2024 Procedure-Specific Complication Measure Updates and Specifications Report

Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) — Version 13.0

Submitted By:

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Prepared For:

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) procedure-specific complication measure that is publicly reported here on Medicare.gov. The measure is used to calculate hospital-level risk-standardized complication rates (RSCRs) following an elective primary total hip arthroplasty (THA) and/or total knee arthroplasty (TKA) procedure. This report serves as a single source of information about this measure for a wide range of readers. Reports describing other outcome measures can be found here on *QualityNet*.

Specifications that define cohort inclusions and exclusions, risk-adjustment variables, and the complications described in this report are detailed in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet.*

This report includes:

- **Section 2 — An overview of the THA/TKA complication measure:**
  - Background
  - Cohort inclusions and exclusions
    - Included and excluded hospitalizations
    - How transferred patients are handled
  - Outcome
  - What is considered a complication
  - Risk-adjustment variables
  - Data sources
  - Complication rate calculation
  - Categorization of hospitals' performance scores

- **Section 3 — 2024 measure updates**

- **Section 4 — 2024 measure results**

- **Section 5 — Glossary**

The appendices include:

- Appendix A: Statistical approach to calculating RSCRs
- Appendix B: Data quality assurance (QA)
- Appendix C: Annual updates to the measure since measure development
- Appendix D: Cohort inclusion/exclusion criteria and outcome criteria

The original measure methodology report and prior updates and specifications reports are available in the "Methodology" section and "Archived Measure Methodology" section (under "Resources") on the complication measure page here on *QualityNet*.

For a list of the supporting resource files for the 2024 THA/TKA complication measure that are available on *QualityNet* (including hyperlinks to the resources), or to review the 2024 Frequently Asked Questions document, refer to the "Resources" section on the complication measure page here on *QualityNet.*

If you have questions about the information in this report or the complementary supplemental file, please submit your inquiry using the QualityNet Q&A tool: https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program: Inpatient Claims-Based Measures > Complication > Understanding Measure Methodology. **Do *NOT* submit patient-identifiable information (for example, date of birth, Social Security number, Medicare Beneficiary Identifier, and encounter dates such as admission dates, discharge dates, procedure dates, and emergency department [ED]/observation dates) into this tool.**

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1. Background on the Complication Measure

In December 2013, CMS began publicly reporting RSCRs for THA/TKA for the nation's non-federal short-term acute care hospitals (including Indian Health Service hospitals) and critical access hospitals (CAHs).

In 2021, CMS and the VHA collaborated to include admissions in Veterans Administration (VA) hospitals in the measure.

Results for this measure are posted and updated annually here on Medicare.gov.

CMS contracted with the Yale New Haven Health Services Corporation — Center for Outcomes Research and Evaluation (YNHHSC/CORE) to update the THA/TKA complication measure for 2024 public reporting through a process of measure reevaluation.

2.2. Overview of Measure Methodology

The 2024 risk-adjusted complication measure uses specifications from the original measure methodology report posted here on *QualityNet*, with refinements to the measure as listed in Appendix C and described in the prior measure updates and specifications reports posted here on *QualityNet*. An overview of the methodology is presented in this section.

For more information on the CMS programs that use the measure for fiscal year (FY) 2025, as well as its use in future FYs, please refer to the FY 2024 Inpatient Prospective Payment System (IPPS) Final Rule posted here on the CMS website.

2.2.1 Cohort

Index Admissions Included in the Measure

An index admission is the hospitalization to which the complication outcome is attributed and includes admissions for patients:

- having a qualifying elective primary THA/TKA procedure during the index admission;
- aged 65 or over; and
- enrolled in Medicare Fee-For-Service (FFS) Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations).

Elective primary THA/TKA procedures are defined as those THA/TKA procedures *without* the following:

- fracture of the pelvis or lower limbs coded in the principal or secondary discharge diagnosis fields on the index admission claim (Note: Periprosthetic fractures must be

additionally coded as present on admission [POA] in order to disqualify a THA/TKA from cohort inclusion, unless exempt from POA reporting.)
- a concurrent partial hip or knee arthroplasty procedure
- a concurrent revision, resurfacing, or implanted device/prosthesis removal procedure
- mechanical complication coded in the principal discharge diagnosis field on the index admission claim
- malignant neoplasm of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or a disseminated malignant neoplasm coded in the principal discharge diagnosis field on the index admission claim
- transfer from another acute care facility for the THA/TKA

The measure uses International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM and ICD-10-PCS) codes on claims to define a THA/TKA procedure and to identify a THA/TKA procedure as non-elective or non-primary (and disqualify the admission from cohort inclusion). These codes are listed in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet*.

Index Admissions Excluded from the Measure

The THA/TKA complication measure excludes index admissions for patients:

- without enrollment in Medicare FFS for at least 90 days following the start of the index admission (not applicable to VA hospitalizations);
- discharged against medical advice;
- with more than two THA/TKA procedure codes during the index admission; or
- with a principal diagnosis code of COVID-19 (ICD-10-CM code U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim. These code specifications are outlined in the 2024 THA/TKA Complication Measure Code Specifications file here on *QualityNet*.

Note that patients who do not have a full 90 days of enrollment in Medicare FFS following the start of the index admission due to death are eligible for inclusion in the cohort. Thus, if a patient died within 90 days of the start of the index admission, the case would be included in the cohort, assuming they met inclusion/exclusion criteria, and if the death occurred within 30 days from the start of the index admission, it would be captured in the outcome.

For patients with more than one eligible admission for a THA/TKA procedure in one of the following three time periods, only one index admission is randomly selected for inclusion in the cohort, and additional admissions within that time period are excluded:

- July 1, 2020 – March 31, 2021
- April 1, 2021 – March 31, 2022
- April 1, 2022 – March 31, 2023

For details on how the measure handles cases where two index admissions occur during the transition between two time periods in the measurement period and both are randomly selected for inclusion, please refer to Appendix D.1.

As a part of data processing prior to the measure calculation, records are removed for non-short-term acute care facilities, such as psychiatric facilities, rehabilitation facilities, or long-term care hospitals. Additional data cleaning steps for non-VA hospitalizations include removing claims with stays longer than one year, claims with overlapping dates, claims for patients not listed in the Medicare Enrollment Database, and records with ineligible provider IDs.

The percentage of admissions excluded based on each criterion is shown in Section 4 in Figure 4.2.1.1.

Patients Transferred Between Hospitals

The measure considers multiple hospitalizations that result from hospital-to-hospital transfers as a single acute episode of care. Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. To qualify as a transfer, the second inpatient admission must occur on the same day or the next calendar day following discharge from the first inpatient admission at a different short-term acute care hospital. Cases that meet this criterion are considered transfers regardless of whether the first institution indicates intent to transfer the patient in the discharge disposition code.

The THA/TKA complication measure excludes index admissions for patients who are transferred to the index hospital from another hospital, as these admissions likely do not represent elective THA/TKA procedures. However, index admissions for patients who were admitted for the THA/TKA and subsequently transferred to another acute care facility are included in the measure, as transfer following THA/TKA is most likely due to a complication of care of the THA/TKA procedure or the perioperative care the patient received. In a series of one or more transfers, the complication outcome is always assigned to the hospital that performed the first (“index”) THA/TKA procedure, even if it is not the discharging hospital. For example, if a patient is admitted to Hospital A and undergoes a THA/TKA procedure, and then is transferred to Hospital B, a complication following the Hospital B admission would be captured in Hospital A’s complication outcome (if it falls within the defined time frame for that complication).

2.2.2 Outcome

The measure assesses a dichotomous yes or no outcome regarding whether each admitted patient experiences one or more of the complications defined below.

THA/TKA Complications and Time Frame

The measure defines a "complication" as:

- acute myocardial infarction (AMI) during the index admission or a subsequent inpatient admission that occurs within seven days from the start of the index admission;
- pneumonia or other acute respiratory complication during the index admission or a subsequent inpatient admission that occurs within seven days from the start of the index admission;
- sepsis/septicemia/shock during the index admission or a subsequent inpatient admission that occurs within seven days from the start of the index admission;
- surgical site bleeding or other surgical site complication during the index admission or a subsequent inpatient admission within 30 days from the start of the index admission;
- pulmonary embolism during the index admission or a subsequent inpatient admission within 30 days from the start of the index admission;
- death during the index admission or within 30 days from the start of the index admission;
- mechanical complication during the index admission or a subsequent inpatient admission that occurs within 90 days from the start of the index admission; or
- periprosthetic joint infection/wound infection or other wound complication during the index admission or a subsequent inpatient admission that occurs within 90 days from the start of the index admission.

Note: Subsequent inpatient admissions with a principal diagnosis code of COVID-19 (U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the claim within the seven/30-day time frames are not eligible for use by the measure (and are excluded) in determining whether the following complications occurred:

- AMI
- pneumonia or other acute respiratory complication
- sepsis/septicemia/shock
- pulmonary embolism

Examples of how the measure assesses the complication outcome:

- Patient is admitted for THA/TKA on January 1, discharged on January 6, and hospitalization for surgical site bleeding occurs on February 5. The measure will not capture the surgical site bleeding as a complication (as it falls outside of the 30-day time window).
- Patient is admitted for THA/TKA on May 15, experiences an AMI on May 25, and is discharged on May 27. The measure will capture the AMI as a complication because it occurred during the index admission (regardless of the seven-day time window).
- Patient is admitted for THA/TKA on September 9, discharged on September 11, and a hospitalization for sepsis with a secondary diagnosis of COVID-19 POA occurs on September 14. The measure will not capture this sepsis as a complication because readmission claims with a secondary diagnosis code of COVID-19 POA are not

eligible for use in determining the sepsis/septicemia/shock complication. Note, an eligible sepsis code as a secondary diagnosis on the **index** admission claim would be captured as a complication.

Note that the measure captures complications that occur during the index admission but after the defined time window (such as in the AMI complication case bulleted above). Experts agree such complications likely represent the quality of care provided during the index admission.

The complications other than death are identified using index admission claims as well as claims for subsequent hospitalizations at short-term acute care hospitals and CAHs (with exceptions for the four complications, as described above). Death, is captured through the Medicare Enrollment Database. Moreover, complications coded as POA on the index admission claim are not captured in the outcome, to prevent classifying a condition as a complication of care of the THA/TKA procedure if it was present at the time the patient was admitted as an inpatient. In the case of VA beneficiaries, VA administrative data are also used to identify complications (during the index admission or in subsequent hospitalizations at VA hospitals), including death.

The ICD-10 codes used to define the complications are listed in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet*. Additional coding requirements, such as POA requirements for certain complications on readmission claims and principal/secondary diagnosis positioning, are provided in this file. The COVID-19 adjustments made to the use of readmission claims for the four complications (as described above) are also detailed in the 2024 supplemental file.

