Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) Complications Measure Submission to PQM: Figures and Tables

Table of Figures

Table of Tables

Figure 1. THA/TKA Complications: Logic Model

Figure 1 above shows the care processes that can influence complication risk by improving healthcare management and support. Targeted efforts such as enrolling patients in peri-operative care programs, providing patient education, delivery of high-quality, and timely delivery of care for THA/TKA patients can reduce complication rates post-surgery (Navathe et al, 2017; Cyriac et al., 2016; Borza et al., 2019). A multidisciplinary team-based approach with regular monitoring of patient symptoms can be beneficial in managing complex cases, improving communication among providers, and encouraging strategies to improve healthcare support (Nag et al., 2024; Lyman et al., 2020). Hospitals have the opportunity to improve overall complication rates after a THA/TKA procedure with a focus on patient-centered approaches. This relationship between these inputs, processes and outcomes is further discussed in Section 2.2 and Section 6.2.1.

References

Borza, T., Oerline, M.K., Skolarus, T.A., Norton, E.C., Dimick, J.B., Jacobs, B.L., Herrel, L.A., Ellimoottil, C., Hollingsworth, J.M., Ryan, A.M., Miller, D.C., Shahinian, V.B., Hollenbeck, B.K., (2019). Association Between Hospital Participation in Medicare Shared Savings Program Accountable Care Organizations and Readmission Following Major Surgery. Annals of Surgery 269(5), 873-878.

https://doi.org/10.1097/sla.0000000000002737

Cyriac, J., Garson, L., Schwarzkopf, R., Ahn, K., Rinehart, J., Vakharia, S., Cannesson, M., Kain, Z. (2016). Total Joint Replacement Perioperative Surgical Home Program: 2-Year Follow-Up. Anesthesia & Analgesia, 123(1), 51-62. https://doi.org/10.1213/ane.0000000000001308

Lyman, S., Hidaka, C., Fields, K., Islam, W., & Mayman, D. (2020). Monitoring patient recovery after THA or TKA using mobile technology. HSS Journal®, 16(2_suppl), 358-365.

Nag, D. S., Swain, A., Sahu, S., Sahoo, A., & Wadhwa, G. (2024). Multidisciplinary approach toward enhanced recovery after surgery for total knee arthroplasty improves outcomes. World Journal of Clinical Cases, 12(9), 1549.

Navathe, A.S., Troxel, A.B., Liao, J.M., Nan, N., Zhu, J., Zhon, W., Emanuel, E.J. (2017). Cost of Joint Replacement Using Bundled Payment Models. Journal of the American Medical Association Internal Medicine, 177(2), 214-222. https://doi.org/10.1001/jamainternmed.2016.8263

Table 1. THA/TKA Complications: Hospital Distribution of Risk-Standardized Complication Rates (RSCRs) (CY2022/2023 Data; January 1, 2022 - December 31, 2023)

Category	January 1, 2022 - December 31, 2023
Number of Hospitals	3,124
Mean (SD)	3.60 (0.65)
Range (min. – max.)	1.47 – 8.79
10th Percentile	2.91
25th Percentile	3.27
50th Percentile	3.50
75th Percentile	3.89
90th Percentile	4.42

Figure 2. THA/TKA Complications: Distribution of THA/TKA Risk-Standardized Complication Rates (n=3,124) (CY2022/2023 Data)

Table 2. THA/TKA Complications: Performance Scores by Decile (CY2022/2023 Data)

	Overall	Min	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Max
Mean Performance Score	3.60	1.47	2.57	3.06	3.26	3.39	3.47	3.53	3.68	3.89	4.19	4.96	8.79
N of Entities	3,124	1	312	312	313	312	313	312	313	312	313	312	1
N of Persons / Encounters / Episodes	272,164	1,072	106,482	30,500	17,776	13,147	8,589	9,316	24,331	18,378	18,134	25,511	112

Table 3. THA/TKA Complications: Dataset Descriptions

Dataset	Type of Testing	Description of Dataset
CY2022/CY2023:2-year Medicare Fee-for-Service (FFS) and Medicare Advantage (MA) dataset (January 1, 2022-December 31, 2023)	Reliability testing Validity testing Measure score distribution Risk variable frequencies and odds ratios.	Dates of Data: January 1, 2022-December 31, 2023 Total number of hospitals (with at least 1 admission): 3,124 Total number of admissions: 272,164 Male (n= 92,463), 33.9%

