

**2016 Procedure-Specific Measures Updates and Specifications Report
Hospital-Level 30-Day Risk-Standardized Readmission Measures**

**Isolated Coronary Artery Bypass Graft (CABG) Surgery – Version 3.0
Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty
(TKA) – Version 5.0**

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) procedure-specific readmission measures used in the Hospital Inpatient Quality Reporting program and publicly reported on *Hospital Compare*. The measures report hospital-level 30-day risk-standardized readmission rates (RSRRs) following isolated coronary artery bypass graft (CABG) surgery and RSRRs 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 these measures for a wide range of readers. Reports describing CABG surgery mortality, THA/TKA complications, hospital-wide readmission, condition-specific readmission, and other outcome measures can be found on *QualityNet*.

This report provides an overview of the measure methodology, methodology updates for 2016 public reporting, and the national results for 2016 public reporting. The appendices provide detailed specifications for each measure, including tables of the codes used for cohort derivation and risk adjustment, as well as a history of annual updates.

Specifically, the report includes:

- **Section 2 - An overview of the CABG surgery and THA/TKA readmission measures:**
 - Background
 - Cohort inclusions and exclusions
 - included and excluded hospitalizations
 - how transferred patients are handled
 - differences in how the THA/TKA and CABG surgery measure scores are calculated for the Hospital Inpatient Quality Reporting program and the Hospital Readmissions Reduction Program (HRRP)
 - Unplanned readmission outcome
 - Risk-adjustment variables
 - Data sources
 - Readmission rate calculation
 - Categorization of hospitals' performance score
- **Section 3 - 2016 measure updates**
- **Section 4 - 2016 measure results**
- **Section 5 - Glossary**

The Appendices contain detailed measure information, including:

- Appendix A: Statistical approach to calculating RSRRs;
- Appendix B: Data quality assurance (QA);
- Appendix C: Annual updates to the measures since measure development;
- Appendix D: Measure specifications; and,
- Appendix E: Detailed overview of the planned readmission algorithm.

For additional references, the original measure methodology reports, as well as prior updates and specifications reports, are available in the Measure Methodology and Archived Resources sections under the claims-based readmission measures page of [QualityNet](#):

- Hospital-Level 30-Day All-Cause Unplanned Readmission Following Coronary Artery Bypass Graft Surgery Measure Technical Report (2014)¹
- Hospital-Level 30-Day All Cause Risk-Standardized Readmission Rate Following Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA): Measure Methodology Report (2012)²
- 2013 Measure Updates and Specifications: THA/TKA Readmission Measure³
- 2014 Procedure-Specific Measure Updates and Specifications: THA/TKA Readmission Measure⁴
- 2015 Procedure-Specific Readmission Measures Updates and Specifications Report: Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA), and Isolated Coronary Artery Bypass Graft (CABG) Surgery⁵

The measure methodology is also described in the peer-reviewed medical literature.⁶

For resources on quality improvement activities aimed at reducing readmission in general, and for more information about the cost and business case for making such improvements, refer to the Reducing Readmissions section under the claims-based readmission measures page of [QualityNet](#).

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Readmission Measures

In December 2013, CMS began publicly reporting 30-day RSRRs for THA/TKA for the nation's non-federal short-term acute care hospitals (including Indian Health Services hospitals) and critical access hospitals. In 2015, CMS began public reporting an additional readmission measure; namely, CABG surgery. This measure also includes admissions to non-federal acute care hospitals and critical access hospitals.

Results for both of these readmission measures are posted on *Hospital Compare*, which CMS updates annually.

CMS contracted with the Yale-New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (CORE) to update the CABG surgery and THA/TKA readmission measures for 2016 public reporting through a process of measure reevaluation. Measures are reevaluated annually in order to improve them by responding to stakeholder input and incorporating advances in science or changes in coding.

2.2 Overview of Measure Methodology

The 2016 risk-adjusted readmission measures use specifications from the initial measure methodology reports with refinements to the measures, as listed in [Appendix C](#) and described in the prior measure updates and specifications reports.¹⁻⁵ An overview of the methodology is presented in this section.

The methodology for the Hospital Inpatient Quality Reporting measures described in this report is the same methodology that will be used to calculate excess readmissions for the THA/TKA and CABG surgery measures for HRRP, with certain differences in the measure cohorts, as noted in [Section 2.2.1](#). These differences may make an individual hospital's results for the two programs slightly different.

2.2.1 Cohort

Index Admissions Included in the Measures

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

- Having a qualifying isolated CABG surgery or elective primary THA/TKA procedure during the index admission;
- Enrolled in Medicare fee-for-service (FFS) Part A and Part B for the 12 months prior to the date of the admission, and enrolled in Part A during the index admission;
- Aged 65 or over; and,
- Discharged alive from a non-federal short-term acute care hospital.

Isolated CABG surgeries are defined as those CABG procedures performed *without* the following concomitant valve or other major cardiac, vascular, or thoracic procedures:

- Valve procedures;
- Atrial and/or ventricular septal defects;
- Congenital anomalies;
- Other open cardiac procedures;
- Heart transplants;
- Aorta or other non-cardiac arterial bypass procedures;
- Head, neck, intracranial vascular procedures; or,
- Other chest and thoracic procedures.

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

- Femur, hip, or pelvic fractures coded in the principal or secondary discharge diagnosis fields of the index admission;
- A concurrent partial hip arthroplasty procedure;
- A concurrent revision procedure;
- A concurrent resurfacing procedure;
- Mechanical complication coded in the principal discharge diagnosis field;
- 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;
- Removal of implanted devices/prostheses; or,
- Transfer from another acute care facility for the THA/TKA.

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort for each measure are listed in Appendix D, in Tables D.1.1 and D.1.2 for CABG surgery, and Tables D.2.1, D.2.2, D.2.3, D.2.4, D.2.5, D.2.6, D.2.7, and D.2.8 for THA/TKA.

Index Admissions Excluded from the Measures

The readmission measures exclude index admissions for patients:

- Without at least 30 days post-discharge enrollment in FFS Medicare; or,
- Discharged against medical advice (AMA).

For patients with more than one qualifying CABG surgery admission in the measurement period, the first CABG admission is selected for inclusion in the measure and the subsequent CABG admission(s) are excluded from the cohort.

Additional exclusion criteria for the THA/TKA cohort:

- Patients admitted for the index procedure and subsequently transferred to another acute care facility; or,
- Patients with more than two THA/TKA procedure codes during the index hospitalization.

Additionally, for the THA/TKA cohort, admissions within 30 days of discharge from an index admission are excluded as index admissions. Thus, no hospitalization will be considered as both a readmission and an index admission within the same measure. However, because the cohorts for the readmission measures are determined independently of each other, a readmission in one measure may qualify as an index admission in other CMS readmission measures.

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 include removing claims with stays longer than one year, claims with overlapping dates, and records for providers with invalid provider IDs.

The percentage of admissions excluded based on each criterion is shown in [Section 4](#) in [Figure 4.2.1](#) and [Figure 4.3.1](#) for CABG surgery and THA/TKA, respectively.

Patients Transferred Between Hospitals

The measures consider multiple contiguous hospitalizations 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 short-term acute care hospital. Cases that meet this criterion are considered transfers regardless of whether or not the first institution indicates intent to transfer the patient in the discharge disposition code.

Admissions associated with transfers between acute care hospitals are not excluded from the CABG readmission measure. A transfer to another acute care facility after CABG surgery is most likely due to a complication of the CABG procedure or the peri-operative care the patient received, and as such, the care provided by the hospital performing the CABG procedure likely dominates readmission risk, even among

transferred patients. However, in a series of one or more transfers, the readmission outcome is always assigned to the hospital that performed the first (“index”) CABG surgery, even if it is not the discharging hospital. For example, if a patient is admitted to Hospital A and undergoes CABG surgery, and then transfers to Hospital B, an unplanned readmission within 30 days of the hospital B admission would be captured in Hospital A’s readmission outcome.

In contrast, admissions associated with transfers between acute care hospitals are excluded from the THA/TKA readmission measure, regardless of where the THA/TKA was performed. In cases where the THA/TKA procedure is performed at the receiving hospital, such procedures are not likely to be elective. When the THA/TKA procedure is performed at the transferring hospital, assignment of the outcome to the appropriate hospital is difficult.

Hospital Readmissions Reduction Program (HRRP)

CMS uses the THA/TKA and CABG surgery readmission measures in the HRRP. The HRRP includes only subsection (d) hospitals and hospitals located in Maryland. Critical access hospitals, cancer hospitals, and hospitals in U.S territories will not be included. Admissions to such hospitals will not be included as index admissions nor considered readmissions. Because the set of hospitals among which these measures are calculated for the HRRP differs from those used in calculations for the Hospital Inpatient Quality Reporting program, hospital scores may differ.

Note: Subsection (d) hospitals encompass any acute care hospital located in one of the fifty states or the District of Columbia which does not meet any of the following exclusion criteria as defined by the Social Security Act: psychiatric, rehabilitation, children’s, or long-term care hospitals, and cancer specialty centers. By definition, all other hospitals are considered subsection (d) hospitals.

More information about the HRRP can be found on *QualityNet’s Hospital Readmissions Reduction Program* webpage and in the FY 2013 - 2016 IPPS Final Rules on the CMS website.

2.2.2 Outcome

All-Cause Unplanned Readmissions

The measures are designed to capture unplanned readmissions that arise from acute clinical events requiring urgent rehospitalization within 30 days of discharge. Only an unplanned inpatient admission to a short-term acute care hospital can qualify as a readmission. Planned readmissions, which are generally not a signal of quality of care, are not considered readmissions in the measure outcome. For more detail about how planned readmissions are defined, refer to Section 2.2.3 and Appendix E.

All unplanned readmissions are considered an outcome, regardless of cause. There are a number of reasons for assessing unplanned readmissions for all causes in the CMS readmission measures. First, from a patient perspective, an unplanned readmission for any cause is an adverse event. In addition, making inferences about quality issues based

solely on the documented cause of readmission is difficult. For example, a patient might experience a procedure-related complication following his/her THA/TKA, which may go untreated and result in renal failure following discharge that necessitates readmission. In this context, considering the readmission to be unrelated to the care the patient received for the THA/TKA during the index admission would be inappropriate.

30-Day Time Frame

The measures assess unplanned readmissions within a 30-day period from the date of discharge from an index admission. The measures use a 30-day time frame because older adult patients are more vulnerable to adverse health outcomes during this time. Readmission occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities in an effort to reduce readmissions.⁷

Multiple Readmissions

If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first is considered a readmission. The measures assess a dichotomous yes or no outcome of whether each admitted patient has any unplanned readmission within 30 days. If the first readmission after discharge is planned, any subsequent unplanned readmission is not considered in the outcome for that index admission because the unplanned readmission could be related to care provided during the intervening planned readmission rather than during the index admission.

2.2.3 Planned Readmission Algorithm (Version 4.0)

The planned readmission algorithm is a set of criteria for classifying readmissions as planned among the general Medicare population using Medicare administrative claims data. The algorithm identifies admissions that are typically planned and may occur within 30 days of discharge from the hospital.

The planned readmission algorithm has three fundamental principles:

1. A few specific, limited types of care are always considered planned (for example, transplant surgery, maintenance chemotherapy/immunotherapy, rehabilitation);
2. Otherwise, a planned readmission is defined as a non-acute readmission for a scheduled procedure; and,
3. Admissions for acute illness or for complications of care are never planned.

The algorithm was developed in 2011 as part of the Hospital-Wide Readmission measure. In 2013, CMS applied the algorithm to its other readmission measures. The planned readmission algorithm replaced the definition of planned readmissions in the original THA/TKA measure because the algorithm uses a more comprehensive definition. In applying the algorithm to condition- and procedure-specific measures, teams of clinical experts reviewed the algorithm in the context of each measure-specific patient cohort and, where clinically indicated, adapted the content of the algorithm to better reflect the likely clinical experience of each measure's patient cohort. The CABG

and THA/TKA readmission measures make a few modifications to the planned readmission algorithm, which are listed in [Appendix E](#).

For each measure, the planned readmission algorithm uses a flowchart and four tables of specific procedure categories and discharge diagnosis categories to classify readmissions as planned ([Appendix E](#)). As illustrated in [Figure PR.1](#), readmissions are considered planned if any of the following occurs during the readmission:

1. A procedure is performed that is in one of the procedure categories that are always planned regardless of diagnosis;
2. The principal diagnosis is in one of the diagnosis categories that are always planned; or,
3. A procedure is performed that is in one of the potentially planned procedure categories and the principal diagnosis is not in the list of acute discharge diagnoses.

2.2.4 Risk-Adjustment Variables

In order to account for differences in patient mix among hospitals, the measures adjust for variables (for example, age, comorbid diseases, and indicators of patient frailty) that 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 12 months prior to, and including, the index admission.

The measures adjust for [case mix](#) differences among hospitals 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 that time or in the 12 months prior, and not complications that arise during the course of the hospitalization, are included in the risk adjustment.

The measures do not adjust for socioeconomic status (SES) because the association between SES and health outcomes can be due, in part, to differences in the quality of health care that groups of patients with varying SES receive. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important quality differences. Additionally, recent analyses show that hospitals caring for high proportions of low-SES patients perform similarly on the measures to hospitals caring for low proportions of low-SES patients.⁸ Please note that the Office of the Assistant Secretary for Planning and Evaluation (ASPE) is conducting research to examine the impact of SES on quality measures, resource use, and other measures under the Medicare program as directed by the IMPACT Act. ASPE will issue an initial report to Congress by October 2016 and a final report to Congress by October 2019. The findings in these reports will be considered in future reevaluation of these measures.