The complication-specific follow-up periods are based on the input of clinical experts informed by analyses of 90-day trends in complication rates post-procedure as described in the original measure methodology report posted here on *QualityNet*:

- The follow-up period for AMI, pneumonia and other acute respiratory complications, and sepsis/septicemia/shock is seven days from the start of the index admission because these conditions are more likely to be attributable to the procedure if they occur within the first week after the procedure. Additionally, analyses indicated a sharp decrease in the rate of these complications after seven days. The occurrence of these complications during the index admission, even if it is beyond seven days, is also most likely due to the surgical procedure and therefore included in the measure outcome.
- Death, surgical site bleeding and other surgical site complications, and pulmonary embolism are followed for 30 days from the start of the index admission because clinical experts agree these complications are still likely attributable to the hospital performing the procedure during this period and rates for these complications remained elevated until roughly 30 days post-admission.
- The measure follow-up period is 90 days from the start of the index admission for mechanical complications and periprosthetic joint infection/wound infection and other wound complications. Experts agree that mechanical complications and periprosthetic joint infection/wound infections due to the index THA/TKA occur up to 90 days following THA/TKA.

In determining whether a complication other than death occurred during an eligible subsequent admission within the complication-specific follow-up periods described above, the measure uses the claim "FROM" date from the subsequent admission claim, which is the date that admission started (that is, the date the patient first received care at that hospital within three days of that admission). Thus, in the case where (a) a patient began their subsequent admission with an ED visit, observation stay, or care received in another outpatient location within the same facility (for example, outpatient diagnostic imaging), (b) the patient was admitted as an inpatient to that hospital within three days of that outpatient encounter, and (c) the care was combined into one claim, the date the outpatient care started would be used to determine the timing of the subsequent admission.

2.2.3 Risk-Adjustment Variables

To account for differences in case mix among hospitals, the measure includes an adjustment for factors such as age, comorbid diseases, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending up to 12 months prior to the index admission, and all claims data for the index admission itself. Risk-adjustment variables are also obtained from VA administrative data in the case of VA beneficiaries. Inpatient, outpatient, and physician claims/VA data from January 1, 2020 through June 30, 2020 encounters are not used due to the declared COVID-19 public health emergency (PHE), as discussed in Section 3.2.2; as a result, the pre-index admission time frame would be less than 12 months for some patients, depending on their index admission date.

The measure's adjustment for case mix differences among hospitals is based on the clinical status of the patient at the time of the index admission. Accordingly, only comorbidities that convey information about the patient at the time of the index admission, or any time within the preceding 12 months (or less), are included in risk adjustment. Complications that arise during the course of the hospitalization are not used in risk adjustment.

The process for determining patient comorbidities present at the time of the index admission from the index admission claim/VA data uses a POA algorithm. In brief, a secondary diagnosis ICD-10-CM code on the index admission is used in risk adjustment if **one** of the following is true:

1. The POA indicator for the secondary diagnosis code = 'Y' on the index admission.
2. The secondary diagnosis code is classified as a POA-exempt code that is considered "always POA" (as designated by our clinical experts).
3. If the index claim/VA data is void of POA coding (that is, no reported POA indicator values for any of the secondary diagnoses), then the secondary diagnosis is used in risk adjustment if it is NOT mapped to a Condition Category (CC) that is included in the potential complications list.

The POA algorithm applies only in the case of secondary diagnosis codes on the index admission that are assigned to a CC used in risk adjustment of a measure. ICD-10 code-defined risk variables, such as 'Post traumatic osteoarthritis,' do not use the algorithm.

Refer to the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet* for the list of CC-defined risk-adjustment variables and the specifications for the ICD-10 code-defined risk-adjustment variables. The list of potential complications referred to in Step 3 of the algorithm are also included in the 2024 supplemental file.

CC mappings to ICD-10-CM codes, as well as the "POA-Exempt Codes Considered Always POA for 2024" table (referred to in Step 2 of the algorithm), are available here on *QualityNet.*

The measure does not include an adjustment for social drivers of health because the association between social drivers of health and health outcomes can be due, in part, to differences in the quality of health care that these groups of patients receive. The intent is for the measure to adjust for patient demographic and clinical characteristics while illuminating important quality differences. The CMS consensus-based entity (CBE) re-endorsed the measure without adjustment for patient-level social drivers of health in the last endorsement maintenance submission prior to 2024.

2.2.4 Data Sources

The data sources for these analyses are Medicare administrative claims, VA administrative data, and enrollment information for patients having hospitalizations with discharge dates between July 1, 2020 and March 31, 2023. The period for public reporting of this measure differs from the complementary THA/TKA readmission measure, which includes admissions for elective THA/TKA procedures between July 1, 2020 and June 30, 2023, due to the longer period of outcome assessment required to adequately capture complications up to 90 days following admission.

The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims and associated inpatient and outpatient VA administrative data from up to 12 months prior to the index admission (as discussed in Section 2.2.3) as well as inpatient Medicare and VA administrative data for the 90 days subsequent to the index admission for patients having hospitalizations with discharge dates in aforementioned time period. Refer to the original methodology report posted here on *QualityNet* for further descriptions of these data sources.

2.2.5 Measure Calculation

The hospital-level all-cause RSCR is estimated using a hierarchical logistic regression model. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals.[1] At the patient level, it models the log-odds of hospital admission with a complication within 90 days of the start of the index admission using age, sex, selected clinical

covariates, and a hospital-specific effect. At the hospital level, the approach models the hospital-specific effects as arising from a normal distribution. The hospital effect represents the underlying risk of a complication at the hospital, after accounting for patient risk. The hospital-specific effects are given a distribution to account for the clustering (non-independence) of patients within the same hospital.[1] If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects should be identical across all hospitals.

The RSCR is calculated as the ratio of the number of "predicted" admissions with a complication to the number of "expected" admissions with a complication at a given hospital, multiplied by the national observed complication rate, as illustrated in Figure 2.2.5.1.

Figure 2.2.5.1 — Equation for RSCR Calculation

$$\text{RSCR} = \frac{\text{Predicted Admissions with a Complication}}{\text{Expected Admissions with a Complication}} \times \text{National Observed Complication Rate}$$

For each hospital, the numerator of the ratio is the number of admissions with a complication within 90 days predicted based on the hospital's performance with its observed case mix; the denominator is the number of admissions with a complication expected based on the nation's performance with that hospital's case mix. This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows a particular hospital's performance, given its case mix, to be compared to an average hospital's performance with the same case mix. Thus, a lower ratio indicates lower-than-expected complication rates or better quality, while a higher ratio indicates higher-than-expected complication rates or worse quality.

The "predicted" number of admissions with a complication (the numerator) is calculated by using the coefficients estimated by regressing the risk factors (Table 4.2.3.1) and the hospital-specific effect on the risk of having an admission with a complication. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are transformed using the inverse-link-function and summed over all patients attributed to a hospital to calculate a predicted value. The "expected" number of admissions with a complication (the denominator) is obtained in the same manner, except that a common effect using all hospitals in our sample is added in place of the hospital-specific effect. These results are also transformed using the inverse-link-function and summed over all patients attributed to a hospital to calculate an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the data in each time period.

Multiplying the predicted over expected ratio by the national observed complication rate transforms the ratio into a rate that can be compared to the national observed complication rate. The hierarchical logistic regression model is described fully in Appendix A and in the original methodology report posted here on *QualityNet*.

2.2.6 Categorizing Hospital Performance

To categorize hospital performance, CMS estimates each hospital's RSCR and the corresponding 95% interval estimate. CMS assigns hospitals to a performance category by comparing each hospital's RSCR interval estimate to the national observed complication rate. Comparative performance for hospitals with 25 or more eligible cases is classified as follows:

- "Better than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed complication rate
- "No Different than the National Rate" if the 95% interval estimate surrounding the hospital's rate includes the national observed complication rate
- "Worse than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed complication rate

If a hospital has fewer than 25 eligible cases for a measure, CMS assigns the hospital to a separate category, "Number of Cases Too Small." This category is used when the number of cases is too small (fewer than 25) to reliably conclude how the hospital is performing. If a hospital has fewer than 25 eligible cases, the hospital's complication rates and interval estimates will not be publicly reported for the measure.

Section 4.2.5 describes the distribution of hospitals by performance category in the U.S. for this reporting period.

3. UPDATES TO MEASURE FOR 2024 PUBLIC REPORTING

3.1. Rationale for Measure Updates

Annual measure reevaluation ensures that the risk-standardized complication model is continually assessed and remains valid, given possible changes in clinical practice and coding standards over time. Modifications made to the measure cohort, risk model, and outcomes are informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, empirical analyses, and assessment of coding trends that reveal shifts in clinical practice or billing patterns. Input is solicited from a workgroup composed of up to 20 clinical and measure experts, inclusive of internal and external consultants and subcontractors. As this report describes, for 2024 public reporting, we made the following modifications to the measure:

- Updated the ICD-10 code-based specifications used in the measure. Specifically, we:
  - incorporated ICD-10-CM/PCS code changes into the cohort definition, complication definitions, and risk model that occurred in the following releases:
    - October 1, 2022 (FY 2023); and
    - April 1, 2023.
  - applied a modified version of the FY 2023 V24 CMS-Hierarchical Condition Category (HCC) crosswalk that is maintained by RTI International to the risk model.

As a part of annual reevaluation, we also undertook the following activities:

- Monitored code frequencies to identify any warranted specification changes due to possible changes in coding practices and patterns;
- Reviewed potentially clinically relevant codes that "neighbor" existing codes used in the measure to identify any warranted specification changes;
- Reviewed select pre-existing ICD-10 code-based specifications with our workgroup to confirm the appropriateness of specifications unaffected by the updates;
- Updated the measure's SAS analytic package (SAS pack) and documentation;
- Evaluated and validated model performance for the 33 months combined (July 1, 2020 through March 31, 2023); and
- Evaluated the stability of the risk-adjustment model over the 33-month measurement period by examining the model variable frequencies, model coefficients, and the performance of the risk-adjustment model in each time period:
  - July 1, 2020 – March 31, 2021
  - April 1, 2021 – March 31, 2022
  - April 1, 2022 – March 31, 2023

3.2. Detailed Discussion of Measure Updates

3.2.1 Annual Updates to ICD-10 Code-Based Measure Specifications

Cohort Definitions and the Complication Outcome

We examined the code sets from the two ICD-10-CM/PCS releases outlined above, with particular attention to newly added codes. We then solicited input from our workgroup to determine which, if any, of the newly implemented ICD-10 codes in the code sets should be added to the cohort and complication definitions. We reviewed approximately 1,218 new ICD-10-CM codes and 365 new ICD-10-PCS codes. These code totals reflect new code additions since 2023 public reporting.

