THE OSTEOARTHRITIS POLICY MODEL
OAPol Team

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- Lisa Suter, MD (Yale School of Medicine)
- Ed Yelin, PhD (UCSF)
A computer simulation model of knee OA progression and treatment.
The Burden of knee OA

- Symptomatic knee OA affects approximately 7% of Americans over age 45

- Obesity and knee injuries, two major risk factors for symptomatic knee OA, have become more prevalent in recent years
  - These trends may contribute to earlier OA onset

- Patients’ demands for earlier and more aggressive treatment may contribute to earlier presentation for care
  - May lead to the unprecedented utilization of health services, including use of total knee replacement (TKR)
Role of Decision Analysis Modeling

- When randomized controlled trials are unavailable, or when the data we need is unavailable at present, we can turn to decision modeling.

- Helps decision-makers in policy and medicine understand how to prioritize further data acquisition.

- Allows researchers to construct hypothetical treatment scenarios and move beyond fixed time horizons, geographic settings, and target populations.
How the Model Works

- Uses a synthesis of epidemiologic, clinical, and economic data to assess the implications of different clinical outcomes or varying treatment options

- Employs Monte Carlo simulation
  - Individuals drawn randomly from initial distribution of age, sex, obesity, major co-morbidities
  - Uses transition probabilities to determine sequence of annual transitions among health states, including:
    - Being diagnosed with symptomatic knee OA
    - Managing pain with corticosteroid injections or non-steroidal anti-inflammatory drugs (NSAIDs)
    - Undergoing primary or revision TKR
  - Risk of OA incidence governed by age, sex, and obesity
How the Model Works

Baseline characteristics

Demographic:
Age, Sex, Race

Clinical:
Obesity, chronic diseases, knee OA pain

Health Transitions
Changes to cost and quality of life at each transition due to:
- Disease progression
- Treatment
- Death

Outcomes
Accumulated costs and decrements to quality of life
Select results from OAPol Publications
To examine cost-effectiveness of TKA in the U.S. Medicare population
**Cost-Effectiveness of TKA in overall population, and stratified by risk of perioperative comorbidities**


<table>
<thead>
<tr>
<th>TKA Status(^b)</th>
<th>Cost</th>
<th>QALYs, No.(^c)</th>
<th>ICER Compared With Next Least Expensive Strategy(^d)</th>
<th>ICER Compared With No TKA(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Overall Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No TKA</td>
<td>37100</td>
<td>6.822</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TKA</td>
<td>57900</td>
<td>7.957</td>
<td>18 300</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stratified by Risk(^e) of Perioperative Comorbidities</th>
<th>Cost</th>
<th>QALYs, No.</th>
<th>ICER Compared With Next Least Expensive Strategy(^d)</th>
<th>ICER Compared With No TKA(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-risk population</td>
<td></td>
<td>Overall Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No TKA</td>
<td>25800</td>
<td>8.716</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TKA</td>
<td>44000</td>
<td>10.589</td>
<td>9700</td>
<td>NA</td>
</tr>
<tr>
<td>Medium-risk population</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No TKA</td>
<td>19800</td>
<td>6.574</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TKA</td>
<td>39900</td>
<td>7.649</td>
<td>18 700</td>
<td>NA</td>
</tr>
<tr>
<td>High-risk population</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No TKA</td>
<td>86800</td>
<td>5.713</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TKA</td>
<td>11500</td>
<td>6.594</td>
<td>28 100</td>
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</tbody>
</table>
Effect of delay in TKR and of treatment costs on cost effectiveness


Quality-adjusted life expectancy vs. Cost of treatment strategy (2006 US $)

TKA without delay
TKA with 1-10 years delay
No TKA

Cost of treatment strategy (2006 US $)

Quality-adjusted life expectancy

$35,000 $40,000 $45,000 $50,000 $55,000 $60,000
Sensitivity analysis of potentially important model parameters for the cost-effectiveness of TKA

To quantify the burden of knee OA and obesity in terms of quality-adjusted life years lost and to determine the health benefits of reducing obesity prevalence to levels observed a decade ago.
Excess of quality-adjusted life-years lost owing to obesity and knee osteoarthritis, as a ratio relative to population size

Per-person quality-adjusted life-years lost owing to obesity and knee osteoarthritis


Table 3. Per-Person Quality-Adjusted Life-Years Lost Owing to Obesity and Knee Osteoarthritis in the U.S. Population Aged 50 to 84 Years

<table>
<thead>
<tr>
<th>Race and Sex</th>
<th>Total Per-Person Quality-Adjusted Life-Years Lost</th>
<th>Attribution of a Single Condition to Total Quality-Adjusted Life-Years Lost in Persons With Both Obesity and Knee Osteoarthritis*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Osteoarthritis-Free and Obese</td>
<td>Knee Osteoarthritis and Nonobese</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>2.611</td>
<td>1.967</td>
</tr>
<tr>
<td>Men</td>
<td>2.540</td>
<td>1.920</td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>2.656</td>
<td>2.012</td>
</tr>
<tr>
<td>Men</td>
<td>2.316</td>
<td>2.041</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>2.533</td>
<td>1.838</td>
</tr>
<tr>
<td>Men</td>
<td>2.325</td>
<td>1.824</td>
</tr>
<tr>
<td>Population average</td>
<td>2.461</td>
<td>1.857</td>
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</tbody>
</table>
To predict the burden of symptomatic knee OA in the elderly US population over 10 years
Percent of the surviving baseline population with symptomatic advanced or end-stage knee OA at 10 years with varying estimates of OA incidence and progression


* The base case uses values reported by Cooper et al. in Arthritis Rheum 2000, the ‘less conservative’ case uses values from the Johnston County Osteoarthritis Project (Jordan, J. Rheumatol 2007), and the ‘more conservative case’ uses data from the Framingham Osteoarthritis Study (Felson, Arthritis Rheum 1995)
10-year projected burden of symptomatic advanced and end-stage knee OA in the U.S. population 60-64 years old

Medical Device Innovation — Is “Better” Good Enough?