Dataset	Type of Testing	Description of Dataset
		Female (n= 179,701), 66.0%
		Dually eligible (DE) (n=23,065), 8.5%
		High ADI (n= 29,094), 10.7%
		Total number of hospitals with at least 25 admissions: 1,777 (57% of total)
		Number of patients within facilities with at least 25 admissions: 259,441 (95%)
CY2022: 1-year MA+FFS Dataset: 1-year Medicare FFS and Medicare Advantage dataset (January 1, 2022- December 31, 2022)	Risk variable selection Risk model performance Social risk factor testing	Dates of Data: January 1, 2022-December 31, 2022 Total number of hospitals (with at least 1 admission): 3,004 Total number of admissions: 143,526 Total number of hospitals with at least 25 admissions: 1,775 (59% of total) Number of patients within facilities with at least 25 admissions: 136,786 (95%)

Dataset	Type of Testing	Description of Dataset
CY2023: 1-year MA+FFS Dataset: 1-year Medicare FFS and Medicare Advantage Dataset (January 1, 2023-December 31, 2023)	Validation of model testing results	Dates of Data: January 1, 2023-December 31, 2023 Total number of hospitals (with at least 1 admission): 2,894 Total number of admissions: 128,638 Total number of hospitals with at least 25 admissions: 1,766 (61% of total) Number of patients within facilities with at least 25 admissions: 122,655 (95%)

Table 4. THA/TKA Complications: Accountable Entity-Level Reliability Testing Results (CY2022/2023 Data) (Hospitals with >=25 Admissions)

Minimum Case Volume	Min-Max	25th Percentile	50th Percentile	75th Percentile
>= 1 Admission (n=3,124)	0.046 – 0.997	0.324	0.605	0.813
>=25 Admissions (n= 1,777)	0.545 – 0.997	0.623	0.784	0.883

Table 5. THA/TKA Complications: Performance Scores by Decile (CY2022/2023 Data)

	Overall	Min	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Max
Reliability	0.561	0.046	0.064	0.181	0.323	0.441	0.558	0.655	0.738	0.810	0.876	0.945	0.997
Mean Performance Score	3.60	3.57	3.55	3.59	3.67	3.63	3.67	3.75	3.78	3.69	3.60	3.08	2.16
N of Entities	3,124	149	265	380	270	330	324	310	307	311	315	312	1
N of Persons / Encounters / Episodes	272,164	149	381	1,790	2,713	5,492	8,621	12,385	18,237	28,076	47,621	146,848	6,172

Table 6. THA/TKA Complications: List of Technical Expert Panel (TEP) Members

Name, Credentials, and Professional Role	Organizational Affiliation, City, State
Ann Borzecki, MD, MPH; *Attending Physician and Research Scientist*	• VA Bedford Healthcare System, Bedford, VA • Center for Healthcare Organization and Implementation Research, Bedford, MA
Sarah Brinkman, MBA, MA, CPHQ; *Quality Program Manager*	• Stratis Health, Minneapolis, MN
Michael Duan, MS; *Principal Data Scientist*	• Premier, Inc., Charlotte, NC
Richard Dutton, MD, MBA; *Anesthesiologist, Adjunct Professor, Chief Quality Officer*	• Baylor University Medical Center • Texas A&M University • US Anesthesia Partners, Dallas, TX
Ryan Merkow, MD, MS*; Surgical Oncologist, Health Services and Outcomes Researcher, Faculty Scholar*	• Northwestern University, Surgical Outcomes and Quality Improvement Center • American College of Surgeons, Division of Research and Optimal Patient Care, Chicago, IL
Matthias Cheung, RPh, PhD; Adjunct Professor of Pharmacy	• University of the Pacific, Thomas J. Long School of Pharmacy, Stockton, CA • Eversana Life Science Services, LLC, Chicago, IL
Sachin Shah, MD, MPH; *General Medicine and Health Administration Fellow*	• Massachusetts General Hospital • Harvard University, Cambridge, MA
Lynn Stillman, RN; *Program Manager Payment Innovation*	• Elevance Health (formerly Anthem Blue Cross/Blue Shield of New Hampshire), Bedford, NH
Mary Vaughan-Sarrazin, PhD; *Associate Professor, Department of Internal Medicine; Director, Quantitative Unit of Health Services and Clinical Research Core, Investigator*	• University of Iowa • Iowa City VA Medical Center, Iowa City, IA