Refer to [Table D.1.3](#) and [Table D.2.9](#) in [Appendix D](#) of this report for the list of comorbidity risk-adjustment variables and the list of complications that are excluded from risk adjustment if they occur during the index admission, for CABG surgery and THA/TKA, respectively.

2.2.5 Data Sources

The data sources for these analyses are Medicare administrative claims data and enrollment information for patients with hospitalizations between July 1, 2012 and June 30, 2015. The period for public reporting of the THA/TKA readmission measure differs from the complementary THA/TKA complication measure, which includes admissions for elective THA/TKA procedures between April 1, 2012 and March 31, 2015, 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 for the 12 months prior to the index admission and one month subsequent to the index admission for patients admitted in this time period. See the original methodology reports for further descriptions of these data sources and an explanation of the three-year measurement period.^{1,2}

2.2.6 Measure Calculation

The measure estimates hospital-level 30-day all-cause RSRRs following each procedure using hierarchical logistic regression models. 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.⁹ At the patient level, it models the log-odds of hospital readmission within 30 days of discharge 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 readmission 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.⁹ If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects should be identical across all hospitals.

The RSRR is calculated as the ratio of the number of “predicted” readmissions to the number of “expected” readmissions at a given hospital, multiplied by the national observed readmission rate. For each hospital, the numerator of the ratio is the number of readmissions within 30 days predicted based on the hospital’s performance with its observed case mix, and the denominator is the number of readmissions 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 readmission rates or better quality, while a higher ratio indicates higher-than-expected readmission rates or worse quality.

The “predicted” number of readmissions (the numerator) is calculated using the coefficients estimated by regressing the risk factors (Table D.1.3 and Table D.2.9 for the CABG surgery and THA/TKA measures, respectively) and the hospital-specific effect on the risk of readmission. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by patient characteristics. The results are

log transformed and summed over all patients attributed to a hospital to get a predicted value. The “expected” number of readmissions (the denominator) is obtained in the same manner, but a common effect using all hospitals in our sample is added in place of the hospital-specific effect. The results are log transformed and summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period.

This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed readmission rate. The hierarchical logistic regression models are described fully in Appendix A and in the original methodology reports.^{1,2}

2.2.7 Categorizing Hospital Performance

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

- “No Different than the National Rate” if the 95% interval estimate surrounding the hospital’s rate includes the national observed readmission rate.
- “Worse than the National Rate” if the entire 95% interval estimate surrounding the hospital’s rate is higher than the national observed readmission rate.
- “Better than the National Rate” if the entire 95% interval estimate surrounding the hospital’s rate is lower than the national observed readmission 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 tell how well the hospital is performing. If a hospital has fewer than 25 eligible cases, the hospital’s readmission rates and interval estimates will not be publicly reported for the measure.

Section 4 describes the distribution of hospitals by performance category in the U.S. for this reporting period.

3. UPDATES TO MEASURES FOR 2016 PUBLIC REPORTING

3.1 Rationale for Measure Updates

Measure reevaluation ensures that the risk-standardized readmission models are continually assessed and remain valid, given possible changes in clinical practice and coding standards over time, while allowing for model refinements. Modifications made to measure cohorts, risk models, and outcomes are informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, and empirical analyses including assessment of coding trends that reveal shifts in clinical practice or billing patterns. As this report describes, for 2016 public reporting, we made the following modification to the measures:

- Updated the planned readmission algorithm based on findings from a validation study and review of those findings by clinical experts.

In addition, each year we assess measure characteristics and revise the statistical software code used to calculate measure results. As a part of these annual reevaluation activities, we undertook the following activities:

- Validated the performance of each procedure-specific model and its corresponding risk-adjustment variables in three recent one-year time periods (July 2012-June 2013, July 2013-June 2014, and July 2014-June 2015);
- Evaluated and validated model performance for the three years combined (July 2012-June 2015);
- Updated the measures' SAS analytic package (SAS pack) and documentation; and,
- Applied the 2015 version of the AHRQ CCS to the planned readmission algorithm.

Although hospitals are using International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) coding for discharges effective on or after October 1, 2015, ICD-10 codes for use in defining the cohorts, ICD-10-based Condition Category (CC) Groups for use in risk adjustment, and ICD-10-based Agency for Healthcare Research and Quality (AHRQ) Clinical Classification Software (CCS) diagnosis and procedure categories for use in planned readmission categorization were not incorporated into the measure specifications this year, as the measurement period for 2016 public reporting does not include claims data after June 30, 2015.

3.2 Detailed Discussion of Measure Updates

3.2.1 Update to Version 4.0 of Planned Readmission Algorithm

The planned readmission algorithm version 4.0 was modified from version 3.0 for 2016 public reporting. The changes from version 3.0 to version 4.0 have been applied to each readmission measure. Version 4.0 incorporates improvements made following a validation study of the algorithm which used data from a medical record review of 634 charts at seven hospitals and review of the results of that study by clinical experts.

Removal of Potentially Planned Procedure Categories

Version 4.0 of the planned readmission algorithm used in all of the CMS readmission measures removes the following five AHRQ CCS categories from the potentially planned procedure lists ([Table PR.3](#) and [Table PR.5](#) for CABG surgery and THA/TKA, respectively, as appropriate):

- AHRQ CCS 47 - Diagnostic cardiac catheterization; coronary arteriography
- AHRQ CCS 48 - Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
- AHRQ CCS 62 - Other diagnostic cardiovascular procedures
- AHRQ CCS 157 - Amputation of lower extremity
- AHRQ CCS 169 - Debridement of wound; infection or burn

However, in terms of the CABG surgery and the THA/TKA readmission measures, note that the removal of AHRQ CCS categories 47, 48, and 157 does not affect either measure, as these particular measures did not use these categories in determining a planned readmission (They apply only in the case of the condition-specific and hospital-wide readmission measures). Similarly, removal of AHRQ CCS category 169 does not affect the CABG surgery measure, as it was never considered a potentially planned procedure in that measure.

Rationale for Removal of Potentially Planned Procedure Categories

The planned readmission algorithm version 3.0 categorized the five AHRQ CCS procedure categories above as planned. However, the validation study revealed that they were very often found to be unplanned in medical record review. We determined that any potential change in the algorithm warranted review by clinical experts in order to reverse the decision of the development working group to include these procedure categories on the lists of potentially planned procedures. Two panels of cardiology experts, including interventional cardiologists and electrophysiologists, were convened. Removal of these procedure categories was confirmed by the panels.

Addition of Potentially Planned Procedures Category

Version 4.0 of the planned readmission algorithm adds AHRQ CCS procedure category 1, Incision and excision of CNS (central nervous system), to the potentially planned procedure lists ([Table PR.3](#) and [Table PR.5](#) for CABG surgery and THA/TKA, respectively).

Rationale for Addition of Potentially Planned Procedures Category

A stakeholder suggested that CMS add AHRQ CCS procedure category 1, Incision and excision of CNS, to the lists of potentially planned procedures because procedures within this CCS category are usually performed during planned admissions. The stakeholder suggested that initial hospitalizations in which CNS tumors are diagnosed are often followed by a period of diagnostic testing after which patients are electively readmitted for resection. A clinical expert panel was convened and confirmed the observations of this

single stakeholder, and recommended inclusion of AHRQ CCS 1 on the planned readmission algorithm’s potentially planned procedures lists.

Full descriptions of the rationale for each change are listed in [Table 3.2.1](#). The full list of codes in version 4.0 of the planned readmission algorithm is located in [Appendix E](#).

Table 3.2.1 – Updates to Planned Readmission Algorithm 3.0

Action	Procedure category	Rationale
Remove from planned procedure list	Diagnostic cardiac catheterization; coronary arteriography (AHRQ CCS 47)	These cardiac procedures are rarely the main reason for an elective inpatient hospitalization. Typically, these procedures are done during an observation stay. Removal of these procedure categories from the potentially planned procedures list reduces the rate of misclassification of unplanned readmissions as planned.
	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator (AHRQ CCS 48)	
	Other diagnostic cardiovascular procedures (AHRQ CCS 62)	
	Amputation of lower extremity (AHRQ CCS 157)	
	Debridement of wound; infection or burn (AHRQ CCS 169)	Readmissions for these procedures typically represent worsening of wound unresponsive to previous management. Removal of these procedure categories from the potentially planned procedures list reduces the rate of misclassification of unplanned readmissions as planned.
Add to planned procedure list	Incision and excision of CNS (AHRQ CCS 1)	Patients admitted with newly diagnosed brain tumors may be electively readmitted for definitive management. The addition of this procedure category to the acute diagnoses list reduces the misclassification of planned readmissions as unplanned.

Effect on the Measures

These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designated as planned or unplanned. The impact of the planned readmission algorithm changes on the CABG surgery and THA/TKA measures is summarized in [Table 3.2.2](#) and [Table 3.2.3](#), respectively.

Table 3.2.2 – Effect of Planned Readmission Algorithm on CABG Surgery Measure (2011-2014)

	CABG Surgery with Planned Readmission Version 3.0	CABG Surgery with Planned Readmission Version 4.0
Number of Admissions	137,874	137,874
Number of Unplanned Readmissions	20,603	20,676
Unplanned Readmission Rate	14.9%	15.0%
Number of Planned Readmissions	343	270
Planned Readmission Rate	0.2%	0.2%
% of Readmissions that are Planned	1.6%	1.3%

Table 3.2.3 – Effect of Planned Readmission Algorithm on THA/TKA Measure (2011-2014)

	THA/TKA with Planned Readmission Version 3.0	THA/TKA with Planned Readmission Version 4.0
Number of Admissions	926,685	926,685
Number of Unplanned Readmissions	44,926	44,970
Unplanned Readmission Rate	4.8%	4.9%
Number of Planned Readmissions	2,225	2,181
Planned Readmission Rate	0.2%	0.2%
% of Readmissions that are Planned	4.7%	4.6%

3.3 Changes to SAS Pack

We revised the measure calculation SAS pack to reflect all changes to the measure outcomes. The new SAS pack and documentation are available upon request by emailing cmsreadmissionmeasures@yale.edu. **Do NOT submit patient-identifiable information (for example, date of birth, Social Security number, health insurance claim number) to this address.**

The SAS pack describes 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 RSRR calculation without the data files which contain longitudinal patient data from the entire national sample of acute care hospitals to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2016 PUBLIC REPORTING

4.1 Assessment of Updated Models

The readmission measures estimate hospital-specific 30-day all-cause RSRRs using hierarchical logistic regression models. See [Section 2](#) for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and technical reports for further details.¹⁻⁵

We evaluated the performance of the models using the July 2012 to June 2015 data for 2016 reporting. We examined differences in the frequency of patient risk factors and the model variable coefficients.

For each of the procedures, we assessed logistic regression model performance in terms of discriminant ability for each year of data and for the three-year combined period. We computed two summary statistics to assess model performance: the predictive ability and the area under the receiver operating characteristic (ROC) curve (c-statistic). The c-statistic is an indicator of the model's discriminant ability or ability to correctly classify those who have and have not been readmitted within 30 days of discharge. Potential values range from 0.5, meaning no better than chance, to 1.0, an indication of perfect prediction. Perfect prediction implies patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in patients' outcomes.

The results of these analyses for the CABG surgery and THA/TKA readmission measures are presented in [Section 4.2](#) and [Section 4.3](#), respectively.

