not statistically different from 1 another ($p > 0.05$). However, the billed surgeon's fee for revision cases was higher than for primary cases ($p < 0.001$).

The total charges for the prostheses in

TABLE 3. Average Charges of Good Samaritan Hospital for Arthroplasty Procedures (1987–1990)

Charges	Primary Total Knee Replacement	Revision Total Knee Replacement	Primary Total Hip Replacement	Revision Total Hip Replacement
Billed surgical fee	$3887 (±75)*	$4511 (±471)	$3875 (±105)	$5415 (±175)
Prosthesis cost	$7102 (±68)	$6510 (±680)	$6800 (±59)	$8532 (±870)
Total hospital charges	$15,343 (±288)	$17,371 (±1486)	$15,503 (±528)	$24,666 (±1872)
Total charges	$19,230 (±264)	$21,883 (±1751)	$19,379 (±502)	$30,082 (±1882)

* Standard error of mean.

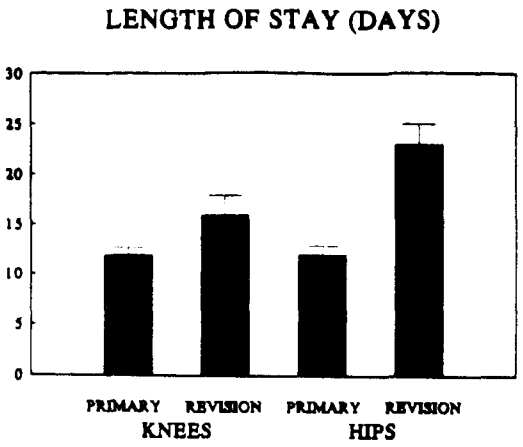

Fig 1. Length of stay for patients undergoing primary and revision surgeries.

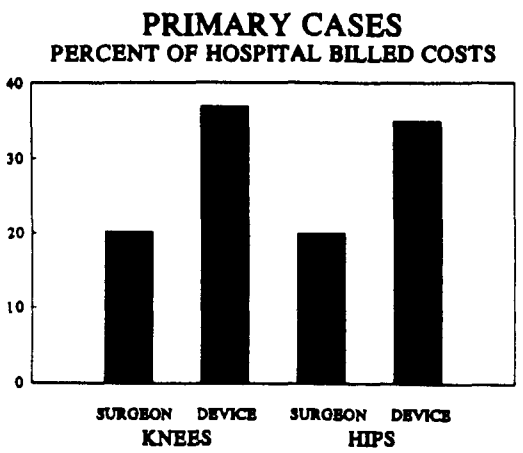

Fig 3. Percentage of hospital billed costs for primary arthroplasty.

the 4 groups were not statistically different. However, the revision hip surgery procedures have a trend for higher costs (Table 3). The percentage of the total hospital costs billed for the prosthetic components was calculated as well as the percentage of the total hospital billed cost that is included in the surgical fee. Figure 3 shows that the percentage of the total hospital billed costs that accounted for the billed surgeons' fee contrasted with the percentage of the total hospital charges for prosthetic costs.

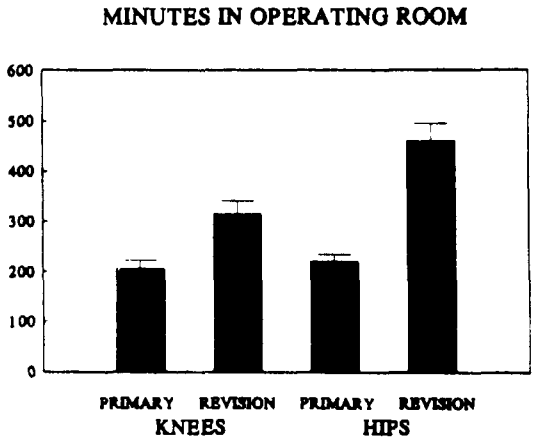

Fig 2. Minutes in the operating room for patients undergoing arthroplasty procedures.

DISCUSSION

These data show no statistical difference in the billed total costs for primary hip, primary knee, and revision knee surgeries. By contrast, revision hip surgery had significantly higher billed costs (Table 3). New diagnostic-related groups reimbursement schemes have identical values for the 4 procedures and are substantially less than actual billed costs. The number of revision hip surgeries performed is increasing steadily. Surgeons performing large numbers of revision total hip arthroplasties can be a financial liability to the hospital. The planned reimbursement scheme could encourage hospitals to deny or limit the number of revision surgeries performed. One of the authors (CJL) has had a complex knee revision surgery canceled by the head administrator of a for-profit hospital for wanting to use "an implant that is too expensive." If this occurs on a large scale, it will limit the access of care to the rising number of patients who will need revision hip surgery.