To forecast clinical outcomes from “innovative” total knee implants compared with existing implants
Cumulative risk of revision surgery 20 years after total knee replacement: comparing a standard implant with implants that decrease long-term failure rates

To examine whether increases in TKR utilization in the U.S. can be explained by population growth and increasing obesity prevalence
Changes in TKR utilization by age group, 1999-2008

To estimate the incidence and lifetime risk of symptomatic knee OA, and to predict the age at diagnosis of knee OA based on self-reports in the US population
Estimated prevalence of diagnosed symptomatic knee OA by age in the US

Estimated cumulative incidence of diagnoses symptomatic knee OA from age 25 years in the US population, stratified by sex and obesity status

To quantify the burden of TKR in the U.S.
Estimated prevalence of total knee replacement in the U.S. by age and sex

Estimated number of adults in the U.S. living with total knee replacement by age and sex

To analyze the costs and benefits associated with the use of innovative TKA implants.
Proportion of population alive with original implant after standard total knee arthroplasty by age and comorbidity


% With Primary TKA  % Failed Primary TKA, but Pre-Revision  % Revised  % Dead

Years after primary TKA (by age and comorbidity cohort)
To develop a framework in which new DMOADs can be pre-evaluated before they enter widespread use.
Threshold efficacy, cost, and life expectancy associated with DMOADs treatment

To evaluate the potential value of pharmacologic prophylaxis for the prevention of symptomatic knee OA in populations that vary in risk for developing OA
Incremental cost-effectiveness ratios of DMOADs as preventative treatment in an obese cohort with history of knee injury

Incremental cost-effectiveness ratios of DMOADs as preventative treatment in a non-obese cohort with history of knee injury


<table>
<thead>
<tr>
<th>Prophylaxis Annual Cost: $300</th>
<th>Prophylaxis Annual Cost: $1,000</th>
<th>Prophylaxis Annual Cost: $2,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICER Cost/QALY</td>
<td>ICER Cost/QALY</td>
</tr>
<tr>
<td>Start Age 30</td>
<td>Efficacy</td>
<td>Late Failure</td>
</tr>
<tr>
<td>ICER</td>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>30%</td>
<td></td>
<td></td>
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<tr>
<td>40%</td>
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<tr>
<td>50%</td>
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<tr>
<td>60%</td>
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<tr>
<td>70%</td>
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<tr>
<td></td>
<td>ICER Cost/QALY</td>
<td>ICER Cost/QALY</td>
</tr>
<tr>
<td>Start Age 40</td>
<td>Efficacy</td>
<td>Late Failure</td>
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<tr>
<td>ICER</td>
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<td>1%</td>
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<td>30%</td>
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<td></td>
<td>ICER Cost/QALY</td>
<td>ICER Cost/QALY</td>
</tr>
<tr>
<td>Start Age 50</td>
<td>Efficacy</td>
<td>Late Failure</td>
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<td>ICER</td>
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<td>30%</td>
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<td>ICER Cost/QALY</td>
<td>ICER Cost/QALY</td>
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<tr>
<td>Start Age 60</td>
<td>Efficacy</td>
<td>Late Failure</td>
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<tr>
<td>70%</td>
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</table>

Key

- Less effective than Standard Care
- ICER > $150,000/QALY
- ICER = $100,000 to $150,000/QALY
- ICER = $50,000 to $100,000/QALY
- ICER = $25,000 to $50,000/QALY
- ICER < $25,000/QALY

Lifetime medical costs of knee osteoarthritis management in the United States: Impact of extending indications for total knee arthroplasty

Losina E, Paltiel AD, Weinstein AM, Yelin, E, Hunter DJ, Chen SP, Klara K, Suter LG, Solomon DH, Burbine SA, Walensky RP, Katz JN

(Accepted Article)

To estimate the incidence and lifetime risk of symptomatic knee OA, and to predict the age at diagnosis of knee OA in the US population
Utilization and duration of knee OA treatments under guideline-concordant care

Utilization and duration of knee OA treatments under guideline-concordant care

Sample of Ongoing Projects

- Estimating lifetime risk of OA and need for TKA after ACL injury
- The value of alternative pain management strategies for high risk (multiple comorbidities) patients with knee OA
- Does Tanezumab have a place in the treatment of OA pain: premarket evaluation
- Raising awareness of knee OA with individualized prospective risk calculator

For inquiries regarding collaboration with the OAPol research team, please contact elosina@partners.org

Select OAPol References

- 2014:
  - Losina E et al. Pharmacologic regimens for knee osteoarthritis prevention: can they be cost-effective? *Osteoarthritis and Cartilage.* PMID 24487044

- 2013:
  - Losina E et al. Lifetime Risk and Age at Diagnosis of Symptomatic Knee Osteoarthritis in the US. *Arthritis Care & Research.* PMID 23203864
  - Losina E et al. Disease-modifying drugs for knee osteoarthritis: can they be cost-effective? *Osteoarthritis and Cartilage.* PMID 23380251
  - Losina E et al. Lifetime risk and age at diagnosis of symptomatic knee osteoarthritis in the US. *Arthritis Care and Research.* PMID 23203864
Select OAPol References

- **2012**

- **2011**

- **2009**