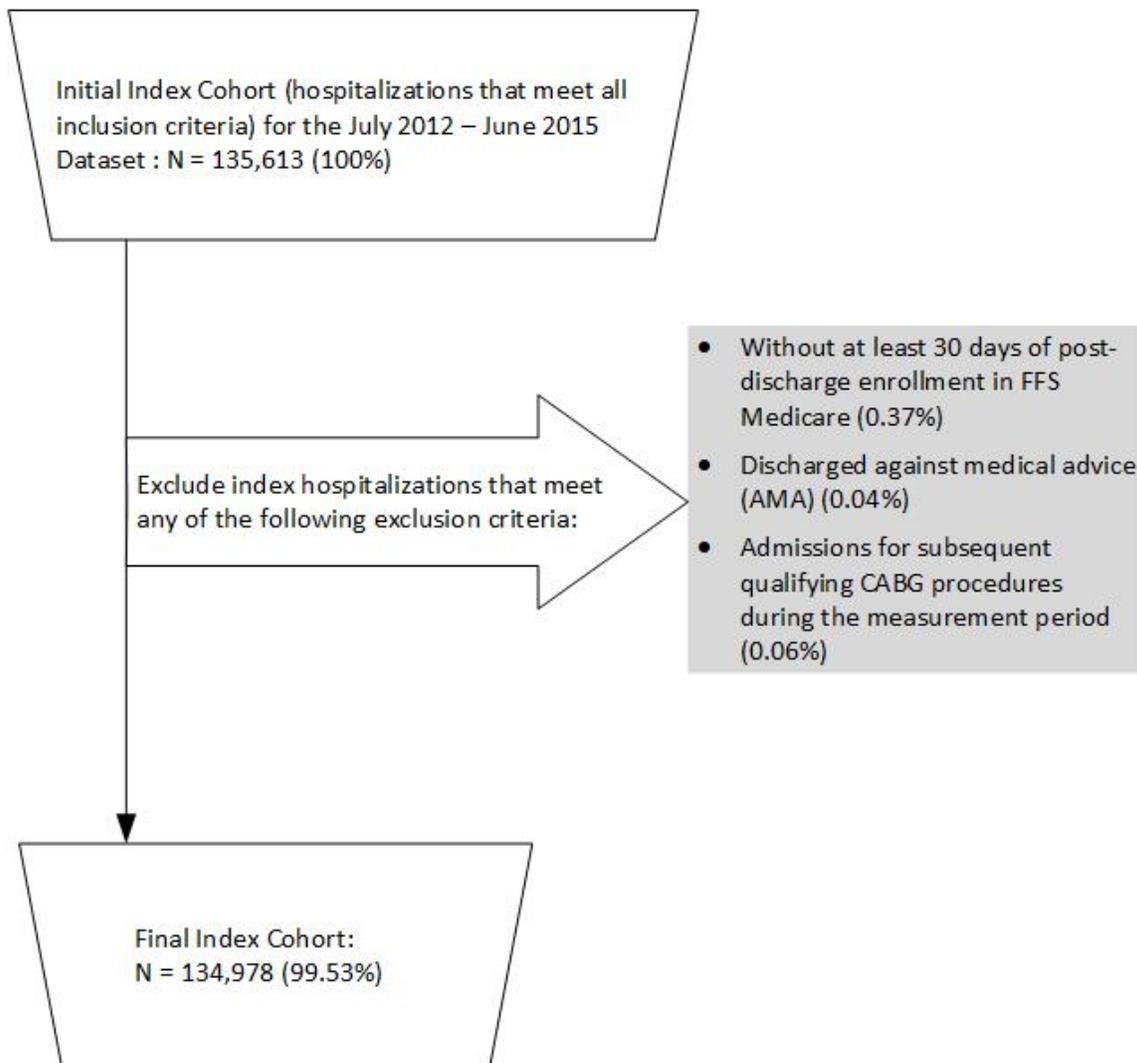
4.2 CABG Surgery Readmission 2016 Model Results

4.2.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in [Section 2.2.1](#). The percentage of CABG surgery admissions meeting each exclusion criterion in the July 2012-June 2015 dataset is presented in [Figure 4.2.1](#).

Admissions may have been counted in more than one exclusion category because the categories are not mutually exclusive. The index cohort includes short-term acute care hospitalizations for Medicare patients aged 65 or over with a qualifying isolated CABG procedure; enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission; and were alive at discharge.

Figure 4.2.1 – CABG Surgery Cohort Exclusions in the July 2012-June 2015 Dataset



4.2.2 Frequency of CABG Surgery Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 15.0% to 13.9%. Notable changes in the frequencies for model variables include:

- Decrease in Chronic Obstructive Pulmonary Disease (COPD) (26.1% to 25.1%)
- Increases in Male % (70.5% to 72.2%), Diabetes mellitus (DM) or DM complications (50.3% to 51.5%), Polyneuropathy (10.3% to 12.0%), Specified arrhythmias and other heart rhythm disorders (29.4% to 30.4%), and Renal failure (17.2% to 18.7%)

Refer to [Table 4.2.1](#) for more detail.

4.2.3 CABG Surgery Model Parameters and Performance

[Table 4.2.2](#) shows hierarchical regression model variable coefficients by individual year and for the combined three-year dataset. [Table 4.2.3](#) shows the risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the CABG readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the c-statistic increased slightly from 0.62 to 0.64 ([Table 4.2.4](#)).

4.2.4 Distribution of Hospital Volumes and RSRRs for CABG Surgery

[Table 4.2.5](#) shows the distribution of hospital admission volumes and [Table 4.2.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 15.0% between July 2012 and June 2013 to 13.9% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 14.4% (Interquartile Range [IQR] 13.8% - 15.0%). [Table 4.2.7](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.031 (Standard Error [SE]: 0.004). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

[Figure 4.2.2](#) shows the overall distribution of the hospital RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation (SD) above the national rate were 1.42 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.⁹

4.2.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset

Of 1,193 hospitals in the study cohort, 5 performed “Better than the National Rate,” 1,027 performed “No Different than the National Rate,” and 7 performed “Worse than the National Rate.” 154 were classified as “Number of Cases Too Small” (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.2.1 – Frequency of CABG Surgery Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	45,451	44,945	44,582	134,978
Observed readmission rate (%)	15.0	14.2	13.9	14.4
Mean age minus 65 (SD)	8.8 (5.7)	8.7 (5.7)	8.6 (5.7)	8.7 (5.7)
Male (%)	70.5	71.6	72.2	71.4
History of Coronary Artery Bypass Graft (CABG) or valve surgery (ICD-9 diagnosis codes: V42.2, V43.3, V45.81, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 996.02, 996.03; ICD-9 procedure code: 39.61)	5.4	5.1	5.0	5.2
Cardiogenic shock (ICD-9 diagnosis code 785.51)	4.5	4.8	5.4	4.9
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	26.1	25.8	25.1	25.7
Cancer; metastatic cancer and acute leukemia (CC 7-12)	19.1	19.0	19.0	19.0
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	50.3	51.0	51.5	50.9
Protein-calorie malnutrition (CC 21)	4.7	4.3	4.1	4.4
Disorders of fluid/electrolyte/acid-base (CC 22-23)	18.6	18.9	19.4	19.0
Other endocrine/metabolic/nutritional disorders (CC 24)	93.6	94.0	94.5	94.0
Severe hematological disorders (CC 44)	0.6	0.6	0.5	0.6
Dementia or other specified brain disorders (CC 49-50)	5.8	5.7	5.5	5.6
Major psychiatric disorders (CC 54-56)	4.5	4.7	4.8	4.6
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	3.4	3.4	3.6	3.5
Polyneuropathy (CC 71)	10.3	11.2	12.0	11.2
Congestive heart failure (CC 80)	19.9	20.3	19.9	20.0
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	29.4	30.3	30.4	30.0
Stroke (CC 95-96)	4.7	4.7	4.9	4.8
Cerebrovascular disease (CC 97-99, 103)	28.3	28.1	27.4	27.9
Vascular or circulatory disease (CC 104-106)	33.1	33.7	33.1	33.3
Fibrosis of lung or other chronic lung disorders (CC 109)	4.3	4.0	4.0	4.1
Pneumonia (CC 111-113)	12.8	12.3	12.3	12.5
Other lung disorders (CC 115)	33.2	32.6	32.6	32.8
Dialysis status (CC 130)	2.0	1.9	2.0	2.0
Renal failure (CC 131)	17.2	17.8	18.7	17.9
Decubitus ulcer or chronic skin ulcer (CC 148-149)	3.5	3.6	3.6	3.6

Table 4.2.2 – Hierarchical Logistic Regression Model Variable Coefficients for CABG Surgery Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.224	-2.343	-2.528	-2.354
Age minus 65 (years above 65, continuous)	0.021	0.031	0.025	0.026
Male	-0.208	-0.250	-0.205	-0.222
History of Coronary Artery Bypass Graft (CABG) or valve surgery (ICD-9 diagnosis codes: V42.2, V43.3, V45.81, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 996.02, 996.03; ICD-9 procedure code: 39.61)	-0.010	-0.023	-0.022	-0.015
Cardiogenic shock (ICD-9 diagnosis code 785.51)	0.242	0.339	0.325	0.304
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.267	0.327	0.348	0.310
Cancer; metastatic cancer and acute leukemia (CC 7-12)	0.005	0.017	0.010	0.012
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.147	0.181	0.139	0.154
Protein-calorie malnutrition (CC 21)	0.252	0.295	0.277	0.278
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.095	0.037	0.088	0.073
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.014	-0.122	0.094	-0.020
Severe hematological disorders (CC 44)	0.324	0.360	0.450	0.379
Dementia or other specified brain disorders (CC 49-50)	0.066	0.149	0.186	0.132
Major psychiatric disorders (CC 54-56)	0.208	0.077	0.189	0.158
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.150	-0.103	0.141	0.069
Polyneuropathy (CC 71)	0.140	0.177	0.242	0.186
Congestive heart failure (CC 80)	0.199	0.205	0.145	0.184
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.120	0.095	0.133	0.116
Stroke (CC 95-96)	-0.011	0.113	0.012	0.037
Cerebrovascular disease (CC 97-99, 103)	-0.077	-0.005	0.036	-0.015
Vascular or circulatory disease (CC 104-106)	0.097	0.132	0.080	0.104
Fibrosis of lung or other chronic lung disorders (CC 109)	0.098	0.180	0.115	0.127
Pneumonia (CC 111-113)	0.227	0.143	0.273	0.212
Other lung disorders (CC 115)	0.022	0.118	0.069	0.072
Dialysis status (CC 130)	0.237	0.370	0.324	0.311
Renal failure (CC 131)	0.244	0.276	0.188	0.235
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.322	0.228	0.233	0.258

Table 4.2.3 – Adjusted OR and 95% CIs for the CABG Surgery Hierarchical Logistic Regression Model Over Different Time Periods

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.02 (1.02 - 1.03)	1.03 (1.03 - 1.04)	1.03 (1.02 - 1.03)	1.03 (1.02 - 1.03)
Male	0.81 (0.77 - 0.86)	0.78 (0.74 - 0.83)	0.82 (0.77 - 0.87)	0.80 (0.78 - 0.83)
History of Coronary Artery Bypass Graft (CABG) or valve surgery (ICD-9 diagnosis codes: V42.2, V43.3, V45.81, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 996.02, 996.03; ICD-9 procedure code: 39.61)	0.99 (0.89 - 1.11)	0.98 (0.87 - 1.10)	0.98 (0.87 - 1.11)	0.99 (0.92 - 1.05)
Cardiogenic shock (ICD-9 diagnosis code 785.51)	1.27 (1.14 - 1.43)	1.40 (1.26 - 1.57)	1.39 (1.24 - 1.54)	1.36 (1.27 - 1.45)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.31 (1.23 - 1.39)	1.39 (1.31 - 1.47)	1.42 (1.33 - 1.51)	1.36 (1.32 - 1.41)
Cancer; metastatic cancer and acute leukemia (CC 7-12)	1.01 (0.94 - 1.07)	1.02 (0.95 - 1.09)	1.01 (0.94 - 1.08)	1.01 (0.97 - 1.05)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.16 (1.10 - 1.22)	1.20 (1.13 - 1.27)	1.15 (1.08 - 1.22)	1.17 (1.13 - 1.21)
Protein-calorie malnutrition (CC 21)	1.29 (1.15 - 1.44)	1.34 (1.20 - 1.51)	1.32 (1.17 - 1.49)	1.32 (1.24 - 1.41)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.10 (1.03 - 1.18)	1.04 (0.97 - 1.12)	1.09 (1.02 - 1.18)	1.08 (1.03 - 1.12)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.99 (0.88 - 1.10)	0.89 (0.79 - 0.99)	1.10 (0.97 - 1.25)	0.98 (0.92 - 1.05)
Severe hematological disorders (CC 44)	1.38 (1.03 - 1.85)	1.43 (1.08 - 1.91)	1.57 (1.15 - 2.14)	1.46 (1.23 - 1.73)
Dementia or other specified brain disorders (CC 49-50)	1.07 (0.96 - 1.19)	1.16 (1.04 - 1.29)	1.21 (1.08 - 1.34)	1.14 (1.07 - 1.21)
Major psychiatric disorders (CC 54-56)	1.23 (1.10 - 1.38)	1.08 (0.96 - 1.22)	1.21 (1.08 - 1.36)	1.17 (1.10 - 1.25)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.16 (1.02 - 1.33)	0.90 (0.78 - 1.04)	1.15 (1.00 - 1.32)	1.07 (0.99 - 1.16)
Polyneuropathy (CC 71)	1.15 (1.06 - 1.25)	1.19 (1.10 - 1.30)	1.27 (1.18 - 1.38)	1.21 (1.15 - 1.26)
Congestive heart failure (CC 80)	1.22 (1.14 - 1.31)	1.23 (1.15 - 1.32)	1.16 (1.08 - 1.24)	1.20 (1.16 - 1.25)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.13 (1.06 - 1.20)	1.10 (1.04 - 1.17)	1.14 (1.08 - 1.21)	1.12 (1.09 - 1.16)
Stroke (CC 95-96)	0.99 (0.87 - 1.12)	1.12 (0.99 - 1.27)	1.01 (0.89 - 1.15)	1.04 (0.97 - 1.12)
Cerebrovascular disease (CC 97-99, 103)	0.93 (0.87 - 0.99)	1.00 (0.93 - 1.06)	1.04 (0.97 - 1.11)	0.99 (0.95 - 1.02)
Vascular or circulatory disease (CC 104-106)	1.10 (1.04 - 1.17)	1.14 (1.08 - 1.21)	1.08 (1.02 - 1.15)	1.11 (1.07 - 1.15)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.10 (0.98 - 1.24)	1.20 (1.06 - 1.35)	1.12 (0.99 - 1.27)	1.14 (1.06 - 1.22)
Pneumonia (CC 111-113)	1.26 (1.16 - 1.35)	1.15 (1.07 - 1.25)	1.31 (1.22 - 1.42)	1.24 (1.18 - 1.29)
Other lung disorders (CC 115)	1.02 (0.97 - 1.08)	1.13 (1.06 - 1.19)	1.07 (1.01 - 1.14)	1.08 (1.04 - 1.11)
Dialysis status (CC 130)	1.27 (1.08 - 1.49)	1.45 (1.23 - 1.71)	1.38 (1.17 - 1.63)	1.37 (1.24 - 1.50)
Renal failure (CC 131)	1.28 (1.19 - 1.37)	1.32 (1.23 - 1.42)	1.21 (1.12 - 1.30)	1.26 (1.21 - 1.32)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.38 (1.22 - 1.56)	1.26 (1.11 - 1.43)	1.26 (1.11 - 1.44)	1.30 (1.20 - 1.39)