Name, Credentials, and Professional Role	Organizational Affiliation, City, State
Thomas Webb, MBA, PhD candidate; *Associate Vice President of Quality Analytics*	• Rush University Medical Center, Chicago, IL
Bonnie Weiner, MD, MSEC, MBA; *Cardiologist, Professor of Medicine, Director Interventional Cardiology Research, Chief Medical Officer, Senior Medical Director*	• University of Massachusetts Medical School • Worcester Medical Center • Accreditation of Cardiovascular Excellence • Avania, Harvard, MA
Patient	• Virginia
Patient	• Illinois

Table 7. THA/TKA Complications: Risk-Standardized Complication Rates (RSCRs) Within Deciles of Admission Volume (CY2022/2023 Data)

Decile	Number of Hospitals	Range of Admissions within the Decile (Min-Max)	RSCR
1	265	1-2	3.55%
2	380	3-7	3.59%
3	270	8-12	3.67%
4	330	13-21	3.63%
5	324	22-32	3.67%
6	310	33-47	3.75%
7	307	48-71	3.78%
8	311	72-111	3.69%
9	315	112-205	3.60%
10	312	207-6,172	3.08%

Table 8. THA/TKA Complications: Risk Variable Frequencies, Odds Ratios (ORs) and 95% Confidence Intervals (CIs) (CY2022/2023 Data)

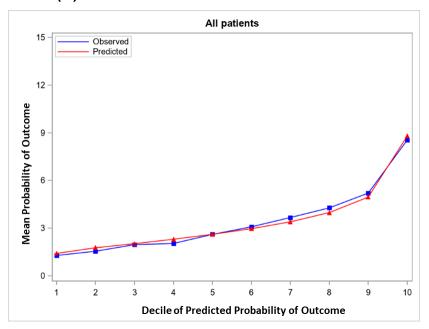| Variable	Description	Frequency (%)	OR (95% CI)
AGE	Age, mean (SD)	75.0 (6.1)	74.6 (6.1)
	ICD-10 codes during the index admission		
D631	Anemia in chronic kidney disease	1.3	1.52 (1.33, 1.73)
D638	Anemia in other chronic diseases classified elsewhere	0.6	1.91 (1.60, 2.27)
E7800	Pure hypercholesterolemia, unspecified	13.9	0.87 (0.81, 0.92)

Variable	Description	Frequency (%)	OR (95% CI)
E8342	Hypomagnesemia	0.7	1.47 (1.22, 1.77)
F0390	Unspecified dementia without behavioral disturbance	1.0	1.56 (1.34, 1.82)
I130	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease	2.7	1.57 (1.43, 1.72)
I255	Ischemic cardiomyopathy	0.6	1.63 (1.38, 1.93)
I2720	Pulmonary hypertension, unspecified	1.6	1.68 (1.50, 1.88)
I428	Other cardiomyopathies	0.6	1.24 (1.01, 1.52)
I4820	Chronic atrial fibrillation, unspecified	1.5	1.43 (1.26, 1.63)
I509	Heart failure, unspecified	2.1	0.75 (0.66, 0.85)
J439	Emphysema, unspecified	1.0	1.47 (1.26, 1.72)
N179	Acute kidney failure, unspecified	2.0	1.55 (1.40, 1.72)
Z6842	Body mass index [BMI] 45.0-49.9, adult	1.4	1.50 (1.30, 1.73)
Z803	Family history of malignant neoplasm of breast	0.8	0.62 (0.46, 0.83)
Z853	Personal history of malignant neoplasm of breast	4.9	0.96 (0.87, 1.06)
	ICD-10 codes in the 12 months prior to admission		
E785	Hyperlipidemia, unspecified	49.7	0.93 (0.89, 0.97)
F419	Anxiety disorder, unspecified	11.7	1.12 (1.05, 1.19)
I10	Essential (primary) hypertension	75.8	1.12 (1.06, 1.18)
L820	Inflamed seborrheic keratosis	7.7	0.88 (0.81, 0.96)
M9901	Segmental and somatic dysfunction of cervical region	3.4	0.84 (0.74, 0.95)
S0990XA	Unspecified injury of head, initial encounter	3.5	1.32 (1.21, 1.45)
Z79891	Long term (current) use of opiate analgesic	3.6	1.22 (1.11, 1.33)
	ICD-10 codes either during the index admission or 12 months prior to admission		
E669	Obesity, unspecified	27.2	1.10 (1.05, 1.16)
E871	Hypo-osmolality and hyponatremia	6.9	1.18 (1.10, 1.26)
F32A	Depression, unspecified	16.5	1.28 (1.21, 1.35)
I110	Hypertensive heart disease with heart failure	8.8	1.32 (1.24, 1.41)

