Is Resurfacing the Patella Cheaper?

An Economic Analysis of Evidence Based Medicine on Patellar Resurfacing

Karim A. Meijer, MD and Vinod Dasa, MD

Investigation performed at the Department of Orthopaedics, Louisiana State University, New Orleans, Louisiana

Background: Primary total knee arthroplasty is a high volume procedure which is expected to grow dramatically in the near future. The decision to resurface the patella has been discussed extensively in the literature yet the financial implications of resurfacing versus not resurfacing have not been demonstrated. Using an expected-value decision tree analysis and sensitivity analysis in combination with actual Medicare costs, we constructed a model showing the most cost-effective treatment choice from a Medicare perspective over a mid term period.

Methods: We identified all randomized prospective trials comparing patellar resurfacing to nonresurfacing in the past ten years and identified the total number of patellofemoral revision surgeries for both resurfaced and nonresurfaced patellas in each study. An expected-value decision tree analysis was created using only data from the randomized ~~control~~ trials identified. Actual costs collected from Medicare reimbursement rates were then applied to the model and a sensitivity analysis was performed.

Results: T~~t~~he expected value of primary total knee arthroplasty with patellar resurfacing was $13,788.48 while a primary total knee arthroplasty without patellar resurfacing was $14,016.41 after five years. The difference represents an additional $227.92 of Medicare dollars for every primary total knee arthroplasty performed without patellar resurfacing at five years. The model remains valid as long as patellofemoral revision rates after patellar resurfacing remain below 3.4% and patellofemoral revision rates after nonresurfaced patellas remain above 0.71%.

Conclusions: While initially counterintuitive**,** resurfacing the patella during a primary total knee arthroplasty is the optimal financial strategy from a Medicare perspective over a mid term period.

Level of Evidence: Economic and decision analysis, Level I.

Introduction

In 2007 in the United States 543,000 total knee arthroplasties were performed.[1] With the volume expected to grow to 3.48 million per year in 2030 the costs related to this procedure will undoubtedly have an economic impact on our healthcare system.[13] The decision to resurface the patella during a primary total knee arthroplasty remains controversial with studies supporting both resurfacing and not resurfacing the patella during primary total knee arthroplasty.[3,14] Traditional indications for both resurfacing and not resurfacing the patella during a primary total knee arthroplasty have been described by Burnett et al.[19] Physicians generally fall into three groups: always resurface, never resurface, or selectively resurface the patella.

With many outcome-based studies related to patellar resurfacing, complications associated with resurfacing the patella include patella fracture, loosening, rupture of the patella tendon, and polyethylene wear. In comparison, the main complication of a

nonresurfaced patella is anterior knee pain which has been well documented.[15] These outcomes, in conjunction with those for resurfaced patellas, provide a frame work for the application of a decision tree with sensitivity analysis.

The goal of this paper is to provide a template for cost effective medical decision making through a combination of evidence based medicine, expected-value decision tree analysis, sensitivity analysis, and current Medicare data that provides an overall cost-savings to the healthcare system using the decision of patellar resurfacing in primary total knee arthroplasty as an index case. To our knowledge this is the first analysis of its kind to apply actual cost data to a decision tree analysis comparing resurfaced versus nonresurfaced patellas in primary total knee arthroplasty.

Decision Tree Analysis

Expected value decision tree analysis is a financial tool designed to produce the best economic decision possible given the information available. Since outcomes have inherent uncertainty and good decisions can lead to bad outcomes, the focus should be placed on the decision making process. The hallmark of a well-designed decision tree accounts for all available evidence based medicine, then quantifies the financial implications and determines the optimal strategy. Decision trees are composed of nodes and branches, where a node represents a point in time, or a decision to be made. A branch is simply a pathway that links possible decisions nodes. With multiple branches possibly emanating from every node, a probability is applied to every outcome. The sum of the probabilities leading out of every node must sum to 1. This construct is very similar to the algorithms used in medicine every day, however, probabilities and financial values are embedded in every decision node. For every choice that is made, a quantifiable financial cost is incurred in conjunction with an estimated probability. The ability to correctly indentify and appropriately apply associated costs with each decision node is important. The variance in costs over time can be accounted for and tested through sensitivity analysis. As the nodes and branches continue from left to right, the pathway will eventually end. This final node indicates that the problem is complete and all probabilities and costs have been computed. The two final values seen at the end node represent the final monetary value and probability of ascertaining the specific outcome.