Table 4.2.4 – CABG Surgery Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	7.9 - 27.9	6.3 - 27.8	6.4 - 26.9	7.0 - 27.4
c-statistic	0.62	0.64	0.64	0.63

Table 4.2.5 – Distribution of Hospital CABG Surgery Admission Volumes Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	1,162	1,156	1,148	1,193
Mean number of admissions (SD)	39.1 (34.7)	38.9 (34.3)	38.8 (34.7)	113.1 (102.1)
Range (min. – max.)	1 – 246	1 - 265	1 - 275	1 - 785
25 th percentile	15	16	15	44
50 th percentile	29	29	29	84
75 th percentile	53	51	52	152

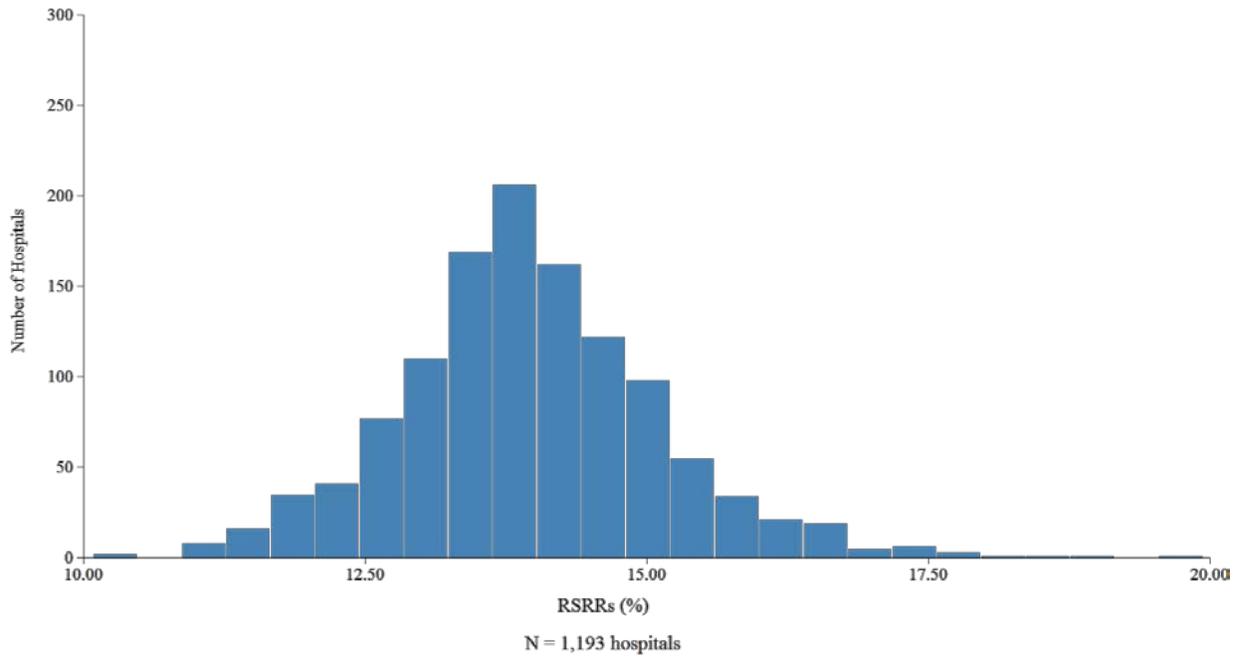
Table 4.2.6 – Distribution of Hospital CABG Surgery RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	1,162	1,156	1,148	1,193
Mean (SD)	15.0 (0.8)	14.3 (0.6)	13.9 (1.1)	14.4 (1.1)
Range (min. – max.)	12.0 - 18.5	12.7 - 17.7	10.5 - 20.2	10.9 - 19.9
25 th percentile	14.5	13.9	13.3	13.8
50 th percentile	15.0	14.2	13.9	14.4
75 th percentile	15.5	14.6	14.5	15.0

Table 4.2.7 – Between-Hospital Variance for CABG Surgery

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.033 (0.009)	0.027 (0.009)	0.051 (0.011)	0.031 (0.004)

Figure 4.2.2 – Distribution of Hospital 30-Day CABG Surgery RSRRs Between July 2012 and June 2015



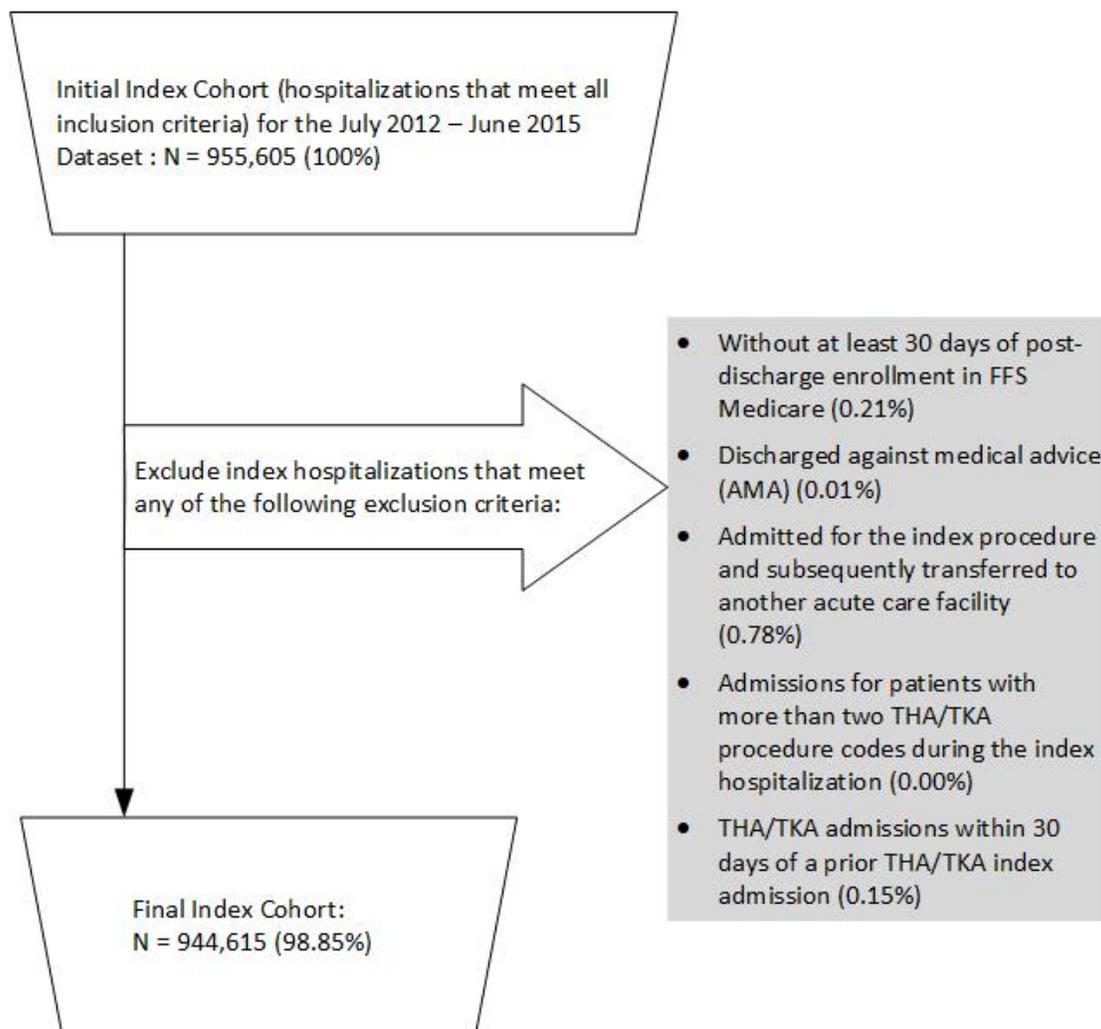
4.3 THA/TKA Readmission 2016 Model Results

4.3.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in [Section 2.2.1](#). The percentage of THA/TKA admissions meeting each exclusion criterion in the July 2012-June 2015 dataset is presented in [Figure 4.3.1](#).

Admissions may have been counted in more than one exclusion category because the categories are not mutually exclusive. The index cohort includes short-term acute care hospitalizations for Medicare patients aged 65 or over with a qualifying elective primary THA/TKA procedure; enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission; and who were alive at discharge.

Figure 4.3.1 – THA/TKA Cohort Exclusions in the July 2012-June 2015 Dataset



4.3.2 Frequency of THA/TKA Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 4.9% to 4.5%. Notable changes in the frequencies for model variables include:

- Decreases in Coronary atherosclerosis or angina (27.3% to 25.4%), Hypertension (82.7% to 81.4%), and Major symptoms, abnormalities (51.2% to 49.2%)
- Increases in Morbid obesity (5.9% to 6.6%) and Renal failure (8.7% to 9.5%)

Refer to [Table 4.3.1](#) for more detail.

4.3.3 THA/TKA Model Parameters and Performance

[Table 4.3.2](#) shows hierarchical regression model coefficients by individual year and for the combined three-year dataset. [Table 4.3.3](#) shows the risk-adjusted ORs and 95% CIs for the THA/TKA readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three year time period; the c-statistic increased slightly from 0.65 to 0.66 ([Table 4.3.4](#)).

4.3.4 Distribution of Hospital Volumes and RSRRs for THA/TKA

[Table 4.3.5](#) shows the distribution of hospital admission volumes and [Table 4.3.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 4.9% between July 2012 and June 2013 to 4.5% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 4.6% (IQR 4.4% - 4.9%). [Table 4.3.7](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.049 (SE: 0.004). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

[Figure 4.3.2](#) shows the overall distribution of the hospital RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one SD above the national rate were 1.56 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.⁹

4.3.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset

Of 3,473 hospitals in the study cohort, 48 performed “Better than the National Rate,” 2,740 performed “No Different from the National Rate,” and 31 performed “Worse than the National Rate.” 654 were classified as “Number of Cases Too Small” (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.3.1 – Frequency of THA/TKA Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	307,122	318,490	319,003	944,615
Observed readmission rate (%)	4.9	4.5	4.5	4.6
Mean age minus 65 (SD)	9.7 (6.0)	9.5 (6.0)	9.4 (6.0)	9.5 (6.0)
Male (%)	36.7	37.3	37.2	37.1
Index admissions with an elective THA procedure	30.5	31.0	32.1	31.2
Number of procedures (two vs. one)	2.3	2.3	2.1	2.2
Morbid obesity (ICD-9 diagnosis code 278.01)	5.9	6.2	6.6	6.2
Other congenital deformity of hip (joint) (ICD-9 diagnosis code 755.63)	0.2	0.2	0.2	0.2
Post traumatic osteoarthritis (ICD-9 diagnosis codes 716.15, 716.16)	0.4	0.4	0.4	0.4
History of infection (CC 1, 3-6)	17.7	17.6	17.5	17.6
Metastatic cancer or acute leukemia (CC 7)	0.6	0.6	0.6	0.6
Cancer (CC 8-12)	18.4	18.4	18.3	18.3
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	28.6	28.2	28.1	28.3
Protein-calorie malnutrition (CC 21)	0.8	0.7	0.7	0.7
Disorders of fluid/electrolyte/acid-base (CC 22-23)	13.1	12.9	12.9	13.0
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	9.3	9.2	9.3	9.3
Severe hematological disorders (CC 44)	0.4	0.4	0.4	0.4
Dementia or other specified brain disorders (CC 49-50)	4.2	4.1	4.1	4.1
Major psychiatric disorders (CC 54-56)	4.6	4.7	4.8	4.7
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.7	1.6	1.6	1.6
Polyneuropathy (CC 71)	7.0	7.2	7.4	7.2
Congestive heart failure (CC 80)	8.6	8.5	8.3	8.5
Coronary atherosclerosis or angina (CC 83-84)	27.3	26.4	25.4	26.3
Hypertension (CC 89, 91)	82.7	82.2	81.4	82.1
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	23.9	24.2	24.3	24.1
Stroke (CC 95-96)	2.1	2.1	2.1	2.1
Vascular or circulatory disease (CC 104-106)	22.1	21.9	21.7	21.9
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	13.5	13.0	12.6	13.0
Pneumonia (CC 111-113)	4.1	4.1	3.9	4.0
Dialysis status (CC 130)	0.2	0.2	0.2	0.2
Renal failure (CC 131)	8.7	9.1	9.5	9.1
Decubitus ulcer or chronic skin ulcer (CC 148-149)	2.4	2.4	2.4	2.4
Cellulitis, local skin infection (CC 152)	7.5	7.3	7.1	7.3
Other injuries (CC 162)	27.9	27.6	27.8	27.8
Major symptoms, abnormalities (CC 166)	51.2	50.2	49.2	50.2