These processes, in addition to the surveillance and workgroup processes described above in the Rationale for Measure Updates section, led to the following changes:

- added ICD-10-PCS codes to the list of codes that identify a THA/TKA procedure as non-elective or non-primary and disqualify the admission from THA/TKA cohort inclusion
- added ICD-10-CM codes to the specifications that define the 'Acute Myocardial Infarction' complication
- added ICD-10-PCS codes to the specifications that define 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications' and 'Surgical Site Bleeding and Other Surgical Site Complications'

Risk Adjustment

We reviewed RTI International's FY 2023 modified version of the V24 CMS-HCC crosswalk, examining how the newly implemented ICD-10 codes in the FY 2023 ICD-10-CM/PCS code set releases were classified and where there may be codes that RTI International reclassified from one HCC to another when they updated to the FY 2023 version. We then solicited input from our workgroup to confirm the clinical appropriateness of the HCC classifications of the newly implemented ICD-10 codes and any changes warranted due to code shifts. The CC to ICD-10-CM code crosswalk was updated based on these processes, in addition to the surveillance and workgroup processes described above. The 2024 crosswalk file is available here on *QualityNet.*

The workgroup also reviewed the newly implemented ICD-10 codes in the two ICD-10-CM/PCS code set releases to determine which, if any, should be added to the singular ICD-10 code lists that are also used in risk adjustment (conditions that are not captured by CCs). No changes were made as a result of this process and the surveillance and workgroup processes described above.

Additionally, we reviewed the 1,218 new codes in the two ICD-10-CM releases and the changes made by CMS to the POA-exempt code list for FY 2023, to determine updates to the "POA-Exempt Codes Considered Always POA" table for 2024, as part of the risk-adjustment methodology used by the measure (discussed in Section 2.2.3). The resulting changes are detailed in the table posted here on *QualityNet*.

3.2.2 COVID-19

The following modifications made to the measure in prior public reporting years in response to the COVID-19 PHE will continue for 2024 public reporting:

- Claims data for January 1, 2020 through June 30, 2020 are excluded from use in the measure under CMS's Extraordinary Circumstances Exception (ECE) policy.[2-5] As a result:
  - The measurement period for 2024 public reporting is again reduced, to approximately 33 months (from the typical three years).
  - The typical 12-month look-back period for use of claims/VA data in risk adjustment totals less than 12 months for those patients whose 12-month period includes any portion of the January 1, 2020 through June 30, 2020 time frame.
- A 'History of COVID-19' risk variable is incorporated into the risk-adjustment model.
- COVID-19 index admissions are excluded from the cohort. COVID-19 index admissions are defined by a principal diagnosis code of COVID-19 **or** a secondary diagnosis code of COVID-19 coded as POA on the index admission claim.
- Readmissions with a principal diagnosis code of COVID-19 (U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the claim within the seven/30-day time frames are not eligible for use by the measure (and are excluded) in determining whether the following complications occurred:
  - AMI
  - pneumonia or other acute respiratory complication
  - sepsis/septicemia/shock
  - pulmonary embolism

A brief summary of how COVID-19 is addressed in the measure, including code specifications, can be found in the 2024 THA/TKA Complication Measure Code Specifications supplemental file here on *QualityNet*.

3.2.3 Additional Notes

The goal of these specification updates was to maintain the intent of the measure.

Changes made to the specifications are detailed in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet*.

The ICD-10 code listings in this report and the 2024 supplemental file reflect the most current descriptions for each code.

3.3. Changes to SAS Pack

We revised the measure SAS pack to accommodate the specification updates discussed in Section 3.1 and Section 3.2 above. The new SAS pack and documentation are available upon request. Please submit your request using the QualityNet Q&A tool: https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program:

Inpatient Claims-Based Measures > Complication > Understanding Measure Methodology. **Do *NOT* submit patient-identifiable information (for example, date of birth, Social Security number, Medicare Beneficiary Identifier, and encounter dates such as admission dates, discharge dates, procedure dates, and ED/observation dates) into this tool.**

The SAS pack includes descriptions of the data files and data elements that feed the model software. Please be aware that CMS does not provide training or technical support for the software. CMS has made the SAS pack available to be completely transparent regarding the measure calculation methodology. However, note that even with the SAS pack, it is not possible to replicate the RSCR calculation without the data files, which contain the longitudinal patient data from the entire national sample of acute care hospitals that is used to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2024 PUBLIC REPORTING

4.1. Assessment of Updated Model

The hospital-level RSCRs for the measure are estimated using a hierarchical logistic regression model. Refer to Section 2 for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and updates and specification reports on the complication measure page here on *QualityNet* for further details.

We evaluated the performance of the model using the July 1, 2020 through March 31, 2023 data for the 2024 reporting period. We examined the differences in the frequencies of patient risk factors and the model parameter coefficients.

We assessed logistic regression model performance in terms of discriminant ability for each of the three time periods of data and for the 33-month combined period. We computed two summary statistics for assessing model performance: the predictive ability and the area under the receiver operating characteristic curve (c-statistic). We also computed between-hospital variance for each of the three time periods of data and for the 33-month combined period. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

The results of these analyses for the measure are presented in Section 4.2.

Please note that, due to seasonal fluctuations and other factors, the statistics from one time period within this section may not be directly comparable to the other two time periods.

4.2. THA/TKA Complication 2024 Model Results

4.2.1 Index Cohort Exclusions

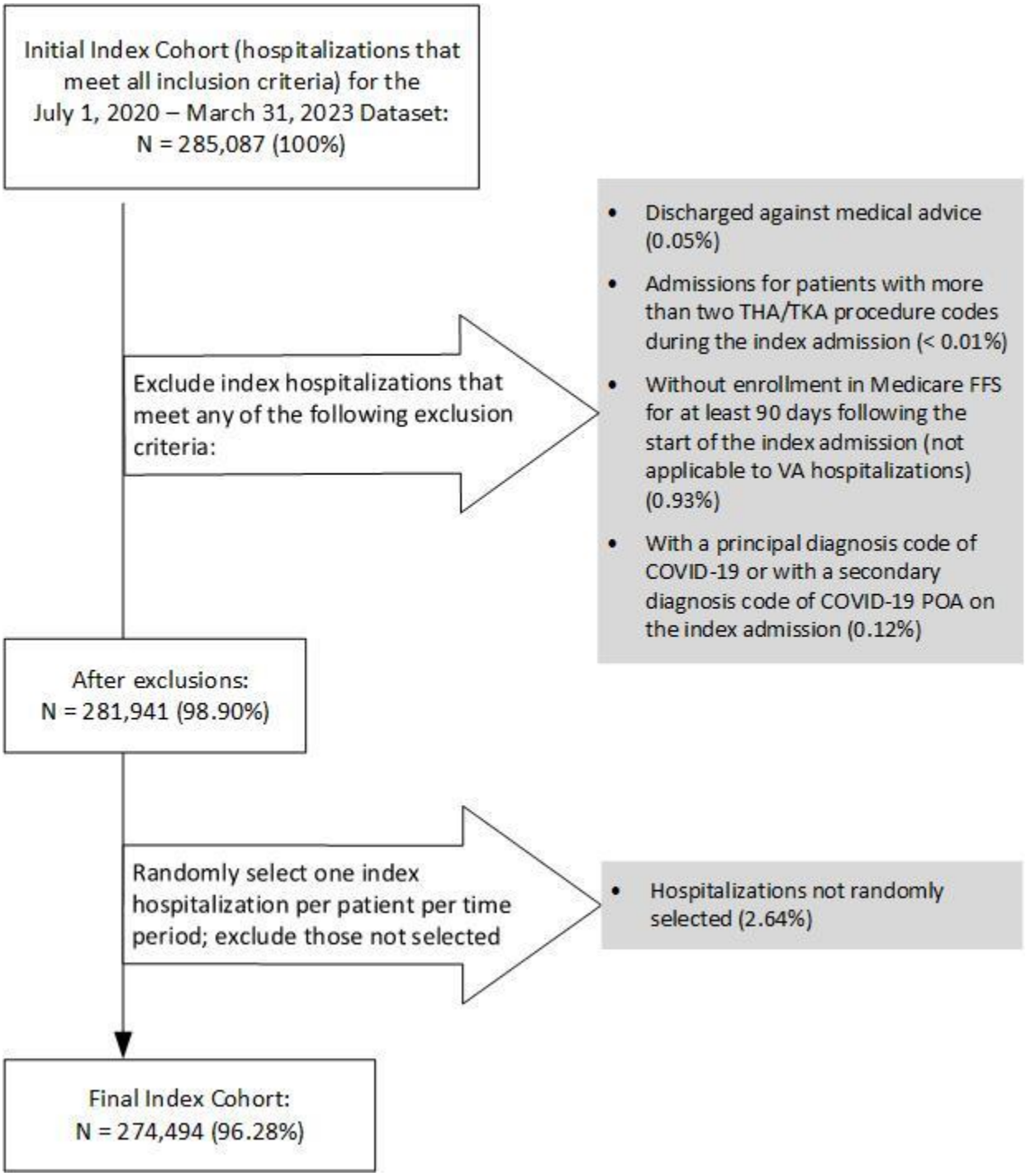
The exclusion criteria for this measure are presented in Section 2.2.1. The percentage of THA/TKA admissions that met each exclusion criterion in the July 1, 2020 through March 31, 2023 dataset is presented in Figure 4.2.1.1.

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes short-term acute care hospitalizations for patients:

- aged 65 or over;
- with a qualifying elective primary THA/TKA procedure; and
- enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations).

Of note, the decrease in measure cohort size that was observed in recent public reporting years continues for 2024 public reporting. These declines may reflect the growing impact of the THA/TKA procedures being performed on an outpatient basis.

Figure 4.2.1.1 — THA/TKA Cohort Exclusions in the July 1, 2020 through March 31, 2023 Dataset



4.2.2 Frequency of THA/TKA Model Variables

We examined the frequencies of clinical and demographic variables. Frequencies of model variables were relatively stable over the measurement period.

Refer to Table 4.2.2.1 for more detail.

