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Original Article

Outpatient total shoulder arthroplasty: A cost-identification analysis

M.E. Steinhaus[a], S.S. Shim[b,*], N. Lamba[c], E.C. Makhni[d], R.K. Kadiyala[b]

[a] Department of Orthopaedic Surgery, Hospital for Special Surgery, 535 E. 70th Street, New York, NY, 10021, United States
[b] Department of Orthopaedic Surgery, Columbia University Medical Center, 622 W. 168th Street, New York, NY, 10032, United States
[c] Harvard Medical School, 25 Shattuck Street, Boston, MA, 02115, United States
[d] Department of Orthopaedic Surgery, Henry Ford Health System, W. Grand Blvd., Detroit, MI, 48202, United States

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ABSTRACT

Background: As demand for total shoulder arthroplasty (TSA) rises, containing costs will become increasingly important. We hypothesize that performing ambulatory TSA procedures results in significant cost savings.
Methods: A model was created to evaluate cost savings. Hospital stay length and cost, pain control method and cost, and number of annual outpatient TSA procedures were estimated based on literature.
Results: Estimated cost savings per patient were $747 to $15,507 (base case $5594), total annual savings of $4.1M to $349M (base case $82M), and ten-year savings of $51M to $5.4B (base case $1.1B).
Conclusion: Ambulatory TSA procedures result in significant cost savings.

1. Introduction

The annual demand for total shoulder arthroplasty (TSA) in the U.S. is significant, and is expected to increase substantially in the future. Recent estimates suggest that a total of 39,000 TSAs are performed annually, with a growth rate of approximately 5%–9% per year.[1–3] In addition, total shoulder arthroplasty is associated with significant costs, with mean total cost estimates of $14,000-$52,000 per patient,[3–5] resulting in total estimated societal costs of $490M-$1.8B per year. As demand for TSA continues to grow, hospital administrators and policy makers will seek to identify means to reduce costs associated with these operations. Inpatient hospital fees are a major contributor to these costs and are sure to be a focus of efforts to optimize care.

Reducing length of stay is one such way to manage rising costs. Attempts at instituting accelerated pathways with quicker discharge have been successful in the total joints literature, cutting costs significantly and improving patient satisfaction while not increasing complication or readmission rates.[6–12] Costs associated with inpatient admission can be eliminated altogether by performing the procedure in an outpatient setting; a strategy that has been successful in other joints literature. Several studies have reported data on outpatient total knee arthroplasty (TKA), with significant reduction in total costs, similar outcomes, high satisfaction rates, and a relatively low rate of complications and readmissions.[8,13–15] Ambulatory total hip arthroplasty (THA) has also been studied and shown success in select groups of patients,[16,17] although one study suggested that additional personnel costs required to affect this change may make the outpatient system more expensive to implement, however a cost analysis was not done in this case.[18] Attempts have been made at performing TSA in the ambulatory setting, although the majority of reports come from the media, as there is little data in the literature reporting on outpatient TSA management.[19–21] Postoperative pain has been one major obstacle to same-day discharge for TSA, though successful ambulatory management with at-home perineural interscalene infusion[22] and continuous brachial plexus blockade[23] has been reported. Other studies have reported successful outpatient pain management of major shoulder surgeries (of which TSA was a part) with continuous interscalene brachial plexus blockade,[24–27] and it has been suggested that such a pathway may be a route to cost savings.[28] An improved understanding of the trade-offs between inpatient and outpatient TSA could aid patients, physicians, researchers, and policy makers in (a) determining if outpatient TSA is more cost-effective than inpatient TSA and (b) in estimating the amount of cost-savings associated with the outpatient procedure over time.

The primary objective of this study was to establish a model to perform a cost-identification analysis of performing total shoulder arthroplasty in the outpatient compared to the inpatient setting. Cost-identification analysis considers the costs associated with the interventions in question, with the purpose of identifying the less expensive option given equal outcomes between the two.[29] Other total joints procedures performed in the outpatient setting[8,13–17] and successful reports in the media[19–21] have shown equal outcomes for inpatient and outpatient operations in a select group of patients. Recent studies in shoulder arthroplasty have similarly shown no significant difference in

* Corresponding author at: 267.210.1466 622 W. 168th Street PH-11, New York, NY, 10032, United States.
E-mail address: ss4723@cumc.columbia.edu (S.S. Shim).

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the adverse event and readmission rates between outpatient and inpatient TSA.[30,31] We aimed to estimate cost savings per patient as well as evaluate societal savings annually and over a period of 10 years. As a part of the model, we hoped to characterize the reduction in costs that would accompany this change. Our hypothesis was that performing ambulatory TSA procedures in appropriate cases would result in considerable cost savings to society.