Table 4.3.2 – Hierarchical Logistic Regression Model Variable Coefficients for THA/TKA Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-4.184	-4.205	-4.260	-4.201
Age minus 65 (years above 65, continuous)	0.035	0.036	0.038	0.037
Male	0.165	0.115	0.153	0.145
Index admissions with an elective THA procedure	0.103	0.077	0.130	0.106
Number of procedures (two vs. one)	0.354	0.189	0.375	0.316
Morbid obesity (ICD-9 diagnosis code 278.01)	0.277	0.287	0.304	0.288
Other congenital deformity of hip (joint) (ICD-9 diagnosis code 755.63)	-0.182	-0.139	0.008	-0.095
Post traumatic osteoarthritis (ICD-9 diagnosis codes 716.15, 716.16)	-0.146	0.172	-0.093	-0.020
History of infection (CC 1, 3-6)	0.061	0.084	0.066	0.068
Metastatic cancer or acute leukemia (CC 7)	0.095	0.091	0.167	0.120
Cancer (CC 8-12)	-0.020	-0.018	-0.031	-0.022
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.147	0.118	0.114	0.124
Protein-calorie malnutrition (CC 21)	0.257	0.292	0.030	0.198
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.095	0.128	0.161	0.127
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	0.154	0.149	0.125	0.143
Severe hematological disorders (CC 44)	0.219	0.483	0.301	0.336
Dementia or other specified brain disorders (CC 49-50)	0.215	0.201	0.151	0.189
Major psychiatric disorders (CC 54-56)	0.274	0.266	0.317	0.286
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.132	0.147	0.182	0.154
Polyneuropathy (CC 71)	0.123	0.164	0.140	0.142
Congestive heart failure (CC 80)	0.194	0.262	0.190	0.214
Coronary atherosclerosis or angina (CC 83-84)	0.169	0.189	0.182	0.180
Hypertension (CC 89, 91)	0.258	0.212	0.205	0.222
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.162	0.117	0.149	0.143
Stroke (CC 95-96)	0.155	0.126	0.153	0.143
Vascular or circulatory disease (CC 104-106)	0.154	0.126	0.120	0.134
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.285	0.316	0.316	0.302
Pneumonia (CC 111-113)	0.180	0.108	0.153	0.147
Dialysis status (CC 130)	0.725	0.627	0.683	0.674
Renal failure (CC 131)	0.224	0.257	0.258	0.244
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.173	0.140	0.172	0.161
Cellulitis, local skin infection (CC 152)	0.122	0.069	0.152	0.115
Other injuries (CC 162)	0.099	0.078	0.104	0.094
Major symptoms, abnormalities (CC 166)	0.160	0.160	0.151	0.157

Table 4.3.3 – Adjusted OR and 95% CIs for the THA/TKA Hierarchical Logistic Regression Model Over Different Time Periods

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.00 (1.03-1.04)	1.00 (1.03-1.04)	1.00 (1.04-1.04)	1.00 (1.04-1.04)
Male	1.20 (1.14-1.22)	1.10 (1.08-1.16)	1.20 (1.12-1.21)	1.20 (1.13-1.18)
Index admissions with an elective THA procedure	1.10 (1.07-1.15)	1.10 (1.04-1.12)	1.10 (1.10-1.18)	1.10 (1.09-1.14)
Number of procedures (two vs. one)	1.40 (1.28-1.58)	1.20 (1.07-1.36)	1.50 (1.30-1.63)	1.40 (1.29-1.46)
Morbid obesity (ICD-9 diagnosis code 278.01)	1.30 (1.24-1.41)	1.30 (1.25-1.42)	1.40 (1.27-1.44)	1.30 (1.29-1.38)
Other congenital deformity of hip (joint) (ICD-9 diagnosis code 755.63)	0.80 (0.55-1.25)	0.90 (0.58-1.32)	1.00 (0.70-1.44)	0.90 (0.73-1.14)
Post traumatic osteoarthritis (ICD-9 diagnosis codes 716.15, 716.16)	0.90 (0.66-1.13)	1.20 (0.92-1.53)	0.90 (0.69-1.20)	1.00 (0.84-1.14)
History of infection (CC 1, 3-6)	1.10 (1.02-1.11)	1.10 (1.04-1.14)	1.10 (1.02-1.11)	1.10 (1.04-1.10)
Metastatic cancer or acute leukemia (CC 7)	1.10 (0.90-1.34)	1.10 (0.90-1.34)	1.20 (0.97-1.44)	1.10 (1.01-1.26)
Cancer (CC 8-12)	1.00 (0.94-1.02)	1.00 (0.94-1.03)	1.00 (0.93-1.01)	1.00 (0.95-1.00)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.20 (1.12-1.20)	1.10 (1.08-1.17)	1.10 (1.08-1.16)	1.10 (1.11-1.16)
Protein-calorie malnutrition (CC 21)	1.30 (1.13-1.48)	1.30 (1.16-1.54)	1.00 (0.88-1.21)	1.20 (1.12-1.32)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.10 (1.05-1.15)	1.10 (1.08-1.19)	1.20 (1.12-1.23)	1.10 (1.10-1.17)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	1.20 (1.11-1.23)	1.20 (1.10-1.22)	1.10 (1.07-1.20)	1.20 (1.12-1.19)
Severe hematological disorders (CC 44)	1.20 (1.02-1.52)	1.60 (1.34-1.96)	1.40 (1.09-1.68)	1.40 (1.25-1.57)
Dementia or other specified brain disorders (CC 49-50)	1.20 (1.16-1.33)	1.20 (1.14-1.31)	1.20 (1.08-1.25)	1.20 (1.16-1.26)
Major psychiatric disorders (CC 54-56)	1.30 (1.23-1.41)	1.30 (1.22-1.40)	1.40 (1.28-1.47)	1.30 (1.28-1.38)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.10 (1.03-1.27)	1.20 (1.04-1.29)	1.20 (1.08-1.34)	1.20 (1.10-1.24)
Polyneuropathy (CC 71)	1.10 (1.07-1.20)	1.20 (1.11-1.25)	1.20 (1.09-1.22)	1.20 (1.12-1.19)
Congestive heart failure (CC 80)	1.20 (1.15-1.28)	1.30 (1.23-1.37)	1.20 (1.15-1.28)	1.20 (1.20-1.28)
Coronary atherosclerosis or angina (CC 83-84)	1.20 (1.14-1.23)	1.20 (1.16-1.26)	1.20 (1.15-1.25)	1.20 (1.17-1.22)
Hypertension (CC 89, 91)	1.30 (1.23-1.37)	1.20 (1.17-1.31)	1.20 (1.16-1.29)	1.20 (1.21-1.29)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.20 (1.13-1.22)	1.10 (1.08-1.17)	1.20 (1.12-1.21)	1.20 (1.13-1.18)
Stroke (CC 95-96)	1.20 (1.06-1.28)	1.10 (1.03-1.25)	1.20 (1.06-1.28)	1.20 (1.09-1.22)
Vascular or circulatory disease (CC 104-106)	1.20 (1.12-1.21)	1.10 (1.09-1.18)	1.10 (1.08-1.17)	1.10 (1.12-1.17)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.30 (1.27-1.39)	1.40 (1.31-1.43)	1.40 (1.31-1.43)	1.40 (1.32-1.39)
Pneumonia (CC 111-113)	1.20 (1.12-1.28)	1.10 (1.04-1.20)	1.20 (1.09-1.25)	1.20 (1.11-1.21)
Dialysis status (CC 130)	2.10 (1.62-2.62)	1.90 (1.48-2.36)	2.00 (1.58-2.48)	2.00 (1.71-2.24)
Renal failure (CC 131)	1.30 (1.19-1.32)	1.30 (1.23-1.36)	1.30 (1.23-1.36)	1.30 (1.24-1.31)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.20 (1.09-1.30)	1.10 (1.05-1.26)	1.20 (1.09-1.30)	1.20 (1.12-1.24)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Cellulitis, local skin infection (CC 152)	1.10 (1.07-1.20)	1.10 (1.01-1.14)	1.20 (1.10-1.23)	1.10 (1.08-1.16)
Other injuries (CC 162)	1.10 (1.06-1.15)	1.10 (1.04-1.12)	1.10 (1.07-1.15)	1.10 (1.08-1.12)
Major symptoms, abnormalities (CC 166)	1.20 (1.13-1.22)	1.20 (1.13-1.22)	1.20 (1.12-1.21)	1.20 (1.14-1.19)

Table 4.3.4 – THA/TKA Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	1.7 - 11.0	1.8 - 10.5	1.6 - 10.4	1.7 - 10.6
c-statistic	0.65	0.66	0.66	0.66

Table 4.3.5 – Distribution of Hospital THA/TKA Admission Volumes Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,332	3,308	3,290	3,473
Mean number of admissions (SD)	92.2 (128.0)	96.3 (133.5)	97.0 (137.4)	272.0 (389.7)
Range (min. – max.)	1 - 2,408	1 - 2,555	1 - 2,780	1 - 7,743
25 th percentile	15	16	15	40
50 th percentile	48	50	50	133
75 th percentile	122	128	128	363

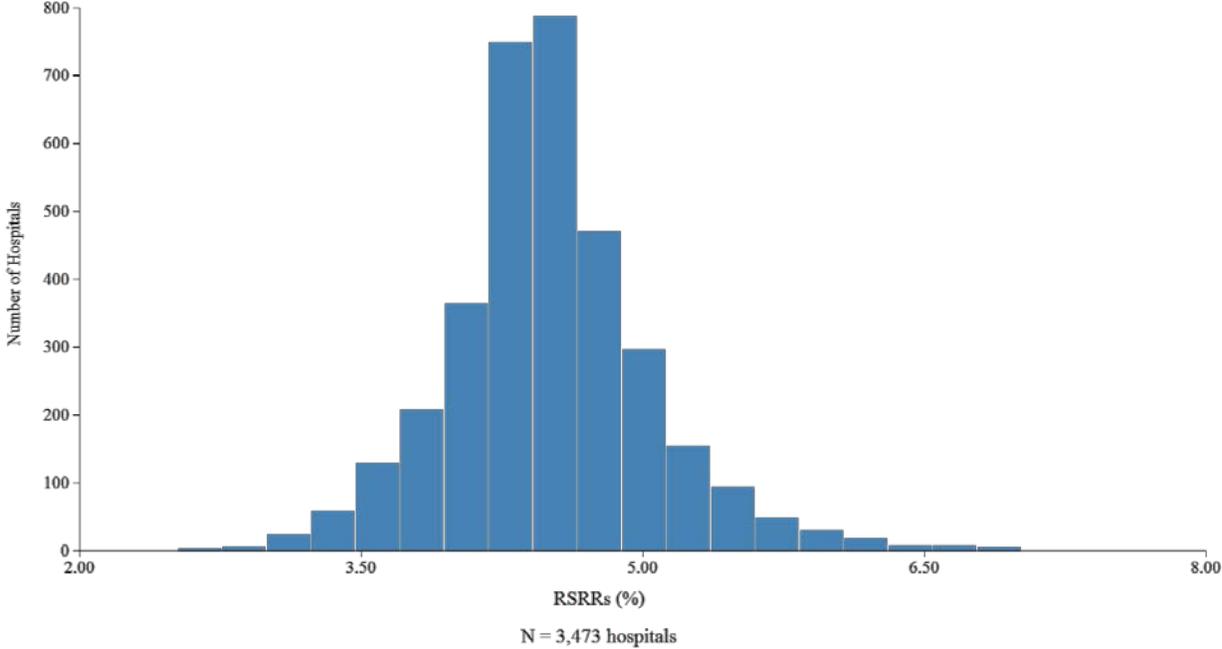
Table 4.3.6 – Distribution of Hospital THA/TKA RSRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,332	3,308	3,290	3,473
Mean (SD)	4.9 (0.5)	4.5 (0.4)	4.5 (0.3)	4.6 (0.5)
Range (min. – max.)	2.9 - 7.8	2.8 - 6.4	2.9 - 6.3	2.4 - 7.8
25 th percentile	4.7	4.3	4.3	4.4
50 th percentile	4.8	4.5	4.4	4.6
75 th percentile	5.1	4.7	4.6	4.9

Table 4.3.7 – Between-Hospital Variance for THA/TKA

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.059 (0.007)	0.054 (0.007)	0.046 (0.007)	0.049 (0.004)

Figure 4.3.2 – Distribution of Hospital 30-Day THA/TKA RSRRs Between July 2012 and June 2015



5. GLOSSARY

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

Clinical Classification Software (CCS): Software maintained by the AHRQ that groups thousands of individual procedure and diagnosis codes into clinically coherent, mutually exclusive procedure and diagnosis categories. CCS categories are used to determine if a readmission is planned. CCS procedure categories are used to define planned and potentially planned procedures. CCS diagnosis categories are used to define acute diagnoses and complications of care that are considered unplanned, as well as a few specific types of care that are always considered planned (for example, maintenance chemotherapy). Crosswalks which show the assignment of ICD codes to the CCS diagnosis and procedure categories are available on the AHRQ website.

Cohort: The index admissions used to calculate the measure after inclusion and exclusion criteria have been applied.

Comorbidities: Medical conditions that the patient had in addition to his/her 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-9-CM diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system. CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Description of the CCs can be found at http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf.

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” would indicate that there is 95% confidence that the OR lies between 1.09 and 1.15.

Expected readmissions: The number of readmissions expected based on average hospital performance with a given hospital’s case mix.

Hierarchical model: A widely accepted statistical method that enables fair 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 structure of the data (patients clustered within hospitals) and calculates (1) how much variation in hospital readmission rates overall is accounted for by patients’ individual risk factors (such as age and other medical conditions); and (2) how much variation is accounted for by hospital contribution to readmission risk.