Table 4.2.2.1 — Frequency of THA/TKA Model Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Total N	92,832	100,011	81,651	274,494
Mean age (SD)	74.2 (5.9)	74.9 (6.1)	75.2 (6.1)	74.8 (6.1)
Male	39.3	37.6	37.7	38.2
History of COVID-19	2.1	7.7	15.8	8.2
Index admissions with an elective THA procedure	39.9	37.7	36.0	37.9
Number of procedures (two vs. one)	2.2	2.0	2.2	2.1
Other congenital deformity of hip (joint)	0.3	0.2	0.2	0.2
Post traumatic osteoarthritis	1.2	1.7	2.0	1.6
Metastatic cancer and acute leukemia (CC 8)	0.8	1.0	1.1	0.9
Other major cancers (CC 9 – 12)	11.4	13.8	14.6	13.2
Respiratory/heart/digestive/urinary/other neoplasms (CC 13 – 15)	12.4	18.8	20.3	17.1
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	26.3	29.3	31.0	28.8
Protein-calorie malnutrition (CC 21)	0.7	1.0	1.2	0.9
Morbid obesity (CC 22)	10.2	11.7	13.3	11.7
Bone/joint/muscle infections/necrosis (CC 39)	3.3	3.7	4.0	3.7
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	9.6	11.3	11.8	10.9
Osteoarthritis of hip or knee (CC 42)	92.0	97.7	97.9	95.8
Osteoporosis and other bone/cartilage disorders (CC 43)	20.5	27.0	27.6	25.0
Dementia or other specified brain disorders (CC 51 – 53)	3.9	5.6	6.8	5.4
Major psychiatric disorders (CC 57 – 59)	6.9	8.7	10.0	8.5
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.5	2.1	2.5	2.0
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	2.7	4.4	5.1	4.0
Coronary atherosclerosis or angina (CC 88 – 89)	24.2	27.2	28.5	26.6
Stroke (CC 99 – 100)	1.6	2.5	2.9	2.3
Vascular or circulatory disease (CC 106 – 109)	20.9	27.5	30.2	26.1
Chronic obstructive pulmonary disease (COPD) (CC 111)	11.3	12.6	13.2	12.3
Pneumonia (CC 114 – 116)	2.3	3.7	4.2	3.4

Variable (% unless otherwise indicated)	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Pleural effusion/pneumothorax (CC 117)	1.1	1.7	2.0	1.6
Dialysis status (CC 134)	0.3	0.4	0.4	0.4
Renal failure (CC 135 – 140)	17.3	20.3	22.9	20.0
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.9	2.8	3.1	2.6
Trauma (CC 166 – 168, 170 – 173)	3.4	5.3	6.5	5.0
Vertebral fractures without spinal cord injury (CC 169)	0.8	1.3	1.5	1.2
Other injuries (CC 174)	17.1	25.1	27.7	23.2
Major complications of medical care and trauma (CC 176 – 177)	5.5	7.5	8.3	7.1

4.2.3 THA/TKA Model Parameters and Performance

Table 4.2.3.1 shows hierarchical logistic regression model parameter coefficients by individual time period and for the combined 33-month dataset.

Table 4.2.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for THA/TKA over Different Time Periods

Variable	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Intercept	-4.305	-3.967	-4.003	-4.103
Years over 65 (continuous)	0.029	0.024	0.023	0.025
Male	0.010	0.102	0.074	0.066
History of COVID-19	-0.171	-0.085	-0.059	-0.080
Index admissions with an elective THA procedure	0.545	0.523	0.519	0.526
Number of procedures (two vs. one)	0.251	0.429	0.055	0.259
Other congenital deformity of hip (joint)	0.385	0.303	0.486	0.377
Post traumatic osteoarthritis	0.186	0.085	0.358	0.226
Metastatic cancer and acute leukemia (CC 8)	0.091	0.060	0.120	0.085
Other major cancers (CC 9 – 12)	0.063	-0.036	-0.109	-0.029
Respiratory/heart/digestive/urinary/other neoplasms (CC 13 – 15)	-0.074	-0.124	-0.065	-0.092
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.134	0.142	-0.035	0.080
Protein-calorie malnutrition (CC 21)	0.508	0.183	0.036	0.208
Morbid obesity (CC 22)	0.515	0.272	0.326	0.362
Bone/joint/muscle infections/necrosis (CC 39)	0.216	0.182	0.111	0.170
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	0.137	0.174	0.133	0.149

Variable	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Osteoarthritis of hip or knee (CC 42)	-0.036	-0.260	-0.208	-0.117
Osteoporosis and other bone/cartilage disorders (CC 43)	0.111	0.057	0.038	0.067
Dementia or other specified brain disorders (CC 51 – 53)	0.312	0.304	0.138	0.238
Major psychiatric disorders (CC 57 – 59)	0.265	0.374	0.216	0.291
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.067	0.169	0.025	0.089
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	0.339	0.353	0.447	0.371
Coronary atherosclerosis or angina (CC 88 – 89)	0.194	0.195	0.189	0.194
Stroke (CC 99 – 100)	0.089	-0.026	-0.009	-0.005
Vascular or circulatory disease (CC 106 – 109)	0.151	0.048	0.159	0.115
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.328	0.239	0.244	0.264
Pneumonia (CC 114 – 116)	0.238	0.296	0.111	0.202
Pleural effusion/pneumothorax (CC 117)	0.110	0.044	0.125	0.093
Dialysis status (CC 134)	0.221	0.514	0.403	0.384
Renal failure (CC 135 – 140)	0.241	0.185	0.330	0.247
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.328	0.225	0.328	0.281
Trauma (CC 166 – 168, 170 – 173)	0.256	0.153	0.031	0.128
Vertebral fractures without spinal cord injury (CC 169)	0.232	0.222	0.055	0.156
Other injuries (CC 174)	0.090	0.056	0.190	0.109
Major complications of medical care and trauma (CC 176 – 177)	0.247	0.205	0.173	0.201

Table 4.2.3.2 shows the risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the THA/TKA complication model by individual time period and for the combined 33-month dataset.

Table 4.2.3.2 — Adjusted OR and 95% CIs for the THA/TKA Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2020 – 03/2021 OR (95% CI)	04/2021 – 03/2022 OR (95% CI)	04/2022 – 03/2023 OR (95% CI)	04/2020 – 03/2023 OR (95% CI)
Years over 65 (continuous)	1.03 (1.02 – 1.04)	1.02 (1.02 – 1.03)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.03)

Variable	07/2020 – 03/2021 OR (95% CI)	04/2021 – 03/2022 OR (95% CI)	04/2022 – 03/2023 OR (95% CI)	04/2020 – 03/2023 OR (95% CI)
Male	1.01 (0.93 – 1.09)	1.11 (1.03 – 1.20)	1.08 (0.99 – 1.17)	1.07 (1.02 – 1.12)
History of COVID-19	0.84 (0.65 – 1.09)	0.92 (0.81 – 1.05)	0.94 (0.85 – 1.04)	0.92 (0.86 – 0.99)
Index admissions with an elective THA procedure	1.72 (1.60 – 1.86)	1.69 (1.57 – 1.81)	1.68 (1.56 – 1.81)	1.69 (1.62 – 1.77)
Number of procedures (two vs. one)	1.29 (0.98 – 1.68)	1.54 (1.20 – 1.96)	1.06 (0.78 – 1.43)	1.30 (1.11 – 1.52)
Other congenital deformity of hip (joint)	1.47 (0.86 – 2.50)	1.35 (0.78 – 2.35)	1.63 (0.93 – 2.83)	1.46 (1.06 – 2.00)
Post traumatic osteoarthritis	1.20 (0.88 – 1.64)	1.09 (0.85 – 1.40)	1.43 (1.13 – 1.81)	1.25 (1.08 – 1.46)
Metastatic cancer and acute leukemia (CC 8)	1.10 (0.77 – 1.56)	1.06 (0.77 – 1.46)	1.13 (0.81 – 1.57)	1.09 (0.90 – 1.32)
Other major cancers (CC 9 – 12)	1.06 (0.95 – 1.19)	0.96 (0.87 – 1.07)	0.90 (0.80 – 1.00)	0.97 (0.91 – 1.03)
Respiratory/heart/digestive/urinary/other neoplasms (CC 13 – 15)	0.93 (0.83 – 1.04)	0.88 (0.81 – 0.97)	0.94 (0.85 – 1.03)	0.91 (0.86 – 0.97)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.14 (1.05 – 1.24)	1.15 (1.07 – 1.24)	0.97 (0.89 – 1.05)	1.08 (1.03 – 1.13)
Protein-calorie malnutrition (CC 21)	1.66 (1.26 – 2.19)	1.20 (0.93 – 1.55)	1.04 (0.80 – 1.34)	1.23 (1.06 – 1.43)
Morbid obesity (CC 22)	1.67 (1.50 – 1.86)	1.31 (1.19 – 1.45)	1.38 (1.25 – 1.54)	1.44 (1.35 – 1.53)
Bone/joint/muscle infections/necrosis (CC 39)	1.24 (1.06 – 1.46)	1.20 (1.04 – 1.39)	1.12 (0.96 – 1.30)	1.19 (1.08 – 1.29)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	1.15 (1.02 – 1.28)	1.19 (1.08 – 1.32)	1.14 (1.03 – 1.27)	1.16 (1.09 – 1.23)
Osteoarthritis of hip or knee (CC 42)	0.96 (0.84 – 1.10)	0.77 (0.63 – 0.94)	0.81 (0.64 – 1.02)	0.89 (0.81 – 0.98)
Osteoporosis and other bone/cartilage disorders (CC 43)	1.12 (1.02 – 1.22)	1.06 (0.98 – 1.15)	1.04 (0.95 – 1.13)	1.07 (1.02 – 1.12)
Dementia or other specified brain disorders (CC 51 – 53)	1.37 (1.18 – 1.59)	1.35 (1.20 – 1.53)	1.15 (1.01 – 1.31)	1.27 (1.17 – 1.37)
Major psychiatric disorders (CC 57 – 59)	1.30 (1.15 – 1.48)	1.45 (1.31 – 1.62)	1.24 (1.11 – 1.39)	1.34 (1.25 – 1.43)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.07 (0.83 – 1.38)	1.18 (0.96 – 1.46)	1.03 (0.83 – 1.26)	1.09 (0.96 – 1.24)
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	1.40 (1.18 – 1.67)	1.42 (1.24 – 1.63)	1.56 (1.36 – 1.79)	1.45 (1.33 – 1.58)
Coronary atherosclerosis or angina (CC 88 – 89)	1.21 (1.12 – 1.32)	1.22 (1.13 – 1.31)	1.21 (1.11 – 1.31)	1.21 (1.16 – 1.27)
Stroke (CC 99 – 100)	1.09 (0.85 – 1.40)	0.97 (0.80 – 1.19)	0.99 (0.81 – 1.21)	0.99 (0.88 – 1.13)