Variable	Description	Frequency (%)	OR (95% CI)
I2510	Atherosclerotic heart disease of native coronary artery without angina pectoris	26.0	1.16 (1.10, 1.21)
I739	Peripheral vascular disease, unspecified	8.8	1.23 (1.15, 1.31)
J449	Chronic obstructive pulmonary disease, unspecified	12.8	1.27 (1.21, 1.35)
M1611	Unilateral primary osteoarthritis, right hip	25.4	0.93 (0.87,1.00)
M1612	Unilateral primary osteoarthritis, left hip	21.3	0.93 (0.86,0.99)
M1711	Unilateral primary osteoarthritis, right knee	45.9	0.98 (0.93, 1.03)
M1712	Unilateral primary osteoarthritis, left knee	42.6	0.96 (0.91, 1.01)
M1990	Unspecified osteoarthritis, unspecified site	16.2	1.08 (1.03, 1.14)
Z6841	Body mass index [BMI] 40.0 – 44.9, adult	7.9	1.26 (1.17, 1.35)
Z794	Long term (current) use of insulin	6.9	1.21 (1.12, 1.30)
Z9181	History of falling	5.0	1.16 (1.07, 1.25)
Other risk variables			
MCCFI	Multiple Chronic Conditions Frailty Index	22.8	1.15 (1.09, 1.20)
PROC_THA	Elective THA procedure	36.9	1.79 (1.64, 1.95)
TWOPROC	Number of procedures (two vs. one)	2.1	1.26 (1.08, 1.47)
HX_COVID	History of COVID-19	15.5	0.98 (0.93, 1.04)
MA	MA (versus FFS)	37.4	1.04 (0.99, 1.08)

Table 9. THA/TKA Complications: Model Performance (Predictive Ability, C-Statistics, Overfitting) (CY2022 Data)

Value	Derivation	Validation
Predictive Ability, % (Lowest Decile – Highest Decile)	1.18% – 8.65%	1.34% – 8.36%
C-statistic	0.671	0.663
Overfitting (γ_0, γ_1)	0.00,1.00	-0.240, 0.920

Figure 3. THA/TKA Complications: Calibration Plot (A) CY2022 and (B) CY2023

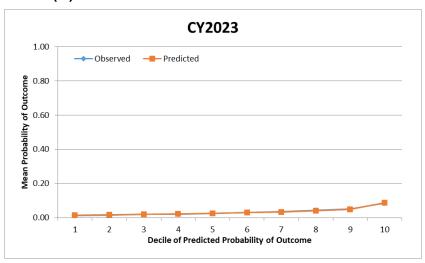**(A) CY2022**

(B) CY2023

Table 10. THA/TKA Complications: Variation in Prevalence of Social Risk Factors Across Measured Entities (CY2022 Data) (Hospitals with >=25 admissions; n=1,270)
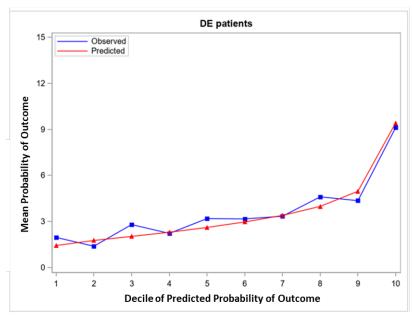
Social Risk Factor	Median Prevalence (%) (25th Percentile-75th Percentile)
Dual Eligibility (DE)	5.13 (2.48 – 10.00)
High Area Deprivation Index (ADI) (>=85)	6.78 (1.22 – 18.75)

Table 11. THA/TKA Complications: Comparison of Observed Complication Rate (%) for Patients with and without Social Risk Factors (CY2022 Data)

Social Risk Factor	Mean Observed Mortality Rate (%)
Dual Eligibility (DE)	4.0
Non-DE	3.4
High Area Deprivation Index (ADI) (>=85)	4.0
Low ADI (<85)	3.3

Figure 4. THA/TKA Complications: Calibration Plot for Patients (A) with the Dual Eligibility (DE) Variable and (B) without the DE Variable (CY2022 Data)

