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# The Cost-Effectiveness of Total Hip Arthroplasty in Patients 80 Years of Age and Older

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A B S T R A C T

*Background:* This study investigates the cost-effectiveness of total hip arthroplasty (THA) in patients 80 years old.

*Methods:* A Markov, state-transition model projecting lifetime costs and quality-adjusted life years (QALYs) was constructed to determine cost-effectiveness from a societal perspective. Costs (in 2016 US dollars), health state utilities, and state transition probabilities were obtained from published literature. Primary outcome was incremental cost-effectiveness ratio, with a willingness-to-pay threshold of $100,000/QALY. Sensitivity analyses were performed to evaluate parameter assumptions.

*Results:* At our base-case values, THA was cost-effective compared to non-operative treatment with a total lifetime accrued cost of $186,444 vs $182,732, and a higher lifetime accrued utility (5.60 vs 5.09). Cost per QALY for THA was $33,318 vs $35,914 for non-operative management, and the incremental cost-effectiveness ratio was $7307 per QALY. Sensitivity analysis demonstrated THA to be cost-effective with a utility of successful primary THA above 0.67, a peri-operative mortality risk below 0.14, and a risk of primary THA failure below 0.14. Analysis further demonstrated that THA is a cost-effective option below a base-rate mortality threshold of 0.19, corresponding to the average base-rate mortality of a 93-year-old individual. Markov cohort analysis indicated that for patients undergoing THA at age 80 there was an approximate 28% reduction in total lifetime long-term assisted living expenditure compared to non-operatively managed patients with end-stage hip osteoarthritis.

*Conclusion:* The results of our model demonstrate that THA is a cost-effective option compared to non-operative management in patients ≥80 years old. This analysis may inform policy regarding THA in elderly patients.



Individuals over 80 years of age comprise one of the fastest growing demographics in the United States [1]. Many of these elderly patients suffer from advanced hip osteoarthritis, and total hip arthroplasty (THA) rates are expected to increase in this population in the coming decades [2–4]. For these patients, THA may hold the promise of decreased pain and improved function [5,6]. However, as with many surgical procedures, mortality and morbidity risks increase with advanced age [4,7]. Although THA is associated with considerable financial costs both to patients and to the healthcare system, poor mobility due to advanced osteoarthritis may also lead to substantial costs, secondary to an increased risk of requiring long-term assisted living [8–11].

These considerations complicate the decision-making process for elderly patients considering THA. Moreover, they contribute uncertainty to the development of evidence-based payer and provider policies regarding THA in this patient population. Although prior analyses have been published evaluating the cost-effectiveness of THA in younger patients, no studies in over 3 decades have evaluated this issue specifically in individuals ≥80 years old [12–16]. Furthermore, while cost-effectiveness analysis of THA in younger patients have considered indirect costs and

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benefits such as lost wages and return to previous level of employment, no prior cost-effectiveness analysis of THA has incorporated differential risk of requiring long-term assisted living with non-operative vs operative management of end-stage osteoarthritis (ESOA) [14,17]. The purpose of this study is to investigate the cost-effectiveness of THA in patients ≥80 years old compared to non-operative management.

## Materials and Methods

### *Patient Population*

The population of interest for our analysis was patients ≥80 years of age with ESOA of the hip who are considering THA vs non-operative management.

### *Model Structure*

A Markov, state transition, simulation model was constructed to determine cost-effectiveness of THA compared to non-operative management of end-stage hip osteoarthritis. The model projects lifetime costs and quality-adjusted life years (QALYs). Cost was considered from a societal perspective. Costs, expressed in 2016 US dollars, were obtained from published literature. Health state utilities and probabilities were obtained from published literature, US Center for Disease Control and US Department of Health and Human Services reports, as well as US Social Security actuarial life tables [18,19]. Costs and utilities were discounted at 3% per year, consistent with current practices of medical cost-effectiveness analysis [20]. Willingness-to-pay threshold was set at 100,000/QALY [21]. The model was constructed using decision analytic software (TreeAge Pro 2017; TreeAge Software, Williamstown, MA). A state transition diagram describing our model structure is included in Figure 1.