Variable	07/2020 – 03/2021 OR (95% CI)	04/2021 – 03/2022 OR (95% CI)	04/2022 – 03/2023 OR (95% CI)	04/2020 – 03/2023 OR (95% CI)
Vascular or circulatory disease (CC 106 – 109)	1.16 (1.07 – 1.27)	1.05 (0.97 – 1.13)	1.17 (1.08 – 1.27)	1.12 (1.07 – 1.18)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.39 (1.26 – 1.53)	1.27 (1.16 – 1.39)	1.28 (1.16 – 1.41)	1.30 (1.23 – 1.38)
Pneumonia (CC 114 – 116)	1.27 (1.05 – 1.54)	1.34 (1.16 – 1.56)	1.12 (0.95 – 1.31)	1.22 (1.11 – 1.34)
Pleural effusion/pneumothorax (CC 117)	1.12 (0.87 – 1.44)	1.04 (0.85 – 1.29)	1.13 (0.92 – 1.39)	1.10 (0.97 – 1.25)
Dialysis status (CC 134)	1.25 (0.81 – 1.92)	1.67 (1.16 – 2.40)	1.50 (1.04 – 2.16)	1.47 (1.18 – 1.83)
Renal failure (CC 135 – 140)	1.27 (1.16 – 1.39)	1.20 (1.11 – 1.31)	1.39 (1.28 – 1.51)	1.28 (1.22 – 1.34)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.39 (1.14 – 1.69)	1.25 (1.06 – 1.48)	1.39 (1.18 – 1.63)	1.32 (1.20 – 1.46)
Trauma (CC 166 – 168, 170 – 173)	1.29 (1.09 – 1.52)	1.17 (1.02 – 1.34)	1.03 (0.90 – 1.18)	1.14 (1.05 – 1.24)
Vertebral fractures without spinal cord injury (CC 169)	1.26 (0.93 – 1.72)	1.25 (0.99 – 1.58)	1.06 (0.82 – 1.37)	1.17 (1.00 – 1.36)
Other injuries (CC 174)	1.09 (0.99 – 1.20)	1.06 (0.97 – 1.15)	1.21 (1.11 – 1.32)	1.11 (1.06 – 1.17)
Major complications of medical care and trauma (CC 176 – 177)	1.28 (1.12 – 1.46)	1.23 (1.09 – 1.38)	1.19 (1.06 – 1.34)	1.22 (1.14 – 1.31)

Overall, model performance was stable over the 33-month period (Table 4.2.3.3).

Table 4.2.3.3 — THA/TKA Logistic Regression Model Performance over Different Time Periods

Characteristic	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Predictive ability, % (lowest decile – highest decile)	1.1 – 8.0	1.4 – 8.2	1.3 – 8.9	1.3 – 8.2
c-statistic	0.66	0.66	0.66	0.66

4.2.4 Distribution of Hospital Volumes and Complication Rates for THA/TKA

The national *observed* complication rate in the combined 33-month dataset was 3.5%. For the three time periods, the *observed* rates were as follows:

- July 1, 2020 – March 31, 2021: 3.3%
- April 1, 2021 – March 31, 2022: 3.4%
- April 1, 2022 – March 31, 2023: 3.6%

Table 4.2.4.1 shows the distribution of hospital admission volumes.

Table 4.2.4.1 — Distribution of Hospital THA/TKA Volumes over Different Time Periods

Characteristic	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Number of hospitals	2,974	2,962	2,840	3,257
Mean number of admissions (SD)	31.2 (62.5)	33.8 (73.0)	28.8 (55.7)	84.3 (176.4)
Range (min. – max.)	1 – 1,483	1 – 1,907	1 – 902	1 – 4,183
25th percentile	4	4	4	9
50th percentile	12	12	10	30
75th percentile	34	34	30	87

Table 4.2.4.2 shows the distribution of hospital RSCRs.

Table 4.2.4.2 — Distribution of Hospital THA/TKA RSCRs over Different Time Periods

Characteristic	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Number of hospitals	2,974	2,962	2,840	3,257
Mean (SD)	3.3 (0.4)	3.4 (0.4)	3.7 (0.4)	3.5 (0.5)
Range (min. – max.)	1.6 – 6.1	1.5 – 6.1	2.1 – 8.0	1.5 – 6.8
25th percentile	3.2	3.3	3.5	3.2
50th percentile	3.3	3.4	3.6	3.4
75th percentile	3.5	3.7	3.8	3.8

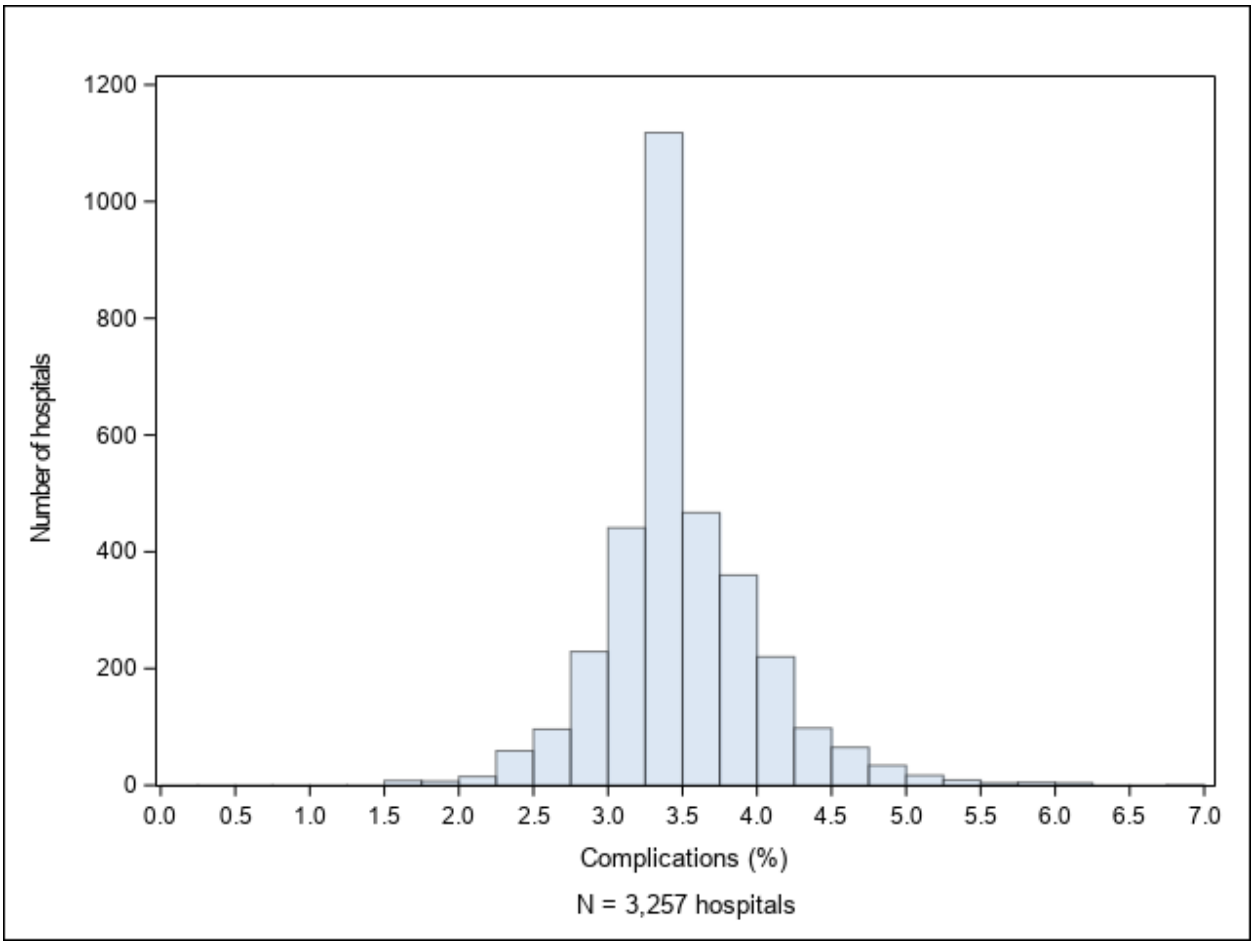
Table 4.2.4.3 shows the between-hospital variance by individual time period, as well as for the combined 33-month dataset.

Table 4.2.4.3 — Between-Hospital Variance for THA/TKA over Different Time Periods

Characteristic	07/2020 – 03/2021	04/2021 – 03/2022	04/2022 – 03/2023	04/2020 – 03/2023
Between-hospital variance (SE)	0.152 (0.027)	0.151 (0.025)	0.129 (0.025)	0.130 (0.013)

Figure 4.2.4.1 shows the overall distribution of the hospital RSCRs for the combined 33-month dataset, which indicates that the hospital RSCRs are approximately normally distributed. The odds of complication if a patient is treated at a hospital one standard deviation (SD) above the national rate were 2.05 times higher than the odds of complication if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.[1]

Figure 4.2.4.1 — Distribution of Hospital THA/TKA RSCRs between July 1, 2020 and March 31, 2023



4.2.5 Distribution of Hospitals by Performance Category in the 33-Month Dataset

Of 3,257 hospitals in the study cohort, 27 performed “Better than the National Rate,” 1,724 performed “No Different than the National Rate,” and 8 performed “Worse than the National Rate.” 1,498 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

5. GLOSSARY

Acute care hospital: A hospital that provides inpatient medical care for surgery and acute medical conditions or injuries. Short-term acute care hospitals provide care for short-term illnesses and conditions. In contrast, long-term acute care hospitals generally treat medically complex patients who require long-stay hospital-level care, which is generally defined as an inpatient length of stay more than 25 days.

Bootstrapping: The bootstrap is a computer-based method for estimating the standard error of an estimate when the estimate is based on a sample with an unknown probability distribution. Bootstrap methods depend on the bootstrap sample, which is a random sample of size *n* drawn with replacement from the population of *n* objects. The bootstrap algorithm works by drawing many independent bootstrap samples, evaluating the corresponding bootstrap replications, and estimating the standard error of the statistic by the empirical SD of the replications.

C-statistic: An indicator of the model's discriminant ability or ability to correctly classify those patients who have and have not had a complication following a THA/TKA procedure. Potential values range from 0.5, meaning no better than chance, to 1.0, an indication of perfect prediction. Perfect prediction implies that patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in their patients' outcomes.

Case mix: The particular illness severity, age, and, for some measures, gender characteristics of patients with index admissions at a given hospital.

Cohort: The index admissions included in the measure after inclusion and exclusion criteria have been applied.

Comorbidities: Medical conditions that the patient had in addition to their primary reason for admission to the hospital.

Complications: Medical conditions that may have occurred as a consequence of care rendered during hospitalization.

Condition Categories (CCs): Groupings of ICD-10-CM diagnosis codes into clinically relevant categories, from the HCC system.[6, 7] CMS uses modified groupings, but not the hierarchical logic of the system, to create risk factor variables. Mappings which show the assignment of ICD-10-CM codes to the CCs are available here on *QualityNet*.