Hospital-specific effect: A measure of the hospital quality of care that is calculated through hierarchical logistic regression, taking into consideration how many patients were eligible for the cohort, these patients’ risk factors, and how many were readmitted. The hospital-specific effect is the calculated random effect intercept for each hospital. The hospital-specific effect will be negative for a better-than-average hospital, positive for a worse-than-average hospital, and close to zero for an average hospital. The hospital-specific effect is used in the numerator to calculate “predicted” readmissions.

Index admission: Any admission included in the measure calculation as the initial admission for a qualifying CABG surgery or 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 associated uncertainty. For example, a 95% interval estimate for a readmission rate indicates that CMS is 95% confident 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 for each individual service provided directly from Medicare. Only beneficiaries in Medicare FFS, not in managed care (Medicare Advantage), are included in the measures.

National observed readmission 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 variable present relative to those without the risk variable present. The model coefficient for each risk 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 readmission measures, the outcome is readmission within 30 days of discharge.

Planned readmissions: A readmission within 30 days of discharge from a short-term acute care hospital that is a scheduled part of the patient's plan of care. Planned readmissions are not considered in the outcomes of these measures.

Predicted readmissions: The number of readmissions within 30 days predicted based on the hospital's performance with its observed case mix, also referred to as "adjusted actual" readmissions.

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

Unplanned readmissions: Acute clinical events a patient experiences that require urgent rehospitalization. Unplanned readmissions are the outcomes of these measures.

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7. APPENDICES

Appendix A. Statistical Approach to RSRRs for CABG Surgery and THA/TKA Measures

We estimate the hospital-specific RSRRs using hierarchical generalized linear models. This strategy accounts for within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes. We model the probability of readmission as a function of patient age and clinically relevant comorbidities with an intercept for the hospital-specific random effect.

We use the following strategy to calculate hospital-specific RSRRs, which we calculate as the ratio of a hospital's "predicted" readmissions to "expected" readmissions multiplied by the national observed readmission rate. The expected number of readmissions for each hospital is estimated using its patient mix and the average hospital-specific effect (that is, the average effect among all hospitals in the sample). The predicted number of readmissions for each hospital is estimated given the same patient mix but an estimated hospital-specific effect. Operationally, the expected number of readmissions for each hospital is obtained by summing the expected probabilities of readmissions for all patients in the hospital. The expected probability of readmission for each patient is calculated via the hierarchical model, which applies the estimated regression coefficients to the observed patient characteristics and adds the average of the hospital-specific effect. The predicted number of readmissions for each hospital is calculated by summing the predicted probabilities for all patients in the hospital. The predicted probability for each patient is calculated through the hierarchical model, which applies the estimated regression coefficients to the patient characteristics observed and adds the hospital-specific effect.

More specifically, we use a hierarchical logistic regression model to account for the natural clustering of observations within hospitals. The model employs a logit link function to link the risk factors to the outcome with a hospital-specific random effect:

$$h(Y_{ij}) = \alpha_i + \beta \mathbf{Z}_{ij} \quad (1)$$

$$\alpha_i = \mu + \omega_i; \quad \omega_i \sim N(0, \tau^2) \quad (2)$$

Where $h(\cdot)$ is a logit link, Y_{ij} is whether the j^{th} patient in the i^{th} hospital was readmitted (equal to 1 if readmitted within 30 days, 0 otherwise); α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \dots, Z_{p_{ij}})$ the patient-specific covariates, μ is the adjusted average hospital intercept across all hospitals in the sample, and τ^2 is the between-hospital variance component.¹⁰ This model separates within-hospital from between-hospital variation. The hierarchical logistic regression models are estimated using the SAS software system (SAS 9.3 GLIMMIX).

Hospital Performance Reporting

Using the selected set of risk factors, we fit the hierarchical generalized linear model defined by Equations (1) - (2) and estimate the parameters, $\hat{\mu}$, $\{\hat{\alpha}_1, \hat{\alpha}_2, \dots, \hat{\alpha}_i\}$, $\hat{\beta}$, and $\hat{\tau}^2$ where i is the total number of hospitals. We calculate a standardized outcome measure, RSRR, for each hospital by computing the ratio of the predicted number of readmissions to the expected number of readmissions, multiplied by the national observed readmission rate, \bar{y} . Specifically, we calculate

$$\text{Predicted} \quad \hat{y}_{ij}(Z_{ij}) = h^{-1}(\hat{\alpha}_i + \hat{\beta}Z_{ij}) \quad (3)$$

$$\text{Expected} \quad \hat{e}_{ij}(Z_{ij}) = h^{-1}(\hat{\mu} + \hat{\beta}Z_{ij}) \quad (4)$$

$$\widehat{RSRR}_i = \frac{\sum_{j=1}^{n_i} \hat{y}_{ij}(Z_{ij})}{\sum_{j=1}^{n_i} \hat{e}_{ij}(Z_{ij})} \quad (5)$$

n_i is the number of index hospitalizations for the i^{th} hospital.

If the “predicted” number of readmissions is higher (or lower) than the “expected” number of readmissions for a given hospital, its \widehat{RSRR}_i will be higher (or lower) than the national observed readmission rate. For each hospital, we compute an interval estimate of $RSRR_i$ to characterize the level of uncertainty around the point estimate using bootstrapping simulations, as described in the next section. The point estimate and interval estimate are used to characterize and compare hospital performance (for example, higher than expected, as expected, or lower than expected).

Creating Interval Estimates

Because the statistic described in Equation 5, that is, \widehat{RSRR}_i , is a complex function of parameter estimates, we use the re-sampling technique, bootstrapping, to derive an interval estimate. Bootstrapping has the advantage of avoiding unnecessary distributional assumptions.

Algorithm:

Let I denote the total number of hospitals in the sample. We repeat steps 1-4 below for B times, where B is the number of bootstrap samples desired:

1. Sample I hospitals with replacement.
2. Fit the hierarchical generalized linear model using all patients within each sampled hospital. 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. At the conclusion of Step 2, we have:
 - a. $\hat{\beta}^{(b)}$ (the estimated regression coefficients of the risk factors).
 - 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, $\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1, 2, \dots, I\}$
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 $\hat{\alpha}_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \widehat{var}(\hat{\alpha}_i^{(b)}))$ 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 $\hat{y}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\widehat{RSRR}_i(Z)^{(B)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\hat{\alpha}_i^{(b^*)}$ 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 the B estimates (or the percentiles corresponding to the alternative desired intervals).¹¹

Appendix B. Data QA

We use a two-phase approach to internal QA for the readmission measures' reevaluation process. Refer to [Figure B.1](#) for a detailed outline of Phase I and [Figure B.2](#) for a detailed outline of Phase II.

This section represents QA for the subset of the work CORE conducted to maintain and report these readmission measures. It does not describe the QA to process data and create the input files, nor does it include the QA for the final processing of production data for public reporting, because that work is conducted by another contractor.

Phase I

The first step in the QA process is to ensure the validity of the input data files. No new variables that impacted the measures were added to the input files; thus, our main task was to ensure that variable frequencies and distributions in the newly created input data files were consistent with data from the prior time period.

In general, we use both manual scan and descriptive analyses to conduct data validity checks, including cross-checking readmission information, distributions of ICD-9-CM codes, and frequencies of key variables. The results are reviewed for accuracy and changes compared to data from prior data sources. Any new variable constructs and other changes in formatting to the input files are also verified. We share our QA findings with our data extraction contractor as needed.

To assure accuracy in SAS pack coding, two analysts independently write SAS code for any changes made in calculating the readmission measures: data preparation, sample selection, hierarchical modeling, and calculation of RSRRs. 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 II

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.

This phase also compares 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.

Figure B.1 – CORE QA Phase I

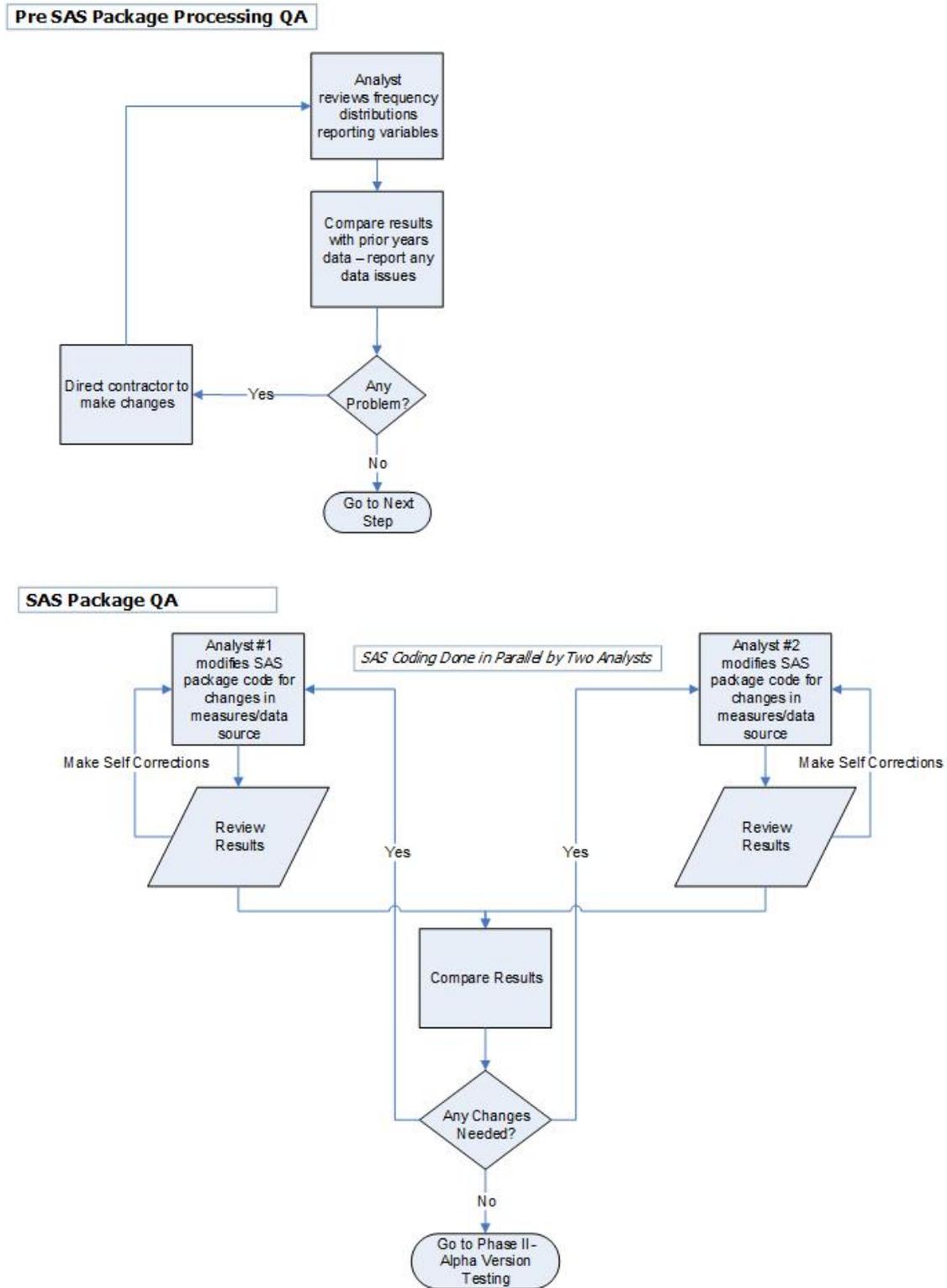
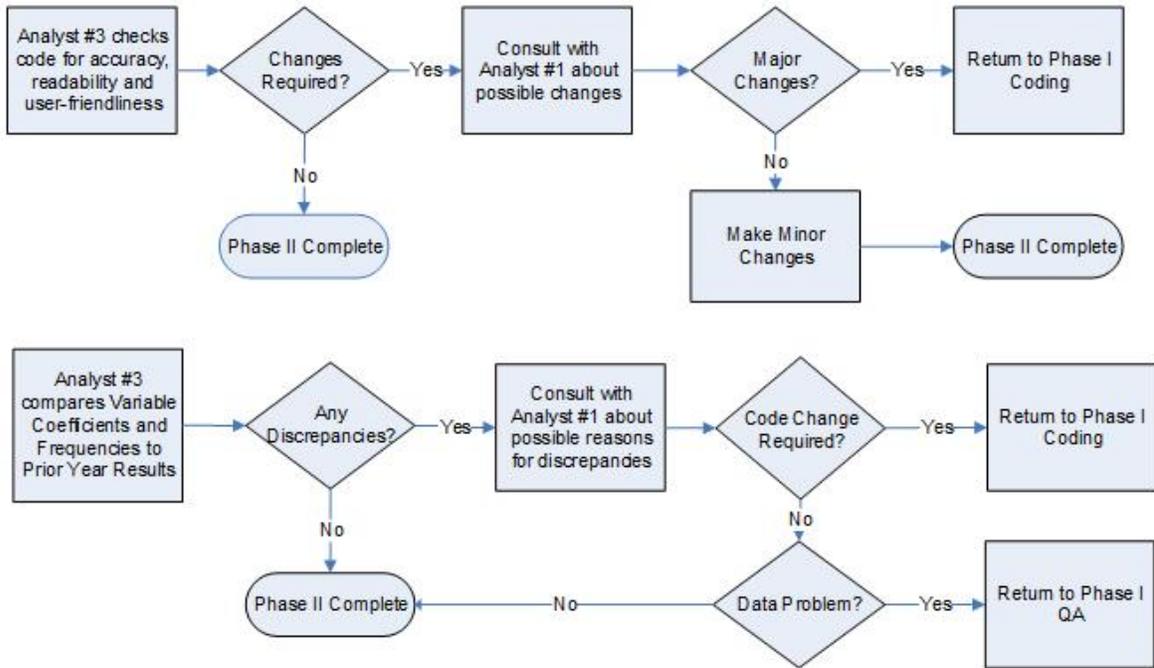


Figure B.2 – CORE QA Phase II

Results Testing – Alpha Version



Appendix C. Annual Updates

Prior annual updates for the measures can be found in the annual updates and specifications reports available 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 report are considered Version 1.0 for each measure. The measures receive a new version number for each subsequent year of public reporting.