Time Value of Money

The value of one dollar today is not the same as its future value. Costs must be discounted back to present values in order to objectively compare their true cost. When patient outcomes and financial implications are not realized until years later, the costs associated with those outcomes must be discounted to present day values. By the same token, costs realized in the future must represent future values. We elected to use 3.95% as our discount rate which is the US Healthcare Inflation Rate as of June 30, 2012. (Bureau of Labor Statistics). Sensitivity analysis will be used given rates were recently as high as 5.16% in December of 2007 and as low as 2.6% in January 2009.

Sensitivity Analysis

Healthcare outcomes and costs will inevitably change over time which will affect the decision tree model. Sensitivity analysis is an important component of any financial model prone to variations. As costs and/or probabilities change, each variable can be accounted for and the model changed to evaluate the impact of each variable on the overall outcome of the model. Daellenbach et al demonstrated the importance of sensitivity analysis in relation to decisions based on new orthopaedic technologies with his example of the effect of survivorship and cost implications in cemented versus cementless total hip arthroplasty. However, since their model did not have reliable outcome data on failure rates of cementless prostheses, they relied exclusively on clinical judgment and sensitivity analysis for the assumptions created. [5]

Methods & Materials

We reviewed the literature for prospective randomized control trials as we well as meta-analyses over the past ten years from peer reviewed journals that compared patellar resurfacing versus not resurfacing during a primary total knee arthroplasty. Three meta-analyses and eight prospectively randomized control trials were found during our search.[2,7,8,9,10,11,15,17,18] However, we elected to use only six of the randomized control trials because of the poorly delineated methodology used in two. Each randomized control trial was evaluated to define the rate of reoperations in each cohort of patients with respect to patellar resurfacing versus not resurfacing and subsequent complications encountered in each study. (Table 1).

Using the data collected we created an expected value decision tree model that evaluates two different strategies in respect to the patella during a primary total knee arthroplasty. The surgeon can either resurface the patella or choose to leave the patella alone. Resurfacing is defined as replacing the articular surface with an implant while not resurfacing does not utilize an implant but can include minor alterations such as removal of osteophytes and circumferential electrocautery of the patella. After the decision regarding the patella is made, the patient will fall into the appropriate limb of the tree. If a patient did not have their patella resurfaced, two options arise: 1. No further patellofemoral surgery or, 2. Patellofemoral revision which is broken down by a diagnosis such as anterior knee pain (AKP), osteonecrosis or other patellofemoral complication. If the patella is resurfaced at the index procedure, the patient again will follow one of two paths: 1. No further patellofemoral surgery or, 2. Patellofemoral revision secondary to fracture, rupture of extensor mechanism, aseptic loosening, patellar instability, or other patellofemoral complication. Each of the diagnoses represents an end node which has a corresponding financial value. (Table 2, Table 3). The probability of incurring each of these costs is based on the reviewed randomized control trials. We assumed that a patient experienced only one complication and that the complication was addressed and resolved. We assumed each complication occurred on average two years after the index procedure except for aseptic loosening which was assumed to occur at five years. Readmission rates for reasons unrelated to patella complications were omitted

from the model because Breeman et al has shown no significant difference in complications requiring reoperations when comparing patellar resurfacing versus not resurfacing.[7]

Table 2

COMPLICATIONS			
Hospital DRG code	Diagnosis	ICD	CPT
Total Knee WITH Patellar Resurfacing DRG 489 (no MCC)	1. Patellar Instability 2. Aseptic Loosening 3. Patella Fracture 4. Rupture of Extensor Mechanism	836.3, 719.86, 719.96 996.45 994.44 727.65, 727.66	27422, 27425 27486 27524 27385, 27380
Total Knee WITHOUT Patellar Resurfacing DRG 489 (no MCC)	1. Anterior Knee Pain 2. Osteonecrois of patella	717.7, 719.46, 715.16 733.44	27438 27438

A sensitivity analysis was performed to test the stability of the decision tree and ascertain parameters where the model would remain stable. We used Medicare reimbursement rates to account for physician compensation and hospital reimbursement from CMS.gov. Each primary index total knee arthroplasty carried the assumption of no medical complication under DRG 470 ($11,750). All subsequent knee procedures to address the patellar complications were assumed to also have no medical complications and listed as DRG 489 ($6,917). Physician reimbursement data was based on a national payment amount using the global modifier. The following are the rates for each procedure related to the model (Table 3). Also included were Medicare reimbursements for spinal anesthesia during a primary total knee arthroplasty as well as general anesthesia for a one-hour patella revision surgery.[12]

Source of Funding

No external source of funding.