Confidence interval (CI): A CI is a range of values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the OR associated with 'Protein-calorie malnutrition' noted as "1.09 – 1.15" means that we are confident that 95 out of 100 times the estimated OR lies between 1.09 and 1.15.

Expected admissions with a complication: The number of admissions with a complication expected based on average hospital performance with a given hospital's case mix.

Hierarchical Generalized Linear Model (HGLM): A widely accepted statistical method that enables evaluation of relative hospital performance by accounting for patient risk factors and the number of patients that a hospital treats. This statistical model accounts for the hierarchical structure of the data

(patients clustered within hospitals are assumed to be correlated) and accommodates modeling of the association between outcomes and patient characteristics. Based on the hierarchical model, we can evaluate:

- how much variation in hospital complication rates overall is accounted for by patients' individual risk factors (such as age and other medical conditions); and
- how much variation is accounted for by hospital contribution to complication risk.

A hierarchical logistic regression model is a type of HGLM used for binary outcomes.

Hospital-specific effect: A measure of a hospital's quality of care calculated using hierarchical logistic regression, taking into consideration the number of patients who are eligible for the cohort, these patients' risk factors, and the number who had THA/TKA complications. The hospital-specific effect is the calculated random effect intercept for each hospital. A hospital-specific intercept less than the average hospital-specific effect indicates the hospital performed better on the measure than the average hospital with the same case mix, a hospital-specific effect greater than the average hospital-specific effect indicates the hospital performed worse than average, and a hospital-specific effect near the average hospital-specific effect indicates about average performance. The hospital-specific intercept is used in the numerator to calculate "predicted" complications.

Index admission: Any admission included in the measure calculation as the initial admission for a qualifying elective THA/TKA procedure and evaluated for the outcome.

Interval estimate: Similar to a CI, the interval estimate is a range of probable values for the estimate that characterizes the amount of uncertainty. For example, a 95% interval estimate for a complication rate indicates there is 95% confidence that the true value of the rate lies between the lower and the upper limit of the interval.

Medicare Fee-For-Service (FFS): Original Medicare plan in which providers receive a fee or payment directly from Medicare for each individual service provided. Patients in managed care (Medicare Advantage) are excluded from the measure.

National observed complication rate: All included hospitalizations with the outcome divided by all included hospitalizations.

Odds ratio (OR): The ORs express the relative odds of the outcome for each of the predictor variables. For example, the OR for 'Protein-calorie malnutrition' (CC 21) represents the odds of the outcome for patients with that risk-adjustment variable present relative to those without the risk-adjustment variable present. The model coefficient for each risk-adjustment variable is the log (odds) for that variable.

Outcome: The result of a broad set of healthcare activities that affect patients' well-being. For the complication measure, the outcome is any one of the specified complications occurring during the index admission or during a readmission, except for death, which can occur anywhere as long as it is within 30 days of the start of the index admission.

Predicted admissions with a complication: The number of admissions with a complication predicted based on the hospital's performance with its observed case mix.

Predictive ability: An indicator of the model's discriminant ability or ability to distinguish high-risk subjects from low-risk subjects. A wide range between the lowest decile and highest decile suggests better discrimination.

Risk-adjustment variables: Patient demographics and comorbidities used to standardize rates for differences in case mix across hospitals.

VA beneficiary: For the purposes of our measure, a "VA beneficiary" is a patient who has VA healthcare benefits (according to VA administrative data). They may or may not be dually enrolled in Medicare FFS.

6. REFERENCES

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7. APPENDICES

Appendix A. Statistical Approach for THA/TKA Measure

The THA/TKA measure uses a hierarchical generalized linear model (HGLM) to estimate RSCRs for hospitals. This modeling approach accounts for the within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes.

In the THA/TKA measure, an HGLM model is estimated. Then for each hospital, a standardized risk ratio (SRR) is calculated. The RSCR is calculated by multiplying the SRR for each hospital by the national observed complication rate.

Hierarchical Generalized Linear Model

We fit an HGLM, which accounts for clustering of observations within hospitals. We assume the outcome has a known exponential family distribution and relates linearly to the covariates via a known link function, *h*. Specifically, we assume a binomial distribution and a logit link function. Further, we account for the clustering within hospitals by estimating a hospital-specific effect, α_i, which we assume follows a normal distribution with a mean μ and variance τ^2, the between-hospital variance component. The following equation defines the HGLM:

$$h\left(\Pr\left(Y_{ij}=1\middle|Z_{ij},\omega_i\right)\right)=log\left(\frac{\Pr\left(Y_{ij}=1|Z_{ij},\omega_i\right)}{1-\Pr\left(Y_{ij}=1|Z_{ij},\omega_i\right)}\right)=\alpha_i+\beta Z_{ij} \qquad (1)$$

$$\text{where } \alpha_i=\mu+\omega_i;\ \omega_i{\sim}N(0,\tau^2)$$

$$i=1,\ldots,I;\ j=1,\ldots,n_i$$

where Y_{ij} denotes the outcome (equal to 1 if the patient has a complication, 0 otherwise) for the *j-th* patient at the *i-th* hospital; $Z_{ij}=\left(Z_{ij1},Z_{ij2},\ldots,Z_{ijp}\right)^T$ is a set of *p* patient-specific covariates derived from the data; *I* denotes the total number of hospitals; and n_i denotes the number of index admissions at hospital *i*. The hospital-specific intercept of the *i-th* hospital, α_i, defined above, comprises μ, the adjusted average intercept over all hospitals in the sample, and ω_i, the hospital-specific intercept deviation from μ.[8]

We estimate the HGLM using the SAS software system (GLIMMIX procedure).

Risk-Standardized Measure Score Calculation

Using the HGLM defined by Equation (1), to obtain the parameter estimates $\hat{\mu},\{\hat{\alpha}_1,\hat{\alpha}_2,\ldots,\hat{\alpha}_I\},\hat{\beta}$, and $\hat{\tau}^2$, we calculate an SRR, $\hat{s}_i$, for each hospital by computing the ratio of the number of predicted complications to the number of expected complications. Specifically, we calculate:

$$\text{Predicted Value: } \hat{p}_{ij}=h^{-1}\left(\hat{\alpha}_i+\hat{\beta}Z_{ij}\right)=\frac{\exp\left(\hat{\alpha}_i+\hat{\beta}Z_{ij}\right)}{\exp\left(\hat{\alpha}_i+\hat{\beta}Z_{ij}\right)+1} \qquad (2)$$

Expected Value: $\hat{e}_{ij} = h^{-1}(\hat{\mu} + \hat{\beta} Z_{ij}) = \frac{\exp(\hat{\mu}+\hat{\beta} Z_{ij})}{\exp(\hat{\mu}+\hat{\beta} Z_{ij})+1}$ (3)

Standardized Risk Ratio: $\hat{s}_i = \frac{\sum_{j=1}^{n_i} \hat{p}_{ij}}{\sum_{j=1}^{n_i} \hat{e}_{ij}}$ (4)

We calculate an RSCR, $\widehat{RSCR}_i$, for each hospital by using the estimate from Equation (4) and multiplying by the national observed complication rate, denoted by $\bar{y}$. Specifically, we calculate:

Risk-Standardized Complication Rate: $\widehat{RSCR}_i = \hat{s}_i \times \bar{y}$ (5)

Creating Interval Estimates

The measure score is a complex function of parameter estimates; therefore, we use re-sampling and simulation techniques to derive an interval estimate to determine if a hospital is performing better than, worse than, or no different than expected. A hospital is considered better than expected if the upper bound of their CI falls below the national observed complication rate, $\bar{y}$, and considered worse if the lower bound of their CI falls above $\bar{y}$. A hospital is considered no different than expected if the CI overlaps $\bar{y}$.

More specifically, we use bootstrapping procedures to compute CIs. Because the theoretical-based standard errors are not easily derived, and to avoid making unnecessary assumptions, we use the bootstrap to empirically construct the sampling distribution for each hospital risk-standardized ratio. The bootstrapping algorithm is described below.

Bootstrapping Algorithm

Let *I* denote the total number of hospitals in the sample. We repeat steps 1 – 4 below for b = 1,2,…B times:

1. Sample *I* hospitals with replacement.
2. Fit the HGLM defined by Equation (1) using all patients within each sampled hospital. The starting values are the parameter estimates obtained by fitting the model to all hospitals. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have *I* random effects to estimate the variance components. After Step 2, we have:
   a. The estimated regression coefficients of the risk factors, $\hat{\beta}^{(b)}$.
   b. The parameters governing the random effects, hospital adjusted outcomes, distribution $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$.
   c. The set of hospital-specific intercepts and corresponding variances, $\left\{\hat{\alpha}_i^{(b)} - \hat{var}\left(\alpha_i^{(b)}\right); i = 1,2,\ldots,I\right\}$.
3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a

normal distribution. Thus, we draw $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \hat{var}\left(\alpha_i^{(b)}\right))$ for the unique set of hospitals sampled in Step 1.

4. Within each unique hospital *i* sampled in Step 1, and for each case *j* in that hospital, we calculate $\hat{p}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\hat{s}_i^{(b)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\alpha_i^{(b*)}$ is obtained from Step 3.

Ninety-five percent interval estimates (or alternative interval estimates) for the hospital-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of a large selected number of estimates for all hospitals (or the percentiles corresponding to the alternative desired intervals).[9]

Appendix B. Data QA

This production year required updates to the SAS pack to account for updates in ICD-10 codes and associated mappings of clinical groupers.

This section represents QA for the subset of the work YNHHSC/CORE conducted to maintain and report the THA/TKA complication measure. It does not describe the QA for processing data and creating the input files, nor does it include the QA for the final processing of production data for public reporting, because another contractor conducts that work.

To assure the quality of measure output, we utilize a multi-phase approach to QA of the THA/TKA complication measure.

Phase I

As the first step in the QA process, we review changes in the cohort and outcomes definitions as determined by the measure-specific code set files that were updated to account for changes in ICD-10 coding. This includes updates to the HCC clinical category maps.

In general, we use both manual scan and descriptive analyses to conduct data validity checks, including cross-checking complication information, distributions of ICD-10 codes, and frequencies of key variables.

Phase II

We update the existing SAS pack to accommodate the new codes and updates to the measure. To ensure accuracy in SAS pack coding, two analysts independently write SAS code for any major changes made in calculating the THA/TKA complication measure: data preparation, sample selection, hierarchical modeling, and calculation of RSCRs. This process highlights any programming errors in syntax or logic. Once the parallel programming process is complete, the analysts cross-check their codes by analyzing datasets in parallel, checking for consistency of output, and reconciling any discrepancies.