A) Dually Eligible Patients

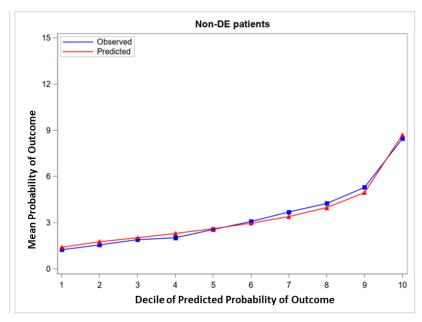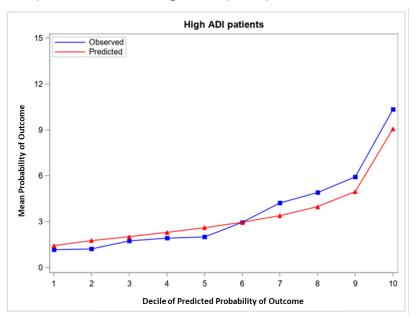

B) Non-Dually Eligible Patients

Figure 5. THA/TKA Complications: Calibration Plot for Patients (A) with the High Area Deprivation Index (ADI) Variable and (B) without the High ADI Variable (CY2022 Data)

A) Patients with High ADI (>=85)
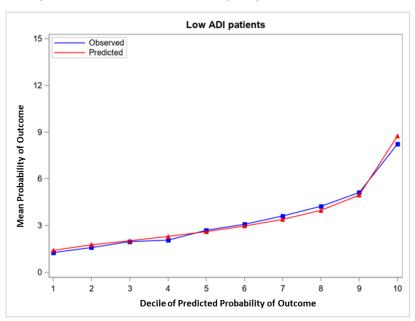

B) Patients with Low ADI (<85)

Table 12. THA/TKA Complications: Differences in Measure Scores, and Correlation Between Measure Scores, for Measure Scores Calculated with and without Social Risk Factors (Dual Eligibility [DE] and High Area Deprivation Index [ADI]) (CY2022 Data)
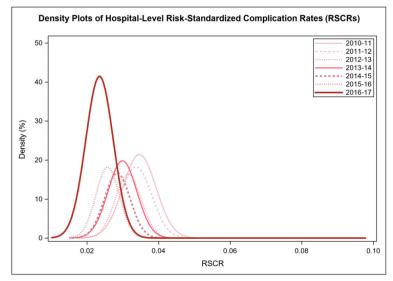
Social Risk Factor	Median Difference in Measure scores (%)	IQR (25th percentile-75th percentile)	Pearson Correlation Coefficient
DE	0.0000	-0.0000 – 0.0000	1.000
High ADI (>=85)	0.0002	0.0000 – 0.0004	0.989

Table 13. THA/TKA Complications: Distribution of Hospital Risk-Standardized Complication Rates (RSCRs) Over Different Time Periods*

	04/2010-03/2013	04/2014-03/2017	04/2016-03/2019	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Number of Hospitals	3,506	3,459	3,418	3,445
Mean (SD)	3.3 (0.6)	2.6 (0.5)	2.5 (0.5)	2.4 (0.4)
Range	1.5 – 6.5	1.2 – 5.4	1.2 – 10.6	1.2 – 5.6
25th Percentile	3.0	2.3	2.2	2.2
50th Percentile	3.3	2.5	2.4	2.4
75th Percentile	3.6	2.8	2.7	2.6

*We do not include more recent data for comparison because in 2021 the measure went through a specification update that added complication codes to the outcome resulting in an increase in the outcome rate.

Figure 6. THA/TKA Complications: Improvement in Hospital-level Risk-Standardized Complication Rates (RSCRs) Over Time

Fig. 1-A

Density plots showing hospital-level RSCRs for each time period studied. Each line represents a different year of data (i.e., seven 12-month periods from April 2010 to March 2011 through April 2016 to March 2017). Density plots show the estimate of an unobservable underlying probability density function and in this case can be interpreted similarly to histograms. The vertical axes display the density in percent of hospitals with a given RSCR noted on the horizontal axis; a value of 0.04 indicates an RSCR of 4%. Curves farther to the left represent higher RSCRs (or worse outcomes); curves farther to the right represent lower RSCRs (or better outcomes). Further, the wider the curve, the more variation in hospital-level complication rates after accounting for all of the comorbidities in the risk model. Therefore, the narrower the curve, the less hospital performance variation that cannot be attributed to patient-level risk factors.