Table 3

CPT CODE	Description	Physician Fee
27447	Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty)	$1,687.13
27425	Lateral retinacular release, open	$485.65
27438	Arthroplasty, patella; with prosthesis	$918.50
27486	Revision of total knee arthroplasty, with or without allograft; 1 component	$1,542.85
27524	Open treatment of patellar fracture, with internal fixation and/or partial or complete patellectomy and soft tissue repair	$822.18
27380	Suture of infrapatellar tendon; primary	$647.78
27385	Suture of quadriceps or hamstring muscle rupture; primary	$630.30
27422	Reconstruction of dislocating patella; with extensor realignment and/or muscle advancement or release (eg, Campbell, Goldwaite type procedure	$811.40

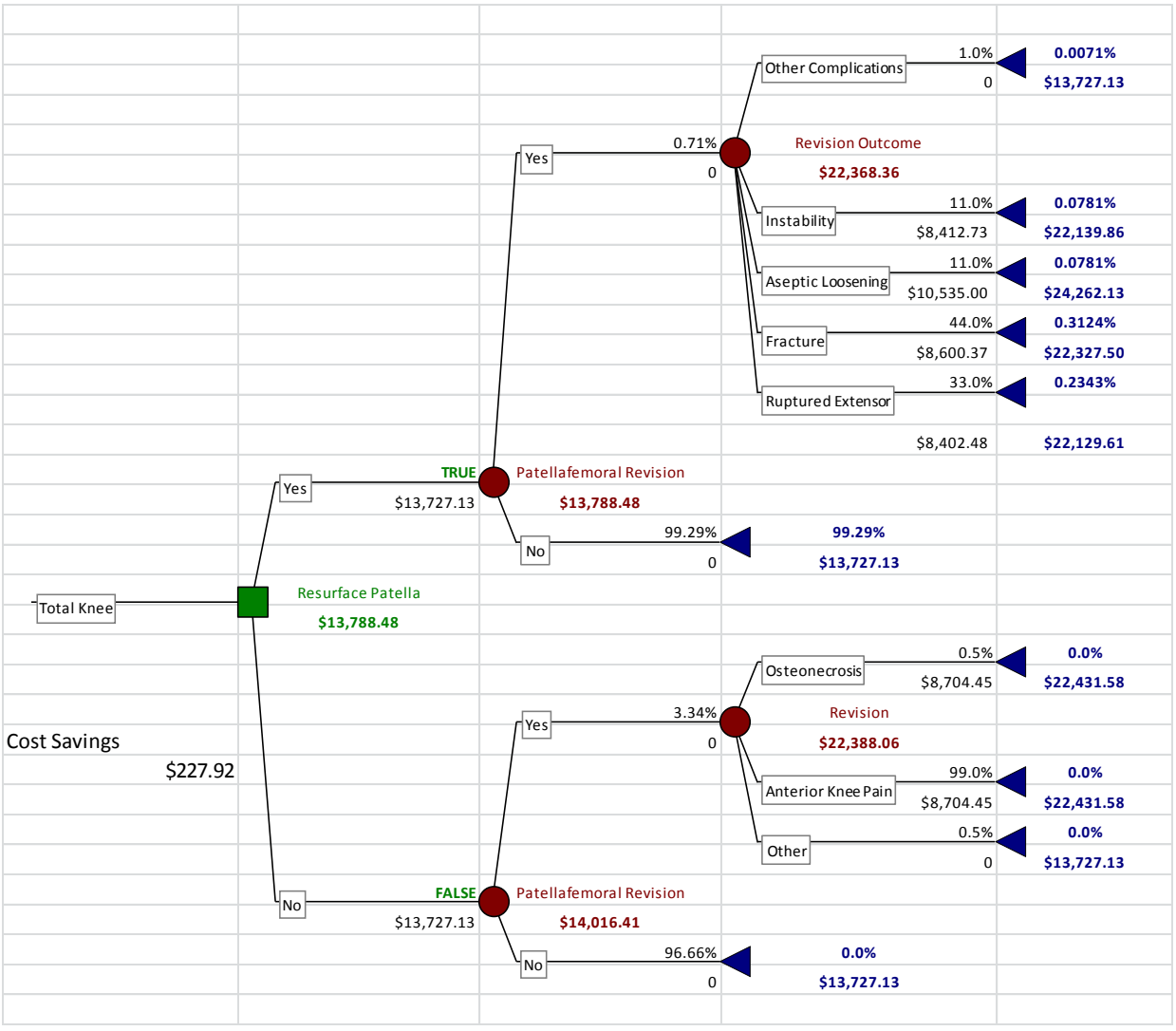
Results

The expected discounted cost of primary total knee arthroplasty with patellar resurfacing was $13,788.48 while a primary total knee arthroplasty without patellar resurfacing was $14,016.41 after accounting for all patellar complications at 5 years (Figure 1). The difference represents an additional $227.92 of Medicare costs for every primary total knee arthroplasty performed without patellar resurfacing. Based on the randomized control trials we reviewed, 3.4% of all nonresurfaced patellas returned for an additional operative procedure versus 0.71% of all resurfaced patellas.