Phase III

A third analyst reviews the finalized SAS code and recommends changes to the coding and readability of the SAS pack, where appropriate. The primary analyst receives the suggested changes for possible re-coding or program documentation when needed.

During this phase, we also compare prior years' risk-adjustment coefficients and variable frequencies to enable us to check for potential inconsistencies in the data and the impact of any changes to the SAS pack. Anything that seems outside of normal coding fluctuation is reviewed in more detail.

Appendix C. Annual Updates

Prior annual updates for the measure can be found in the annual updates and specifications reports available here on *QualityNet*. For convenience, we have listed all prior updates here under the reporting year and corresponding report. In 2013, CMS began assigning version numbers to its measures. The measure specifications in the original methodology reports are considered Version 1.0 for a measure. The measure receives a new version number for each subsequent year of public reporting.

2024

2024 Measure Updates and Specifications Report (Version 13.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
  - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2023 public reporting (namely, October 1, 2022 [FY 2023] and April 1, 2023) into the cohort definition, complication definitions, and risk model;
  - applied a modified version of the FY 2023 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
  - made additional code specification changes prompted by the activities described in Section 3.1.
    - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Expanded the measurement period for 2024 public reporting to approximately 33 months
  - Rationale: The rates for the measure are calculated using rolling data. Each year, the rates are updated by dropping the data representing the oldest year and adding data for the newest available year. As a result, the 2024 measurement period begins with July 2020 discharges (incremented one year from the start of the 2023 public reporting period of April 1, 2019 and then adjusted to exclude index admissions with discharges in the January 1, 2020 – June 30, 2020 claims exclusion time frame).

2023

2023 Measure Updates and Specifications Report (Version 12.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
  - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2022 public reporting (namely, October 1, 2021 [FY 2022] and April 1, 2022) into the cohort definition, complication definitions, and risk model;
  - applied a modified version of the FY 2022 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
  - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
    - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Added 26 ICD-10-CM codes to the specifications that define the 'Mechanical Complications' outcome, as finalized in the FY 2023 IPPS Rule — To elaborate:
  - The 26 codes were identified during routine measure maintenance work and vetted by our experts, including orthopedic surgeons and clinical coding experts. They reflect fractures of the pelvis, femur, tibia or fibula, or other bone following insertion of an orthopedic implant as well

as periprosthetic fractures around the internal prosthetic left/right hip/knee joint or other/unspecified internal prosthetic joint.
    - The addition of these clinically relevant codes contributed to an increase in the national observed complication rate of 0.8%.
    - The addition of the 26 codes applies only to the THA/TKA complication measure as included in the Hospital Inpatient Quality Reporting Program (FY 2024 payment determination) and publicly reported on Medicare.gov. It does not apply to the THA/TKA complication measure as included in the FY 2024 Hospital Value-Based Purchasing (VBP) Program.
        - Rationale: The expanded outcome will allow the measure to capture a more complete outcome.

2022

2022 Measure Updates and Specifications Report (Version 11.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
    - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2021 public reporting (namely, April 1, 2020; August 1, 2020; October 1, 2020 [FY 2021]; and January 1, 2021) into the cohort definition, complication definitions, and risk model;
    - applied a modified version of the FY 2021 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
    - made additional code specification changes prompted by the other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
        - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Adjusted the specifications and methodology for the measure in response to the COVID-19 PHE — Specifically, we:
    - removed COVID-19 index admissions from the cohort;
    - rendered COVID-19 readmission claims ineligible for use and excluded them for the following complications:
        - AMI
        - pneumonia or other acute respiratory complication
        - sepsis/septicemia/shock
        - pulmonary embolism
    - added a new 'History of COVID-19' risk variable to the risk-adjustment model;
    - shortened the measurement period for 2022 public reporting to approximately 27 months (from the typical three-year measurement period), similar to 2021 public reporting; and
    - reduced the look-back period for use of claims/VA data in risk adjustment to less than 12 months (from the typical 12 months) for those patients whose 12-month period included any portion of the January 1, 2020 through June 30, 2020 claims exclusion time frame.
        - Rationale: The COVID-19 PHE continues to have significant and enduring effects on the provision of medical care in the country and around the world. Adjustments to measure specifications and methodology for 2022 help to ensure the intent of the measure is maintained. The measurement period and look-back period reductions (in certain cases) are in response to CMS's decision to exclude claims data for January 1, 2020 through June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Added a POA algorithm to the risk-adjustment methodology used to pull CC-defined risk-adjustment variables from the index admission claim/VA data

- Rationale: POA coding is a logical reflection of comorbidities. POA indicators more accurately distinguish complications of care from conditions already present at admission, in comparison to the previous methodology that utilized only the potential complications list.[10] Additionally, use of POA indicators helps particularly in cases where a patient has not been hospitalized or had provider visits in the last year or where a comorbid condition present at the time of admission is relatively new.

2021

2021 Measure Updates and Specifications Report (Version 10.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
  - incorporated the code changes that occurred in the FY 2020 version of the ICD-10-CM/PCS (effective with October 1, 2019+ discharges) into the cohort definition, complication definitions, and risk model;
  - applied a modified version of the FY 2020 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
  - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
    - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Shortened the measurement period for 2021 public reporting to approximately 30 months (from the typical three-year measurement period)
  - Rationale: The measurement period reduction is in response to the COVID-19 PHE and CMS's decision to exclude claims data for January 1, 2020 through June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Removed the International Classification of Diseases, Ninth Revision (ICD-9) code-based specifications from the measure and SAS pack
  - Rationale: The Medicare claims and VA administrative data for the measurement period of April 1, 2017 through October 2, 2019 are completely ICD-10 code-based. 2020 public reporting was the last year that warranted any ICD-9 code specifications.
- Added admission data from VA hospitals to the measure
  - Rationale: Creates a more inclusive perspective of the relative quality of U.S. hospitals

2020

2020 Measure Updates and Specifications Report (Version 9.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
  - incorporated the code changes that occurred in the FY 2019 version of the ICD-10-CM/PCS (effective with October 1, 2018+ discharges) into the cohort definition, complication definitions, and risk model;
  - applied a modified version of the FY 2019 V22 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
  - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
    - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.

- Added the revenue center codes 0138 (Semi_private 3 and 4 beds-rehabilitation) and 0158 (Room&Board ward (medical or general)-rehabilitation) to the revenue center code list used to identify transfers to rehabilitation units, to ensure these transfers are not captured as readmission claims eligible for use in identifying complications (Refer to the 2018 updates below)
    - Rationale: Revenue center codes 0138 and 0158 are appropriate codes for identifying rehabilitation claims.

2019

2019 Measure Updated and Specifications Reports (Version 8.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:
    - incorporated the code changes that occurred in the FY 2018 version of the ICD-10-CM/PCS (effective with October 1, 2017+ discharges) into the cohort definition, complication definitions, and risk model;
    - applied a modified version of the FY 2018 V22 CMS-HCC crosswalk that is maintained by RTI International to the risk model; and
    - made additional code specification changes prompted by other workgroup activities including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches. For example, ICD-10-PCS code 0SPD4JC, Removal of Synthetic Substitute from Left Knee Joint, Patellar Surface, Percutaneous Endoscopic Approach, was identified through a "neighboring code search" (found near existing code 0SPD4JZ, Removal of Synthetic Substitute from Left Knee Joint, Percutaneous Endoscopic Approach) and determined through clinical review to be a code which meets measure intent. As a result, it was added to the 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications' code list.
        - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Added use of secondary diagnoses and POA code requirements (for codes not exempt from POA reporting) for readmission claims to the 'AMI' and 'Pneumonia and Other Respiratory Complications' complication specifications (for discharges prior to October 1, 2015 as well as discharges on or after October 1, 2015)
    - Rationale: POA code additions were made per clinical expert recommendation as well as input from the workgroup review. Incorporation of secondary diagnoses to 'AMI' and 'Pneumonia and Other Respiratory Complications' was done to align these conditions with the diagnosis placement specifications of the other complications.
- Revised the descriptions of three of the complication categories — Specifically:
    - 'Periprosthetic Joint Infection/Wound Infection' was changed to 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications';
    - 'Pneumonia' was changed to 'Pneumonia and Other Respiratory Complications'; and
    - 'Surgical Site Bleeding' was changed to 'Surgical Site Bleeding and Other Surgical Site Complications'.
        - Rationale: We have changed the above complication category descriptions to more accurately reflect the contents of the code lists that define these complications. The descriptions previously were narrower and led to some confusion from stakeholders. The lists continue to maintain the intent of the complication outcome from development.

2018

2018 Measure Updates and Specifications Report (Version 7.0 — THA/TKA Complication)

- Updated the ICD-10 code-based specifications used in the measure — Specifically, we:

- incorporated the code changes that occurred in the FY 2017 version of the ICD-10-CM/PCS into the cohort definition;
- applied the FY 2017 version of the V22 CMS-HCC crosswalk maintained by RTI International to the risk model; and
- monitored code frequencies to identify any code specification changes warranted due to possible changes in coding practices and patterns. Additionally, our clinical and measure experts reviewed the pre-existing ICD-10 code-based specifications to confirm the appropriateness of the specifications unaffected by the updates.
  - Rationale: Updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk were released. Revisions to the measure specifications were warranted to accommodate these updates.

- Updated the methodology used in analytic input file production to identify transfers to rehabilitation units, to further ensure these transfers are not captured as readmission claims eligible for use in identifying complications. In addition to the previous methods described in the 2017 updates below, use of revenue center codes has been implemented to help identify these cases in both ICD-9 and ICD-10 code-based claims. Specifically:
  - 0024: Inpatient Rehabilitation Facility services paid under PPS submitted as TOB 11X
  - 0118: Private medical or general-rehabilitation
  - 0128: Semi-private 2 bed (medical or general)-rehabilitation
  - 0148: Private (deluxe)-rehabilitation
    - Rationale: The inability to use principal discharge diagnosis codes to identify rehabilitation stays (due to ICD-10 coding guidance) has led to an under-counting of these transfers primarily for Maryland hospitals and CAHs, hospitals that are not part of the IPPS. Utilization of revenue center codes augments our ability to identify and exclude claims for rehabilitation beds in these hospitals that are not identified through discharge disposition codes alone. Of note, rehabilitation units are most often identified by CMS certification number (CCN).