2016

2016 Measures Updates and Specifications Report (Version 5.0 - THA/TKA Readmission) (Version 3.0 - CABG Surgery Readmission)

1. Respecified the measures by updating to CMS planned readmission algorithm version 4.0
 - Rationale: Version 4.0 incorporates improvements made following a validation study of the algorithm using data from a medical record review and input from clinical experts. These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designates as planned/unplanned by adding one procedure category and removing five procedure categories (only two of which apply to the CABG surgery and THA/TKA measures; the remaining three were only considered potentially planned procedures in the condition-specific and hospital-wide readmission measures).
2. Applied the 2015 version of the AHRQ CCS to the planned readmission algorithm.
 - Rationale: A 2015 version of the AHRQ CCS was released.

2015

2015 Measures Updates and Specifications Report (Version 4.0 - THA/TKA Readmission) (Version 2.0 - CABG Readmission)

1. Applied updated AHRQ CCS version to the planned readmission algorithm.
 - Rationale: An updated version of the AHRQ CCS was released in 2014.

2014

2014 Measures Update and Specifications Report THA/TKA Readmission (Version 3.0)

1. Respecified the measure by adding the CMS planned readmission algorithm (version 3.0).
 - Rationale: Version 3.0 incorporates improvements made following a validation study of the algorithm using data from a medical record review. These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designated as planned by removing two procedure categories and adding several acute diagnoses.
2. Updated measure specifications to not include all patients with a secondary diagnosis of fracture during index admission in the measure cohort.
 - Rationale: These procedures are presumably not elective THA/TKA procedures, and the cohort aims to include only elective THA/TKA procedures.
3. Applied updated AHRQ CCS version to the planned readmission algorithm.
 - Rationale: An updated version of the AHRQ CCS was released in 2013.

2013

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

1. Respecified the measure by adding a planned readmission algorithm.

- Rationale: Unplanned readmissions are acute clinical events a patient experiences that require urgent rehospitalization. In contrast, planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients scheduled for elective or necessary procedures within 30 days of discharge.
- 2. Updated 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.
- 3. Changes from prior methodology report.
 - Rationale: There were two changes from the original methodology report.
 - i. Table A3 contains the updated listing of the ICD-9-CM codes for fractures, malignant neoplasms, revisions, and other procedures that exclude patients from the measure cohort.
 - ii. The mean risk-standardized readmission rate for the 2008 sample on page 54 was corrected.
- 4. Updated planned readmission algorithm handling of admissions to psychiatric and rehabilitation hospitals.
 - Rationale: Psychiatric and rehabilitation hospitals in Maryland have the same provider ID number as acute care hospitals. Therefore, readmissions are not counted if the patient has a principal diagnosis code beginning with a “V57” (indication of admission to a rehab unit) or 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 (ICD-9 codes 290-319); (2) the index admission has a discharge disposition code to a psychiatric hospital or psychiatric unit from the index admission; and (3) the admission being evaluated as a potential readmission occurred during the same day as or the day following the index discharge.
 - The criteria for identifying such admissions are available in the 2010 AMI, HF, and pneumonia readmission measures maintenance report.

Appendix D. Measure Specifications

Appendix D.1 Hospital-Level 30-Day RSRR Following CABG Surgery (NQF #2515)

Cohort

Inclusion Criteria for CABG Surgery Measure

1. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**

Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.

2. **Aged 65 or over**

Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because Medicare patients younger than 65 are considered to be too clinically distinct from Medicare patients 65 and over.

3. **Discharged alive from a non-federal short-term acute care hospital**

Rationale: It is only possible for patients to be readmitted if they are discharged alive.

4. **Having a qualifying isolated CABG procedure during the index admission**

Rationale: Isolated CABG surgery is the procedure targeted for measurement ([Table D.1.1](#)). Isolated CABG procedures are defined as those procedures performed without concomitant valve or other major cardiac, vascular, or thoracic procedures, because they represent a population of patients with higher risk. These procedure groups include ([Table D.1.2](#)):

- **Valve procedures;**
- **Atrial and/or ventricular septal defects;**
- **Congenital anomalies;**
- **Other open cardiac procedures;**
- **Heart transplants;**
- **Aorta or other non-cardiac arterial bypass procedures;**
- **Head, neck, intracranial vascular procedures; and,**
- **Other chest and thoracic procedures.**

Exclusion Criteria for CABG Surgery Measure

1. **Without at least 30 days post-discharge enrollment in FFS Medicare**

Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.

2. **Discharged against medical advice (AMA)**

Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

3. **Admissions for subsequent qualifying CABG procedures during the measurement period**

Rationale: CABG procedures are expected to last for several years without the need for revision or repeat revascularization. A repeat CABG procedure during the measurement period likely represents a complication of the original CABG procedure and is a clinically more complex and higher risk surgery. Therefore, we select the first CABG surgery admission for inclusion in the measure and exclude subsequent CABG surgery admissions from the cohort.

Table D.1.1 – ICD-9-CM Codes Used to Identify Eligible CABG Procedures

ICD-9-CM Procedure Codes	Description
36.10	Aortocoronary bypass for heart revascularization, not otherwise specified
36.11	(Aorto) coronary bypass of one coronary artery
36.12	(Aorto) coronary bypass of two coronary arteries
36.13	(Aorto) coronary bypass of three coronary arteries
36.14	(Aorto) coronary bypass of four or more coronary arteries
36.15	Single internal mammary- coronary artery bypass
36.16	Double internal mammary- coronary artery bypass
36.17	Abdominal- coronary artery bypass
36.19	Other bypass anastomosis for heart revascularization

The CABG surgery readmission measure excludes admissions where any of the following ICD-9-CM procedure codes occur with one of the ICD-9 procedure codes in [Table D.1.1](#) above.

Table D.1.2 – ICD-9-CM Codes Used to Identify Non-Isolated CABG Procedures Not Included in Final Cohort

ICD-9-CM Procedure Code	Description	Category
00.61	Percutaneous angioplasty or atherectomy of precerebral (extracranial) vessel(s)	Head, neck, intracranial vascular procedures
00.62	Percutaneous angioplasty or atherectomy of intracranial vessel(s)	Head, neck, intracranial vascular procedures
00.63	Percutaneous insertion of carotid artery stent(s)	Head, neck, intracranial vascular procedures
00.64	Percutaneous insertion of other precerebral (extracranial) artery stent(s)	Head, neck, intracranial vascular procedures
00.65	Percutaneous insertion of intracranial vascular stent(s)	Head, neck, intracranial vascular procedures
32.41	Thoracoscopic lobectomy of lung	Other chest and thoracic procedures
32.49	Other lobectomy of lung	Other chest and thoracic procedures
33.50	Lung transplantation, not otherwise specified	Other chest and thoracic procedures
33.51	Unilateral lung transplantation	Other chest and thoracic procedures
33.52	Bilateral lung transplantation	Other chest and thoracic procedures
33.6	Combined heart-lung transplantation	Other chest and thoracic procedures
35.00	Closed heart valvotomy, unspecified valve	Valve procedures
35.01	Closed heart valvotomy, aortic valve	Valve procedures
35.02	Closed heart valvotomy, mitral valve	Valve procedures
35.03	Closed heart valvotomy, pulmonary valve	Valve procedures
35.04	Closed heart valvotomy, tricuspid valve	Valve procedures
35.10	Open heart valvuloplasty without replacement, unspecified valve	Valve procedures
35.11	Open heart valvuloplasty of aortic valve without replacement	Valve procedures

ICD-9-CM Procedure Code	Description	Category
35.12	Open heart valvuloplasty of mitral valve without replacement	Valve procedures
35.13	Open heart valvuloplasty of pulmonary valve without replacement	Valve procedures
35.14	Open heart valvuloplasty of tricuspid valve without replacement	Valve procedures
35.20	Replacement of unspecified heart valve	Valve procedures
35.21	Replacement of aortic valve with tissue graft	Valve procedures
35.22	Other replacement of aortic valve	Valve procedures
35.23	Replacement of mitral valve with tissue graft	Valve procedures
35.24	Other replacement of mitral valve	Valve procedures
35.25	Replacement of pulmonary valve with tissue graft	Valve procedures
35.26	Other replacement of pulmonary valve	Valve procedures
35.27	Replacement of tricuspid valve with tissue graft	Valve procedures
35.28	Other replacement of tricuspid valve	Valve procedures
35.31	Operations on papillary muscle	Valve procedures
35.32	Operations on chordae tendineae	Valve procedures
35.33	Annuloplasty	Valve procedures
35.34	Infundibulectomy	Valve procedures
35.35	Operations on trabeculae carneae cordis	Valve procedures
35.39	Operations on other structures adjacent to valves of heart	Valve procedures
35.41	Enlargement of existing atrial septal defect	Atrial and/or ventricular septal defects
35.42	Creation of septal defect in heart	Atrial and/or ventricular septal defects
35.50	Repair of unspecified septal defect of heart with prosthesis	Atrial and/or ventricular septal defects
35.51	Repair of atrial septal defect with prosthesis, open technique	Atrial and/or ventricular septal defects
35.52	Repair of atrial septal defect with prosthesis, closed technique	Atrial and/or ventricular septal defects
35.53	Repair of ventricular septal defect with prosthesis, open technique	Atrial and/or ventricular septal defects
35.54	Repair of endocardial cushion defect with prosthesis	Atrial and/or ventricular septal defects
35.55	Repair of ventricular septal defect with prosthesis, closed technique	Atrial and/or ventricular septal defects
35.60	Repair of unspecified septal defect of heart with tissue graft	Atrial and/or ventricular septal defects
35.61	Repair of atrial septal defect with tissue graft	Atrial and/or ventricular septal defects
35.62	Repair of ventricular septal defect with tissue graft	Atrial and/or ventricular septal defects
35.63	Repair of endocardial cushion defect with tissue graft	Atrial and/or ventricular septal defects

ICD-9-CM Procedure Code	Description	Category
35.70	Other and unspecified repair of unspecified septal defect of heart	Atrial and/or ventricular septal defects
35.71	Other and unspecified repair of atrial septal defect	Atrial and/or ventricular septal defects
35.72	Other and unspecified repair of ventricular septal defect	Atrial and/or ventricular septal defects
35.73	Other and unspecified repair of endocardial cushion defect	Atrial and/or ventricular septal defects
35.81	Total repair of tetralogy of Fallot	Congenital anomalies
35.82	Total repair of total anomalous pulmonary venous connection	Congenital anomalies
35.83	Total repair of truncus arteriosus	Congenital anomalies
35.84	Total correction of transposition of great vessels, not elsewhere classified	Congenital anomalies
35.91	Interatrial transposition of venous return	Congenital anomalies
35.92	Creation of conduit between right ventricle and pulmonary artery	Congenital anomalies
35.93	Creation of conduit between left ventricle and aorta	Congenital anomalies
35.94	Creation of conduit between atrium and pulmonary artery	Congenital anomalies
35.95	Revision of corrective procedure on heart	Congenital anomalies
35.96	Percutaneous valvuloplasty	Valve procedures
35.98	Other operations on septa of heart	Atrial and/or ventricular septal defects
35.99	Other operations on valves of heart	Valve procedures
37.31	Pericardiectomy	Other open cardiac procedures
37.32	Excision of aneurysm of heart	Other open cardiac procedures
37.33	Excision or destruction of other lesion or tissue of heart, open approach	Other open cardiac procedures
37.35	Partial ventriculectomy	Other open cardiac procedures
37.51	Heart transplantation	Heart transplants
37.52	Implantation of total internal biventricular heart replacement system	Other open cardiac procedures
37.53	Replacement or repair of thoracic unit of (total) replacement heart system	Other open cardiac procedures
37.54	Replacement or repair of other implantable component of (total) replacement heart system	Other open cardiac procedures
37.55	Removal of internal biventricular heart replacement system	Other open cardiac procedures
37.63	Repair of heart assist system	Other open cardiac procedures
37.67	Implantation of cardiomyostimulation system	Other open cardiac procedures
38.11	Head and neck endarterectomy	Head, neck, intracranial vascular procedures
38.12	Endarterectomy, other vessels of head and neck	Head, neck, intracranial vascular procedures
38.14	Endarterectomy of Aorta	Aorta or other non-cardiac arterial bypass procedures