In an attempt to quantify the amount of work done by the surgeons in these procedures, several alternatives were assessed. Because of the retrospective nature of this study, only 2 readily available figures could

be used to quantify the amount of effort placed by the surgeon in each surgical procedure: length of stay of the patient and minutes spent in the operating room. Lengths of stay for arthroplasty surgery performed in the mid 1980s were approximately 12 days for primary surgery and 21 for revision surgery. Currently, lengths of stay at the authors' institution averaged 6 days for primary surgery and 9 for revision surgery. Length of stay represents time spent on daily rounds, writing notes on the patients' charts, and providing general medical care. The number of minutes spent in the operating room is a direct measure of the surgical effort involved in a particular procedure. The intensity of the work, the preoperative evaluation, and the surgical planning and preparation were not assessed.

These data clearly show that revision hip surgery is not comparable with other arthroplasty cases. If preoperative planning and intensity of work were to be considered in this type of analysis, this disparity only would increase. Reimbursement schemes projected for 1996 reimburse revision hip arthroplasty procedures $400 more than primary hip cases. Comparing the planned reimbursements and the work that the surgeon has to perform in these procedures conveys a financial disincentive to surgeons and hospitals performing revision hip surgery. Revision hip cases take at least twice as long as primary cases, and patients' stay is almost twice as long in the hospital.

Billed prosthetic costs represented 45% of the total billed hospital costs in this study. The senior authors used a porous-coated hip system (average charge, $7000) in every patient. These devices are among the most expensive in the market. Several differentially priced implants now are available and being marketed aggressively for use in older patients. Contemporary hip implants range in price from $500 for diagnostic-related groups cast cobalt-chrome-molybdenum-alloy stems to >$7000 for modular devices with ceramic heads. With the full reduction of fees projected for 1996, the percentage of the total billed costs can increase depending on the implant selected. Some of the less-expensive implants have been shown to be successful in the older patient population for long periods.[9] These data show that reducing implant cost by selecting a cheaper alternative in selected cases is an efficient way to reduce the overall economic impact of arthroplasty surgery. Traditionally, the implant selection process has been left to the surgeon performing the procedure. Economic aspects have not been a priority item in this selection process, and aggressive marketing efforts have been shown to be effective. Clinicians must participate actively in the development of scientific methodology to facilitate the cost-effective selection of implants for arthroplasty surgery. Failure to do so will cause the imposition of rules and standards by bureaucrats with little or no patient-care experience.

Prior attempts to reduce the economic impact of arthroplasty surgery have focused on length of stay as well as surgical fees. These data demonstrate that the next step in reduction of the economic impact of arthroplasty surgery may involve a selection process by the surgeon in which implant cost is considered. Although this work represents the experience of 2 surgeons in a specific hospital, the trends observed are applicable to the general surgical population.

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References

1. AAOS Bulletin, 37:51-52, October 1991.
2. Clark C: Cost containment: Total joint implants. J Bone Joint Surg 76A:799-800, 1994.
3. Harris WH, Sledge CB: Medical progress: Total hip and knee replacement. N Engl J Med 11:725-731, 1990.

4. Harris WH, Sledge CB: Medical progress: Total hip and total knee replacement. N Engl J Med 12:801–807, 1990.
5. Karpman RR: Cost-effectiveness and savings in total joint replacement. Surg Rounds Orthop 75-78, 1989.
6. Liang MH, Martin GL, Cullen KE, Schwartz JA: Comparative measurement efficiency and sensitivity of five health status instruments for arthritis research. Arthr Rheum 28: 1985.
7. Keeler EB, Kahn EL, Draper D, et al: Changes in sickness at admission following the introduction of the prospective payment system. JAMA 264:1962–1966, 1990.
8. Sommers LS, Schurman DJ, Jamison JQ, et al: Clinician-directed hospital cost management for total hip arthroplasty patients. Clin Orthop 258:168–175, 1990.
9. Sullivan PM, MacKenzie JR, Callaghan JJ, Johnston RC: Total hip arthroplasty with cement in patient who are less than fifty years old. J Bone Joint Surg 76A: 863-869, 1994.