2017

2017 Measure Updates and Specifications Report (Version 6.0 — THA/TKA Complication)

- Revised the measure specifications to accommodate the implementation of ICD-10 coding — Specifically, we:
  - identified the ICD-10 codes used to define the measure cohort for discharges on or after October 1, 2015;
  - identified the ICD-10 codes used to define the complications for discharges on or after October 1, 2015; and
  - re-specified the risk model, updating the CC-based risk variables to the ICD-10-compatible HCC system version 22 and applying ICD-10 codes for certain risk variables (for example, 'Post traumatic osteoarthritis') to the model.
    - Rationale: The ICD-9 code sets used to report medical diagnoses and inpatient procedures were replaced by ICD-10 code sets on October 1, 2015. The U.S. Department of Health and Human Services mandated that ICD-10 codes be used for medical coding, effective with October 1, 2015 discharges. The measurement period for 2017 public reporting required data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification was warranted to accommodate ICD-10 coding.
- Updated the original methodology built into the measure to identify transfers to psychiatric and rehabilitation units, to ensure these transfers are not captured as readmission claims eligible for use in identifying complications:

- Psychiatric admissions — A psychiatric admission is identified if ALL three of the following criteria are met:
  (1) The admission being evaluated as a potential readmission has a psychiatric principal discharge diagnosis code, defined as ICD-9-CM codes beginning with "29," "30," or "31," for discharges prior to October 1, 2015, or ICD-10-CM codes beginning with "F," for discharges on or after October 1, 2015 (ICD-10-CM codes were added to the specifications).
  (2) The index admission has a discharge disposition code to a psychiatric hospital or psychiatric unit from the index admission.
  (3) the admission being evaluated as a potential readmission occurred during the same day as or the day following the index discharge.
- Rehabilitation admissions — For discharges prior to October 1, 2015: Rehabilitation admissions are identified by the ICD-9-CM principal discharge diagnosis code and defined as codes beginning with "V57," which indicate admission to a rehabilitation unit (no change).
- Rehabilitation admissions — Specifications for discharges on or after October 1, 2015 were added. A rehabilitation admission is identified if BOTH of the following criteria are met:
  (1) The index admission has a discharge disposition code to a rehabilitation hospital or rehabilitation unit from the index admission.
  (2) The admission being evaluated as a potential readmission occurred on the same day as or the day following the index discharge.
  - Rationale: With the implementation of ICD-10 coding effective with discharges on or after October 1, 2015, the ICD-9-code-based criterion developed in 2010 needed to be re-specified. For psychiatric admissions, defining "psychiatric diagnosis" with ICD-10-CM codes for discharges on or after October 1, 2015 was a simple solution, as mental health diagnosis codes all reside under the Category "F" (Mental, Behavioral and Neurodevelopmental disorders). However, for rehabilitation admissions, rehabilitation diagnosis codes are not coded consistently. Thus, re-defining the V57.0 ICD-9-CM code criterion with ICD-10-CM codes was not a viable option, and a different strategy was warranted.

2016

2016 Measure Updates and Specifications Report (Version 5.0 — THA/TKA Complication)

No updates were made to the specifications of the THA/TKA complication measure for 2016 public reporting.

2015

2015 Measure Updates and Specifications Report (Version 4.0 — THA/TKA Complication)

- Updated the cohort to exclude patients without at least 90 days of enrollment in Medicare FFS following the start of the index admission
  - Rationale: Removing index admissions for patients who withdrew from the Medicare FFS program within 90 days after the start of the index admission improves the accuracy of the measure by removing patients for whom there is no available outcome data and makes the measure consistent with the methodology used in the THA/TKA 30-day readmission measure and other publicly reported condition-specific readmission measures for AMI, heart failure, pneumonia, COPD, and stroke admissions.

2014

2014 Measure Updates and Specifications Reports (Version 3.0 — THA/TKA Complication)

- Updated the cohort to not include all patients with a secondary diagnosis of fracture during the index admission

- Rationale: These procedures are presumably not elective THA/TKA procedures, and the cohort aims to include only elective THA/TKA procedures.
- Updated the outcome specifications to exclude complications coded as POA during the index admission
  - Rationale: These complications are presumably not related to the index procedure and/or perioperative care provided and the measure aims to assess quality of hospital care.

2013

2013 Measure Updates and Specifications Report (Version 2.0 — THA/TKA Complication)

- Updated the CC map
  - Rationale: Prior to 2014, the ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.
- Revised the complication and fracture exclusion code lists — Specifically, we:
  - Updated the ICD-9-CM codes that define the pneumonia, sepsis/septicemia, and pulmonary embolism complications; and
  - Updated the ICD-9-CM codes that define the femur, hip, and pelvic fracture cohort exclusions.
    - Rationale: New ICD-9-CM codes were identified and added to the measure specifications where appropriate.
- Updated two tables in the Appendices — Specifically, we:
  - Revised the ICD-9 cohort exclusion categories table to incorporate ICD-9-CM codes 00.86 and 00.87 under the THA Resurfacing Procedure code list (instead of the Femur, Hip, and Pelvic Fracture code list); and
  - Added CC 82 ('Unstable Angina and Other Acute Ischemic Heart Disease') to the list of risk variables considered complications of care during the index admission and removed CC 85 ('Heart Infection/Inflammation, Except Rheumatic'), in accordance with the SAS pack code.
    - Rationale: Needed corrections to the tables from the original methodology report.
- Shortened the measurement period from 36 months to 33 months
  - Rationale: This change was needed due to the timing of public reporting and the longer period of outcome assessment required to adequately capture complications up to 90 days following admission.

Appendix D. Measure Specifications

Appendix D.1 Hospital-Level RSCR following Elective Primary THA and/or TKA (CBE #1550)

Cohort

Inclusion Criteria for THA/TKA Measure

- **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations)**
  - Rationale: For patients who are not VA beneficiaries, the 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission.
- **Aged 65 or over**
  - Rationale: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or over.
- **Having a qualifying elective primary THA/TKA procedure during the index admission**
  - Rationale: Elective primary THA or TKA is the procedure targeted for measurement. Elective primary THA/TKA procedures are defined as those THA/TKA procedures *without* the following:
    - **Fracture of the pelvis or lower limbs coded in the principal or secondary discharge diagnosis fields on the index admission claim** (Note: Periprosthetic fractures must be additionally coded as POA in order to disqualify a THA/TKA from cohort inclusion, unless exempt from POA reporting.)
      - Rationale: Patients with fractures have higher mortality, complication, and readmission rates, and the procedures are typically not elective.
    - **A concurrent partial hip or knee arthroplasty procedure**
      - Rationale: Partial arthroplasty procedures are primarily done for hip and knee fractures and are typically performed on patients who are older, frailer, and have more comorbid conditions.
    - **A concurrent revision, resurfacing, or implanted device/prosthesis removal procedure**
      - Rationale: Revision procedures may be performed at a disproportionately small number of hospitals and are associated with higher mortality, complication, and readmission rates. Resurfacing procedures are a different type of procedure involving only the joint's articular surface and are typically performed on younger, healthier patients. Elective procedures performed on patients undergoing removal of implanted device/prosthesis procedures may be more complicated.
    - **Mechanical complication coded in the principal discharge diagnosis field on the index admission claim**
      - Rationale: A complication coded as the principal discharge diagnosis suggests the procedure was more likely the result of a previous procedure and indicates the complication was POA. These patients may require more technically complex arthroplasty procedures and may be at increased risk for complications, particularly mechanical complications.

- **Malignant neoplasm of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or a disseminated malignant neoplasm coded in the principal discharge diagnosis field on the index admission claim**
  - Rationale: Patients with these malignant neoplasms are at increased risk for complication, and the procedure may not be elective.
- **Transfer from another acute care facility for the THA/TKA**
  - Rationale: The THA/TKA complication measure does not include admissions for patients transferred to the index hospital, as they likely do not represent elective THA/TKA procedures.

Exclusion Criteria for THA/TKA Measure

- **Without enrollment in Medicare FFS for at least 90 days following the start of the index admission (not applicable to VA hospitalizations)**
  - Rationale: The 90-day complication outcome cannot be assessed in this group since claims data are used to determine whether a complication of care occurred.
- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **With more than two THA/TKA procedure codes during the index admission**
  - Rationale: Although clinically possible, it is highly unlikely that patients would receive more than two elective THA/TKA procedures in one hospitalization. Coding in such cases may reflect a coding error.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
  - Rationale: COVID-19 patients are removed from the THA/TKA cohort in response to the COVID-19 PHE, and to maintain alignment with the THA/TKA complication measure included in the FY 2025 Hospital VBP Program.

After the above exclusions are applied, the measure randomly selects one index admission per patient per time period for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. Additional admissions within that time period are excluded.

For the 33-month combined data, if a randomly selected index admission for one time period falls within 90 days of a randomly selected index admission for another time period (the transition period between two time periods), the measure includes both admissions; however, a complication that falls within the defined time frame for both admissions would only be captured in the complication outcome for the second admission. For example, if a patient has a randomly selected admission on March 1, 2021 and then again on April 2, 2021, and then has a readmission for a periprosthetic joint infection on May 3, 2021, the periprosthetic joint infection is attributed to the April 2, 2021 admission.

The ICD-10 codes used to define the THA/TKA cohort are outlined in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet*.

Outcome

Outcome Criteria for the THA/TKA Measure

- **Complication within the specified time frame**
  - Rationale: The goal is to identify medical and surgical complications that could be attributable to the care provided during and after an elective THA or TKA procedure. The outcome for this measure is any one of the specified complications occurring during the index admission or coded on an eligible readmission claim* except for deaths, which can occur anywhere as long as it is within 30 days of the start of the index admission. Therefore, if a patient experiences one or more complications in the applicable time period, the outcome variable is coded as a "yes." If an otherwise qualifying complication is coded as POA during the index admission, the complication is excluded from the measure outcome. Applicable time period recommendations specific to each complication were established through clinical input and examining 90-day trends in complication rates.

    * Readmissions with a principal diagnosis code of COVID-19 **or** a secondary diagnosis code of COVID-19 coded as POA on the claim within the seven/30-day time frames are not eligible for use (and are excluded) in determining whether the following complications occurred:

    - AMI
    - pneumonia or other acute respiratory complication
    - sepsis/septicemia/shock
    - pulmonary embolism

- The measure avoids inappropriate attribution of complications in staged THA/TKA procedure scenarios through the following approach: The measure logic identifies specific ICD-10-CM codes (for example, arthropathy) that, when present as a principal discharge diagnosis concurrent with a THA/TKA procedure code on a readmission, exclude a complication on that readmission from being captured in the complication outcome. This is done to prevent a complication resulting from a second THA/TKA in staged THA/TKA cases from being inappropriately attributed to the first hospital performing the first THA/TKA (in the event that first admission is randomly chosen as the index admission). Note that staged scenarios are relatively rare.

The ICD-10 codes used to define the complications in claims and the ICD-10-CM codes used to help identify staged THA/TKA procedure scenarios are outlined in the 2024 THA/TKA Complication Measure Code Specifications supplemental file posted here on *QualityNet.*