### *Model Parameters*

Several general assumptions were made regarding model design and parameters. The population of interest was assumed to be healthy and living independently in the community at the outset of our model. Admission to a long-term assisted living facility was assumed to be a static state, such that patients did not return to independent living after they had entered a long-term assisted living situation. Because discharge disposition may be influenced by factors unrelated to the patient's immediate health status, we sought to make our model as conservative as possible by implementing a base-case scenario that assumed that all patients undergoing THA would require post-operative acute rehabilitation [22,23]. Our model also assumed that all patients who experienced failure of their primary THA would undergo revision, and patients who experienced failure of their revision THA would not undergo further revision surgery.

### *Probabilities*

Transition probabilities used in our model were obtained from published literature, and are presented in Table 1. Our model incorporated a differential base-rate annual mortality, and a differential risk of requiring long-term assisted living with increasing age above 80 years. We assumed the base-rate annual mortality to be equal to the average base-rate annual mortality of age-matched men and women, as reported in 2013 US Social Security Actuarial Life Tables [28]. After primary or revision surgery, patients were assigned a status of full vs limited benefit.

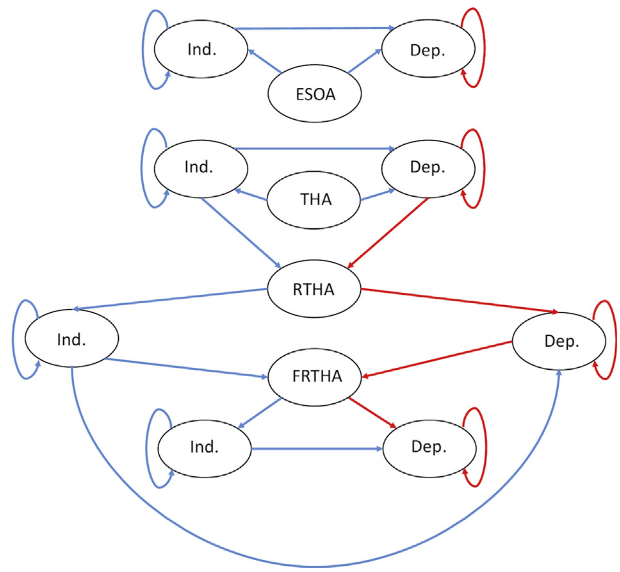


**Fig. 1.** State transition diagram of our model. The diagram demonstrates the 2 potential treatment modalities, non-operative (top) and total hip arthroplasty (bottom). The blue lines represent possible state transitions. The red lines also represent possible state transitions; however, it additionally denotes that participants in the model who entered a dependent, long-term assisted living situation did not return to an independent living situation in the model. Not included in this diagram is the absorbing state of death, which model participants could enter from any other state in the model. Ind., independent living; Dep., dependent living (in a long-term assisted living situation); RTHA, revision total hip arthroplasty; FRTHA, failed revision total hip arthroplasty.

Full vs limited benefit status was used as the determinate of whether the patient was at a decreased risk or at an equivalent risk, compared to non-operative management patients, of requiring long-term assisted living after primary or revision

**Table 1**
Age-Specific Probabilities.

| Probabilities | Value | Source(s) |
|---|---|---|
| Peri-operative mortality after primary THA (first 30 d) | 0.0162 | [24–27] |
| Peri-operative mortality after revision THA (first 30 d) | 0.0393 | [24] |
| Baseline mortality | Variable | [28] |
| Failure rate after primary THA (all cause) | 0.0571 | [29–31] |
| Failure rate after revision THA (all cause) | 0.0239 | [31–33] |
| Probability of full benefit after primary THA | 0.76 | [34,35] |
| Probability of full benefit after revision THA | 0.38 | Assumption |
| Probability of dependent living after primary THA for patients aged 80-84 | 0.0288 | [8,9] |
| Probability of dependent living after primary THA for patients aged >85 | 0.0576 | [8,9] |
| Probability of dependent living after revision THA for patients aged 80-84 | 0.0369 | Assumption |
| Probability of dependent living after revision THA for patients aged >85 | 0.0737 | Assumption |
| Probability of dependent living after failed revision THA for patients aged 80-84 | 0.0527 | [9] |
| Probability of dependent living after failed revision THA for patients aged >85 | 0.1054 | [9] |
| Probability of dependent living after ESOA for patients aged 80 | 0.0449 | [9] |
| Probability of dependent living after ESOA for patients aged >85 | 0.0898 | [9] |
| Probability of medical complication after primary THA | 0.098 | [36,37] |
| Probability of medical complication after revision THA | 0.23 | [37] |