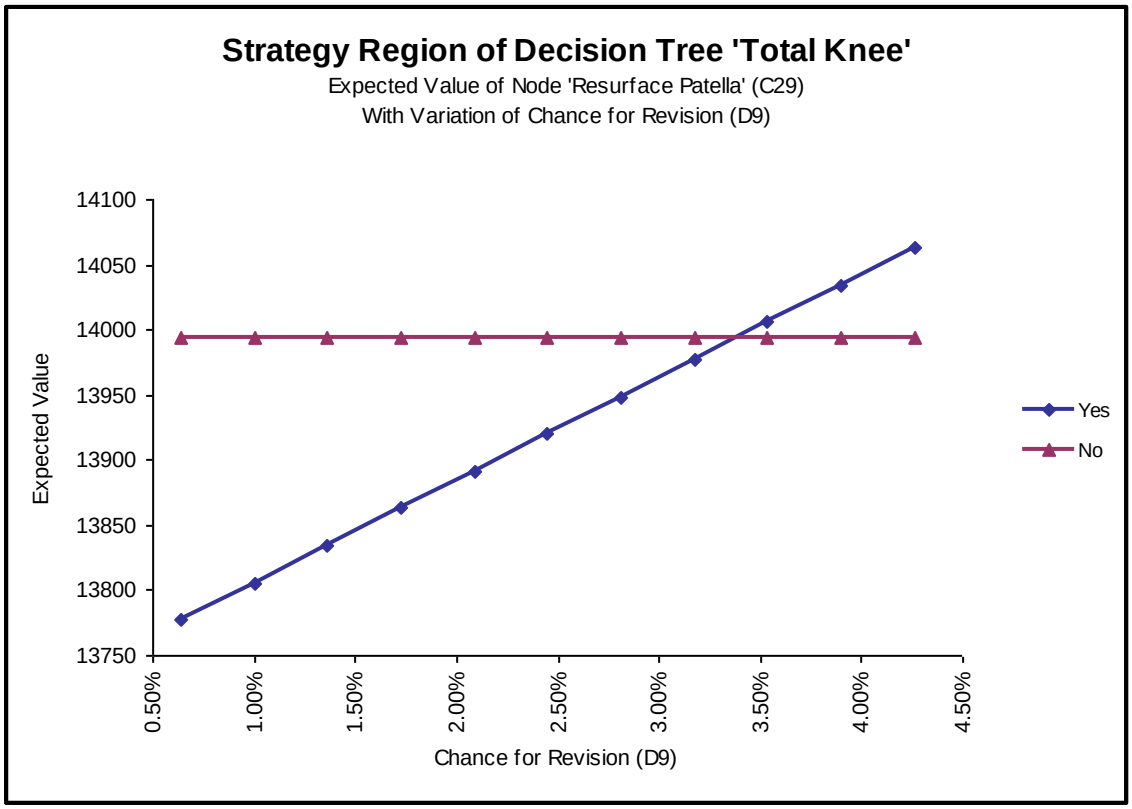
Individual sensitivity analyses of the two procedures' revision rates showed that if the assumed non-resurfacing revision rate of 3.34% is correct, the patella resurfacing option remains superior as long as the resurfacing revision rate remains below 3.4%. Also if the assumed resurfacing revision rate of 0.71% is correct, then patella resurfacing remains the superior option so long as the non-resurfacing revision rate is above 0.71% (Figure 2,3). Two way sensitivity analysis was also done (Figure 4). The connected line in the figure is the "indifference curve." Any combinations of revision rates that fall on the line are those revision rate combinations for which expected costs are the same regardless of initial procedure choice. It follows that any combination of revision rates that falls below the indifference curve would favor resurfacing and any combination that falls above the indifference curve would favor non-resurfacing. Our results are plotted on

