Total Knee Arthroplasty Predictive Model – Enabling Shared Decision Making

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Background

Knee osteoarthritis and other joint disorders cause significant chronic pain and disability. Treatment options include high-cost total knee arthroplasty (TKA), an elective procedure that may lead to complications. The U.S. prevalence of TKA has been estimated to be 1.5% in the total population, totaling 4.7 million people.[1] Over 680,000 TKAs were performed in 2014 and by 2030 this annual volume could increase to 1.3 million.[2,3]

Objective

To create a predictive model to identify high-risk individuals likely to undergo TKA in the next 3 months

Methods

Study Design: Development of a predictive model

Data Sources:

- Medical and pharmacy claims, prior authorization records, and enrollment records from Humana Inc., a multistate health and wellness company
- External vendors

Patient Selection Criteria:

- Medicare Advantage participants at high risk of knee surgery according to a set of trigger criteria (see following description)
- Continuous enrollment for 3 months after score date

Triggers Criteria:

- Identified in the 6 months prior to score date
- Cumulatively, captured ~75% of TKA events
- Based on a refined set of ICD9/10 diagnosis codes (Fig 2), procedure codes, and CPT codes, resulting in ~480,000 scored individuals per score date

Dependent Variable: TKA in the following 3 months

Predictor Variables: Selected from 14,000+ variables measured in the past 12 months from the score date

Modeling Methods:

- Fig 1 shows the main steps used in model development.
- For each score date, 50% of records were sampled for model development (70% of these records were used for training, 15% for testing, and 15% for validation).

Definitions

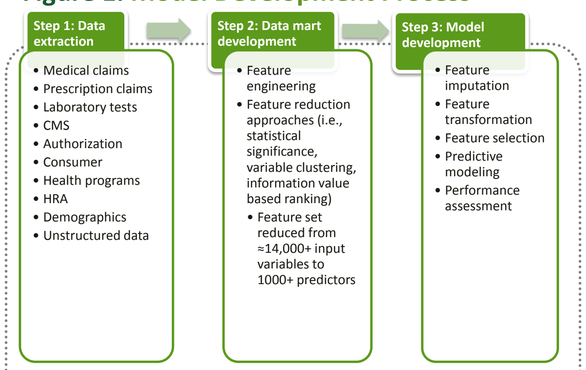
Capture rate:

Number of total TKA events within model-identified population/Total TKA events in study population

Overall lift:

TKA event rate within model-identified population/TKA event rate in study population

Figure 1. Model Development Process



CMS, Centers for Medicare & Medicaid Services; HRA, health risk assessment.

Results

Table 1. Population Characteristics

Characteristic	N (%)	3-Month TKA Rate, %
All unique patients	448,958	1.21
Gender		
Female	288,972 (64)	1.23
Male	159,986 (36)	1.19
Age group, y		
<65	110,258 (25)	0.86
≥65 to <75	202,649 (45)	1.43
≥75 to <85	103,316 (24)	1.37
≥85	29,735 (7)	0.51

Table 2. Representative significant predictors

• PMPM claim count, for musculoskeletal & connective tissue disorder*	• CMS risk-adjusted payment rate	• Ratio of diagnostic procedures claims over overall medical claims
• PMPM claim count for surgery related complications	• Number of knee surgery triggers	• Anti-inflammatory analgesics claims as % of all Rx claims*
• Past knee arthroplasty	• Presence of arthritis	• PMPM claim count for cardiovascular stress test
• Number of comorbid conditions	• Use of nonemergency transport	• Morbid obesity
	• Knee MRI with contrast	

*Past 3 months' claims; all other predictors, past 12 months.

Key: MRI, magnetic resonance imaging; PMPM, per member per mo; Rx, prescription

Figure 2. Triggers Defined by Knee-Related Diagnosis Codes (ICD-9/ICD-10)

- ***Most predictive of 3-mo TKA: arthroplasty associated with infections***
- ***Most prevalent: overweight, obesity and other hyperalimentation.***