2. Methods

2.1. Study and model design

A model was created to evaluate the cost savings associated with outpatient TSA procedures compared with those performed in the inpatient setting. Our reference case was a hypothetical cohort of patients who were candidates for total shoulder arthroplasty, including both male and female patients with all underlying etiologies. The subgroup of patients who would be candidates for outpatient management was estimated based on the literature. Two studies were identified which studied outpatient TSA, with the first defining patients as candidates for same-day discharge if they 1) had a numerical rating scale pain score ≤ 4, 2) required < 5 mg IV morphine, 3) ambulated without assistance or light-headedness, 4) tolerated oral liquids, 5) had normal vital signs, 6) had estimated blood loss $<$ weight (kg) x 10 mL, and 7) had no medical issues requiring admission, as well as lived within 2 h of the hospital and had a caretaker for the duration of the local anesthetic infusion.[22] In the second study, eligibility criteria for outpatient TSA were: 1) American Society of Anesthesiologists (ASA) Grade 1 or 2, 2) no major medical reason for postoperative monitoring, 3) residency in the same region as the hospital, and 4) availability of a caretaker during the first 24 h after surgery.[23]

Costs were calculated from both an individual patient and societal perspective, with an annual and ten-year time horizon. Outcomes were expressed as cost differences in 2015 US dollars, which takes into account an annual discount rate of 3%. A model was generated with inputs (assumptions on inpatient hospitalization, pain control, and prevalence of outpatient TSA), which provided cost difference outcomes associated with inpatient and outpatient management of TSA. Sensitivity analyses were performed on key model parameters to evaluate their effects on base case conclusions.

2.2. Inpatient hospitalization

One of the primary inputs into the model is length of stay associated with inpatient TSA. Our assumptions were based on the previous literature, which has shown that length of stay associated with these procedures ranges from one to four or more days of hospitalization.[4,23,32] At our institution, the current average length of stay for patients undergoing TSA is 2.2 days. In our reference case, we estimated the length of stay based on the experience at our institution as well as that reported by Virani et al and Dunn et al[4,32]

One of the primary differences in cost outcomes of inpatient and outpatient TSA is related to the cost of inpatient hospitalization. This cost, which was included in the calculation of inpatient TSA costs but not in outpatient TSA costs, was estimated based on the previous literature, which varies greatly with reports of inpatient admission costing from $1,500/day to $12,500/day.[9–12,33] In our reference case, we estimated the cost of inpatient admission to be $3300 per inpatient day based on the work of Raphael et al and Scranton.[11,12]

2.3. Pain control

Previous work has suggested that oral pain medication or nurse-administered analgesia is insufficient to provide pain relief following TSA.[23,34] For this reason, the pain control options considered in our study included patient-controlled analgesia (PCA) with opiates and peripheral nerve blockade (PNB). Cost estimates for PCA were based on the prior literature, which shows a range from $64 to $347 per patient per day.[35–37] We estimated PCA cost of $224, based on work by Palmer et al[35] corrected for average length of stay. Similarly, PNB cost estimates were based on the previous literature, with ranges from $1752 to $5550 in total cost per patient. In our reference case, we estimated the cost of PNB $3556 based on similar reports by Cheng et al[38], Horn et al[39], and Williams et al[40]

The proportion of those undergoing inpatient TSA managed with each of these pain regimens was also estimated. We could not identify prior studies in the literature upon which to draw when generating estimates about pain control.

2.4. Prevalence of outpatient TSA

Reports from previous literature were used to estimate the total number of TSA procedures performed annually.[1–3] The annual growth rate was estimated from the work of Kim et al[2] and Day et al[1] (7.2%, the average of 4.9%, annual growth rate of Kim et al prior to introduction of reverse TSA, and 9.4%, annual growth rate reported by Day et al), and our reference case for the total number of TSAs performed in 2015 derived from these studies, as well as by Ponce et al[3] (39,104 cases in 2015, calculated using above growth rate, applied to the total prevalence reported by Ponce et al). The subset of patients undergoing TSA who were candidates for outpatient management was also estimated based on previous literature[23], with our base case being 36% of those undergoing TSA being candidates for outpatient management, a figure which corresponds well to both of these references.

2.5. Sensitivity analysis

Sensitivity analysis was performed to evaluate the uncertainties in key parameter values. A multi-way sensitivity analysis was performed to evaluate the combined uncertainties of average length of inpatient stay, cost of inpatient hospitalization, cost of both methods of pain control, annual prevalence of total TSAs, annual growth rate in the number of TSA procedures, and the proportion of TSAs performed that could be done in the outpatient setting.

3. Results

3.1. Reference case

The results of the model output are presented in Table 2. When compared to inpatient management of total shoulder arthroplasty, performing the procedure in the ambulatory setting was associated with cost savings of $5594 per patient. Assuming 15,000 total outpatient TSAs performed in 2016 in the US, total cost savings in that year was estimated to be $82M (Fig. 1). In the base case scenario, 10-year cost savings from 2016 to 2025 was estimated to be $1.1B.

3.2. Sensitivity analysis

In the multi-way sensitivity analyses, in which parameters were varied according to the ranges specified in Table 1, outpatient TSA was associated with substantial cost savings in every scenario, even when all of the low case assumptions were used in the model. Using the multi-way sensitivity analyses, cost savings per patient varied from a nadir of $747 to a peak of $15,507 per patient. Overall cost savings in 2016 ranged from $4.1M to $349M (Fig. 1). Ten-year cost savings from 2016 to 2025 varied from $51M to $5.4B.

4. Discussion

Total shoulder arthroplasty is an increasingly common procedure that is associated with substantial costs. A considerable portion of these