the graph with the revision rate combination of 0.71% for resurfacing and 3.34% for non-resurfacing which falls below the indifference curve and therefore favors resurfacing.

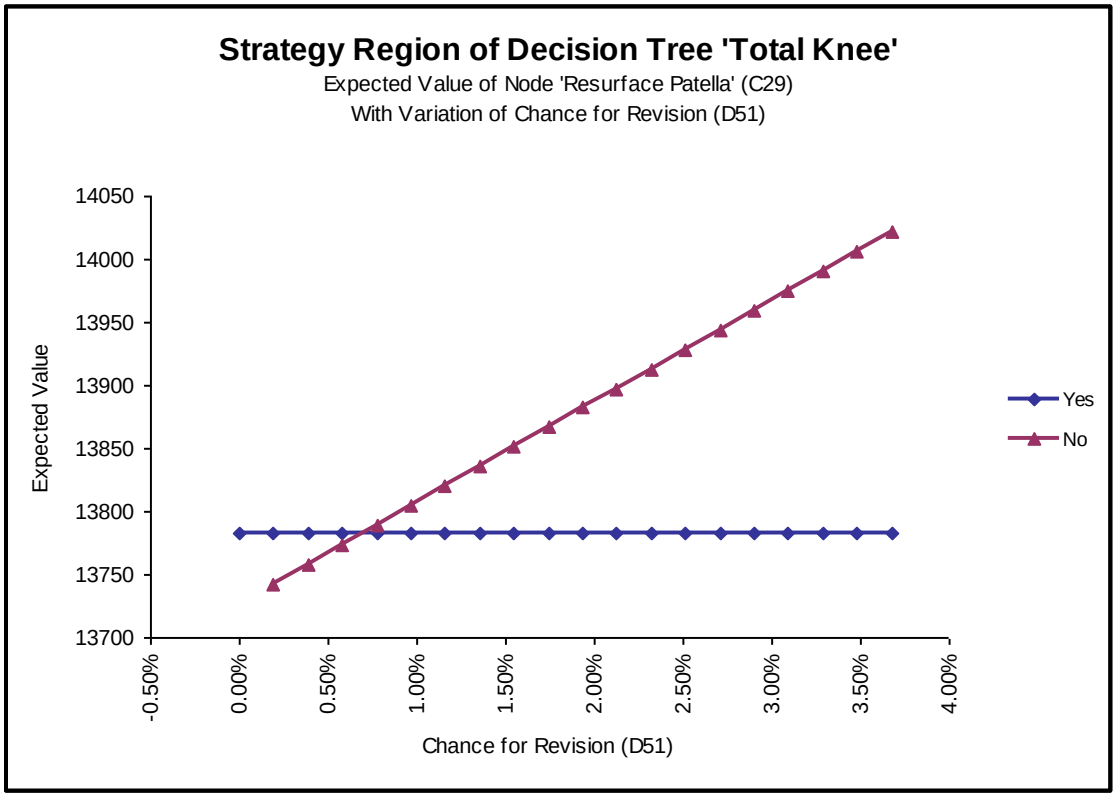
Decision Tree (Figure 1)