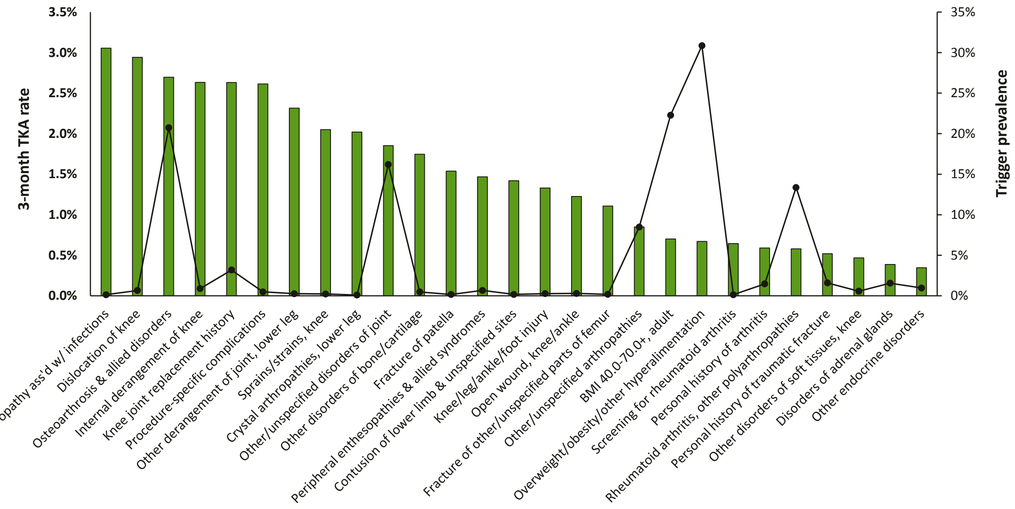


Figure 3. Trigger and Target Analysis

Compared with other combinations, a 3-mo target period and a 6-mo trigger period yielded the highest TKA capture rate.

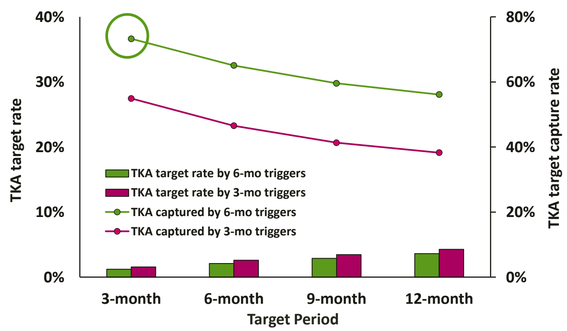


Figure 4. Model Performance: Cumulative TKA Capture Rate (next 3 months)

- ***Good TKA capture rates in the top score rankings (51.2% for the top 10%)***
- ***Analysis of area under the receiver operating characteristics curve (AUC-ROC) yielded an ROC index value of 0.851***

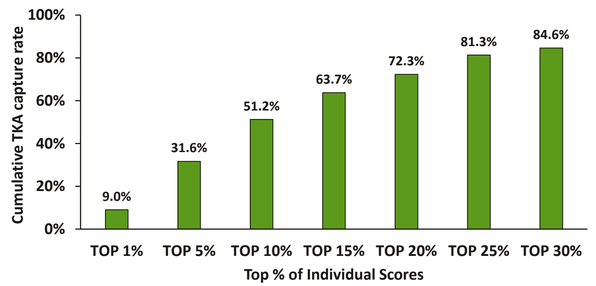
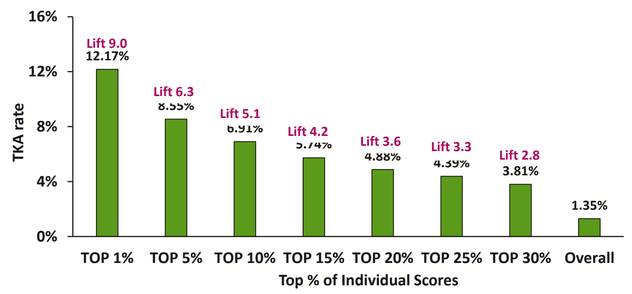


Figure 5. Model Performance: Overall Lift (next 3 months)

Good lift and percentage of correctly identified admit cases (lift 5.1 and 6.91 % correctly identified for the top 10% of scores).



Conclusions

- A trigger based predictive model identified individuals very likely to undergo elective TKA in 3 months.
- The strongest predictors included musculoskeletal disorder, past knee arthroplasty, comorbidities, osteoarthritis, use of antiinflammatory drugs, and morbid obesity.
- The information from this predictive model could facilitate physician engagement with patients for shared decision making.
- Use of the model could also facilitate patient education about post-surgery risks.

Limitations

- This study is subject to limitations inherent to all claims-based analyses (e.g., missing data, coding errors, fixed variables).
- Because we developed this model using a Medicare population, the results might not be generalizable to other populations.

References

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