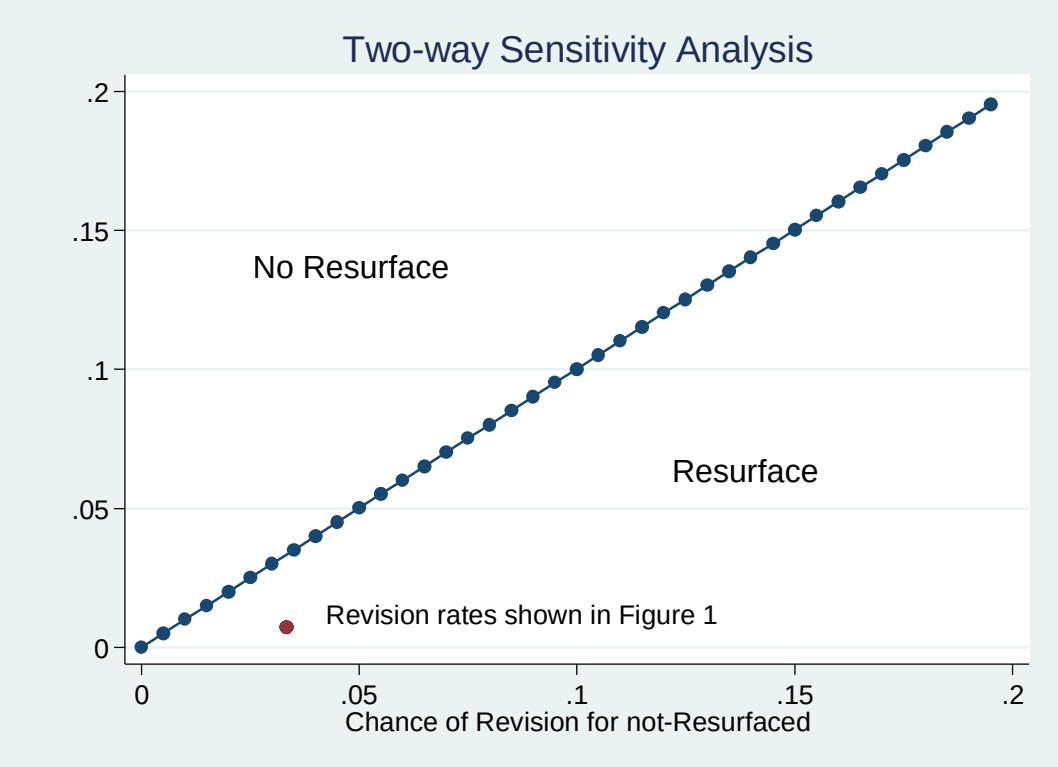
One Way Sensitivity Analysis (Figure 2)



One Way Sensitivity Analysis (Figure 3)



Two Way Sensitivity Analysis (figure 4)



Discussion

Based on our decision tree, the lowest expected cost in the long run is achieved by resurfacing the patella at the initial procedure. This counterintuitive result stems from the higher likelihood of revising a nonresurfaced patella in the future versus a resurfaced patella. The idea of not resurfacing the patella during a primary total knee arthroplasty may initially seem like a cost savings to the healthcare system. However, one must understand both the perspective from which the presumed savings is seen and how healthcare is compensated in the US. The initial savings is seen only by the hospital system providing the service in the form of not using a patellar implant, less cement, quicker operative times, and possibly less surgical trays. There is no difference in Medicare payment ($13,727.13) at the index procedure despite the operative cost to a hospital being increased in cases with resurfaced patellas. Since Medicare gives equal reimbursements to hospitals and providers regardless of patellar resurfacing, Medicare is assuming the procedures have similar outcomes and costs. This incorrect assumption and misaligned reimbursement structure actually leads to greater costs because the outcomes and costs associated with resurfaced and nonresurfaced patellas are different. After a few years, nonresurfaced patellas have higher patellofemoral revisions rates than resurfaced patellas. These additional procedures generate further healthcare costs for Medicare and

are the main reason why patellar resurfacing at the index procedure is the cost effective choice from a Medicare perspective.

Kurtz et al projected 3.48 million (2.95 to 4.14 million 95% prediction interval) primary total knee arthroplasties will be performed in the United States in 2030.[13] Given 15% of orthopaedic surgeons do not routinely resurface the patella based on a 2012 AAHKS survey, an additional $111,449,260 dollars in unnecessary costs can be expected per year by 2030. This number is a gross underestimate of the actual cost in 2030 because of healthcare inflation. If current healthcare inflation rates are used, this number would balloon to over $175 million dollars per year in 2030.

This real world practical application provides physicians, hospital systems, and payors the ability to assess the impact of medical decisions on healthcare costs. In addition, payors may have a better understanding of potential costs related to a total knee arthroplasty with or without a patellar resurfacing. At the current time, regardless of patellar resurfacing, physician reimbursement for a primary total knee arthroplasty is the same. Changing the reimbursement may incentivize physicians who do not resurface the patella to change their practice and thus decrease the overall Medicare costs at 5 years. The increase in reimbursement should not exceed $228 dollars because what would be saved in future operations is lost with increased reimbursements.

The strengths of the study include actual reported revision rates of operations with associated cost data. Many decision tree models rely on assumptions that patients will follow a set path regardless if the literature supports the assumption. Our model used only reported data from prospective randomized control trials that represent actual patient outcomes. To our knowledge, this is the first expected value decision tree analysis model which combines both evidence based literature and actual financial data comparing patella resurfacing in primary total knee arthroplasty.

Next, our results for revision rates after both patellar resurfacing and not resurfacing were very similar to those results published by Johnson et al during their evaluation of a community-based joint registry of 9530 cemented, all-polyethylene patella TKAs and 627 bicompartmental knee arthroplasty without patellar resurfacing. They reported a lower cumulative revision rate for patella-only revision than with bicompartmental knee arthroplasty (0.8% versus 4.8%).[6] In addition, a meta-analysis in 2005 by Nizard et al showed an incidence of reoperations for patellofemoral problems in 6.5% of nonresurfaced cases versus 2.3% in the resurfaced group.[15] More recently a meta-analysis by Pilling et al showed a revision rate 1.1% for patellar resurfacing and 2.8% for nonresurfaced patellas.[20] Most studies have rationalized this increase to be an inherent bias secondary to surgeons having the ability to offer a secondary procedure to a patient with persistent knee pain in the face of an unresurfaced patella. Regardless of bias, the procedures are being done and do lead to increased healthcare costs.

Finally, our study complements the decision tree analysis done by Helmy et al who demonstrated that resurfacing the patella at the index procedure leads to a higher health utility.[16] This combination of a higher health utility and lower cost when resurfacing the patella at the index procedure presents a treatment strategy that dominates. Therefore, based on healthcare economic principals, resurfacing the patella should be accepted as the correct strategy and adopted by physicians for this high volume procedure.

There are limitations to the study which include the variability of the costs reported in the study. The financial data was collected from available Medicare reimbursement rates based on a national payment system. These rates may vary by region but not enough in our opinion to influence the results of the overall model. Other limitations include the inherent assumptions necessary to create an expected value decision tree. Every patient was assumed to have only one complication and that it was resolved. We understand this may not be the case for some patients which would lead to further unaccounted costs. We do not believe this would affect the model given the very small impact these patients would have to influence the financial outcomes of the model. Finally, every model is only as reliable as the information from which it was created. Using multiple well-designed prospective randomized trials gives the best chance to create a reliable model, however, these studies only had outcomes as far as 10 years which could potentially under or over estimate the results.

Healthcare costs will continue to rise unless a more proactive approach into understanding the financial implications of medical decisions is embraced. Physicians should take the lead in understanding the business of medicine and take control of our industry by providing quality cost effective care built on sound business principals and evidence based medicine. Our results support resurfacing every patella, however, further financial analysis needs to be done to evaluate costs from a hospital's perspective to fully understand the economics of patellar resurfacing.

Karim A. Meijer, M.D.
Department of Orthopaedic Surgery, PGY-3
Louisiana State University Health Science Center
1542 Tulane Avenue, Box T6-7
New Orleans, Louisiana 70112
kmeije@lsuhsc.edu

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James Dyer, Professor
Department of Information, Risk and Operations Management
McCombs School of Business
The University of Texas at Austin

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