ICD-9-CM Procedure Code	Description	Category
38.15	Thoracic endarterectomy	Aorta or other non-cardiac arterial bypass procedures
38.16	Endarterectomy: Excision of tunica intima of artery to relieve arterial walls thickened by plaque or chronic inflammation. Location includes abdominal arteries excluding abdominal aorta: Celiac, Gastric, Hepatic, Iliac, Mesenteric, Renal, Splenic, Umbilical	Aorta or other non-cardiac arterial bypass procedures
38.17	Endarterectomy - abdominal veins: Iliac, Portal, Renal, Splenic, Vena cava.	Aorta or other non-cardiac arterial bypass procedures
38.34	Resection of vessel with replacement: Angiectomy, excision of aneurysm (arteriovenous), blood vessel (lesion) with anastomosis (4=aorta, abdominal)	Aorta or other non-cardiac arterial bypass procedures
38.42	Resection of vessel with replacement: Angiectomy, excision of aneurysm with replacement (2= other vessels of head and neck; carotid, jugular)	Head, neck, intracranial vascular procedures
38.44	Resection of vessel with replacement, aorta, abdominal	Aorta or other non-cardiac arterial bypass procedures
38.45	Resection of vessel with replacement, thoracic vessels	Aorta or other non-cardiac arterial bypass procedures
39.21	Caval-pulmonary artery anastomosis	Aorta or other non-cardiac arterial bypass procedures
39.22	Aorta-subclavian-carotid bypass	Aorta or other non-cardiac arterial bypass procedures
39.23	Other intrathoracic vascular shunt or bypass	Aorta or other non-cardiac arterial bypass procedures
39.24	Aorta-renal bypass	Aorta or other non-cardiac arterial bypass procedures
39.25	Aorta-iliac-femoral bypass	Aorta or other non-cardiac arterial bypass procedures
39.26	Other intra-abdominal vascular shunt or bypass	Aorta or other non-cardiac arterial bypass procedures
39.28	Extracranial-intracranial (EC-IC) vascular bypass	Head, neck, intracranial vascular procedures
39.29	Other (peripheral) vascular shunt or bypass	Aorta or other non-cardiac arterial bypass procedures
39.71	Endovascular implantation of graft in abdominal aorta	Aorta or other non-cardiac arterial bypass procedures
39.72	Endovascular embolization or occlusion of head and neck vessels	Head, neck, intracranial vascular procedures
39.73	Endovascular implantation of graft in thoracic aorta	Aorta or other non-cardiac arterial bypass procedures
39.74	Endovascular removal of obstruction from head and neck vessel(s)	Head, neck, intracranial vascular procedures
39.75	Endovascular embolization or occlusion of vessel(s) of head or neck using bare coils	Head, neck, intracranial vascular procedures

ICD-9-CM Procedure Code	Description	Category
39.76	Endovascular embolization or occlusion of vessel(s) of head or neck using bioactive coils	Head, neck, intracranial vascular procedures
39.79	Other endovascular procedures on other vessels	Aorta or other non-cardiac arterial bypass procedures
85.22	Resection of quadrant of breast	Other chest and thoracic procedures
85.23	Subtotal mastectomy, which excludes quadrant resection (85.22)	Other chest and thoracic procedures
85.41	Unilateral simple mastectomy	Other chest and thoracic procedures
85.42	Bilateral simple mastectomy	Other chest and thoracic procedures
85.43	Unilateral extended simple mastectomy	Other chest and thoracic procedures
85.44	Bilateral extended simple mastectomy	Other chest and thoracic procedures
85.45	Unilateral radical mastectomy	Other chest and thoracic procedures
85.46	Bilateral radical mastectomy	Other chest and thoracic procedures
85.47	Unilateral extended radical mastectomy	Other chest and thoracic procedures
85.48	Bilateral extended radical mastectomy	Other chest and thoracic procedures

Risk Adjustment

Table D.1.3 – Risk Variables for CABG Surgery Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by “X”)
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
History of Coronary Artery Bypass Graft (CABG) or valve surgery	ICD-9 diagnosis codes: V42.2, V43.3, V45.81, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 996.02, 996.03; ICD-9 procedure code: 39.61	
Cardiogenic Shock	ICD-9 diagnosis code 785.51	
Cancer; metastatic cancer and acute leukemia	CC 7 Metastatic cancer or acute leukemia	
	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	X
Severe hematological disorders	CC 44 Severe hematological disorders	
Dementia or other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
CC 178 Amputation status, upper limb	X	
Polyneuropathy	CC 71 Polyneuropathy	
Congestive heart failure	CC 80 Congestive heart failure	X
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified heart arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Cerebrovascular disease	CC 97 Precerebral arterial occlusion and transient cerebral ischemia	X
	CC 98 Cerebral atherosclerosis and aneurysm	
	CC 99 Cerebrovascular disease, unspecified	
	CC 103 Cerebrovascular disease late effects, unspecified	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Fibrosis of lung or other chronic lung disorders	CC 109 Fibrosis of lung or other chronic lung disorders	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	X
Other lung disorders	CC 115 Other lung disorders	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	

Outcome

Outcome Criteria for CABG Surgery Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix D.2 Hospital-Level 30-Day RSRR Following Elective Primary THA and/or TKA (NQF #1551)

Cohort

Inclusion Criteria for THA/TKA Measure

1. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**

Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.

2. **Aged 65 or over**

Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because Medicare patients younger than 65 are considered to be too clinically distinct from Medicare patients 65 and over.

3. **Discharged alive from a non-federal short-term acute care hospital**

Rationale: It is only possible for patients to be readmitted if they are discharged alive.

4. **Having a qualifying elective primary THA/TKA procedure during the index admission**

Rationale: Elective primary THA or TKA is the procedure targeted for measurement ([Table D.2.1](#)).

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

- **Femur, hip, or pelvic fractures coded in the principal or secondary discharge diagnosis fields of the index admission**

Rationale: Patients with fractures have a higher mortality, complication, and readmission rates, and the procedures are typically not elective ([Table D.2.2](#)).

- **A concurrent partial hip arthroplasty procedure**

Rationale: Partial arthroplasty procedures are done primarily for hip fractures and are typically performed on patients who are older, frailer, and who have more comorbid conditions ([Table D.2.3](#)). Partial knee arthroplasty procedures are not distinguished by ICD-9-CM codes and are therefore currently captured by the THA/TKA readmission measure.

- **A concurrent revision procedure**

Rationale: Revision procedures may be performed at a disproportionately small number of hospitals and are associated with higher mortality, complication, and readmission rates ([Table D.2.4](#)).

- **A concurrent resurfacing procedure**

Rationale: Resurfacing is a different type of procedure involving only the joint's articular surface. Resurfacing procedures are typically performed on younger, healthier patients ([Table D.2.5](#)).

- **Mechanical complication coded in the principal discharge diagnosis field of the index admission**

Rationale: A complication coded as the principal discharge diagnosis suggests that the procedure was more likely the result of a previous procedure. These patients may require more technically complex arthroplasty procedures and may be at increased risk for readmission ([Table D.2.6](#)).

- **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**
Rationale: Patients with these malignant neoplasms are at increased risk for readmission, and the procedure may not be elective ([Table D.2.7](#)).
- **Removal of implanted devices/prostheses**
Rationale: Elective procedures performed in these patients may be more complicated ([Table D.2.8](#)).
- **Transfer from another acute care facility for the THA/TKA**
Rationale: The THA/TKA readmission measure does not include admissions for patients transferred in to the index hospital, as they likely do not represent elective THA/TKA procedures.

Exclusion Criteria for THA/TKA Measure

1. **Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
2. **Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
3. **Admitted for the index procedure and subsequently transferred to another acute care facility**
Rationale: Patients admitted for the index procedure and subsequently transferred to another acute care facility are excluded, as determining to which hospital the readmission outcome should be attributed is difficult.
4. **With more than two THA/TKA procedure codes during the index hospitalization**
Rationale: Although clinically possible, it is highly unlikely that patients would receive more than two elective THA/TKA procedures in one hospitalization, which may reflect a coding error.
5. **THA/TKA admissions within 30 days of a prior THA/TKA index admission**
Rationale: Additional THA/TKA admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.

Table D.2.1 – ICD-9-CM Codes Used to Identify Eligible THA/TKA Procedures

ICD-9-CM Procedure Codes	Description
81.51	Total hip replacement
81.54	Total knee replacement

Table D.2.2 – ICD-9-CM Codes for Fractures That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Diagnosis Codes	Description
733.10	Pathological fracture unspecified site
733.14	Pathological fracture of neck of femur
733.15	Pathological fracture of other specified part of femur
733.19	Pathological fracture of other specified site
733.81	Malunion of fracture
733.82	Nonunion of fracture
733.95	Stress fracture of other bone
733.96	Stress fracture of femoral neck
733.97	Stress fracture of shaft of femur
808.0	Closed fracture of acetabulum
808.1	Open fracture of acetabulum
808.2	Closed fracture of pubis
808.3	Open fracture of pubis
808.41	Closed fracture of ilium
808.42	Closed fracture of ischium
808.43	Multiple closed pelvic fractures with disruption of pelvic circle
808.44	Multiple closed pelvic fractures without disruption of pelvic circle
808.49	Closed fracture of other specified part of pelvis
808.51	Open fracture of ilium
808.52	Open fracture of ischium
808.53	Multiple open pelvic fractures with disruption of pelvic circle
808.54	Multiple open pelvic fractures without disruption of pelvic circle
808.59	Open fracture of other specified part of pelvis
808.8	Closed unspecified fracture of pelvis
808.9	Open unspecified fracture of pelvis
820.00	Closed fracture of intracapsular section of neck of femur, unspecified
820.01	Closed fracture of epiphysis (separation) (upper) of neck of femur
820.02	Closed fracture of midcervical section of neck of femur
820.03	Closed fracture of base of neck of femur
820.09	Other closed transcervical fracture of neck of femur
820.10	Open fracture of intracapsular section of neck of femur, unspecified
820.11	Open fracture of epiphysis (separation) (upper) of neck of femur
820.12	Open fracture of midcervical section of neck of femur
820.13	Open fracture of base of neck of femur
820.19	Other open transcervical fracture of neck of femur
820.20	Closed fracture of trochanteric section of neck of femur
820.21	Closed fracture of intertrochanteric section of neck of femur
820.22	Closed fracture of subtrochanteric section of neck of femur
820.30	Open fracture of trochanteric section of neck of femur, unspecified
820.31	Open fracture of intertrochanteric section of neck of femur
820.32	Open fracture of subtrochanteric section of neck of femur
820.8	Closed fracture of unspecified part of neck of femur
820.9	Open fracture of unspecified part of neck of femur
821.00	Closed fracture of unspecified part of femur
821.01	Closed fracture of shaft of femur

ICD-9-CM Diagnosis Codes	Description
821.10	Open fracture of unspecified part of femur
821.11	Open fracture of shaft of femur
821.20	Closed fracture of lower end of femur, unspecified part
821.21	Closed fracture of condyle, femoral
821.22	Closed fracture of epiphysis, lower (separation) of femur
821.23	Closed supracondylar fracture of femur
821.29	Other closed fracture of lower end of femur
821.30	Open fracture of lower end of femur, unspecified part
821.31	Open fracture of condyle, femoral
821.32	Open fracture of epiphysis, lower (separation) of femur
821.33	Open supracondylar fracture of femur
821.39	Other open fracture of lower end of femur

Table D.2.3 – ICD-9-CM Codes for Partial Hip Replacement That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Procedure Codes	Description
81.52	Partial hip replacement

Table D.2.4 – ICD-9-CM Codes for THA and TKA Revisions That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Procedure Codes	Description
81.53	Revision of hip replacement, not otherwise specified
81.55	Revision of knee replacement, not otherwise specified
81.59	Revision of joint replacement of lower extremity, not elsewhere classified
00.70	Revision of hip replacement, both acetabular and femoral components
00.71	Revision of hip replacement, acetabular component
00.72	Revision of hip replacement, femoral component
00.73	Revision of hip replacement, acetabular liner and/or femoral head only
00.80	Replacement of knee replacement, total (all components)
00.81	Replacement of knee replacement, tibial component
00.82	Revision of knee replacement, femoral component
00.83	Revision of knee replacement, patellar component
00.84	Revision of total knee replacement, tibial insert (liner)

Table D.2.5 – ICD-9-CM Codes for Resurfacing Procedures That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Procedure Codes	Description
00.85	Resurfacing hip, total, acetabulum and femoral head
00.86	Resurfacing hip, partial, femoral head
00.87	Resurfacing hip, partial, acetabulum

Table D.2.6 – ICD-9-CM Codes for Mechanical Complications That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Diagnosis Codes	Description
996.40	Unspecified mechanical complication of internal orthopedic device, implant and graft
996.41	Mechanical loosening of prosthetic joint
996.42	Dislocation of prosthetic joint
996.43	Broken prosthetic joint implant
996.44	Peri prosthetic fracture around prosthetic joint
996.45	Peri prosthetic osteolysis
996.46	Articular bearing surface wear of prosthetic joint
996.47	Other mechanical complication of prosthetic joint implant
996.49	Other mechanical complication of other internal orthopedic device, implant, and graft
996.77	Other complications due to internal joint prosthesis
996.78	Other complications due to other internal orthopedic device implant and graft

Table D.2.7 – ICD-9-CM Codes for Malignant Neoplasms That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Diagnosis Codes	Description
170.6	Malignant neoplasm of pelvic bones, sacrum, and coccyx
170.7	Malignant neoplasm of long bones of lower limb
170.9	Malignant neoplasm of bone and articular cartilage, site unspecified
195.3	Malignant neoplasm of pelvis
195.5	Malignant neoplasm of lower limb
198.5	Secondary malignant neoplasm of bone and bone marrow
199.0	Disseminated malignant neoplasm without specification of site

Table D.2.8 – ICD-9-CM Codes for Removal of Devices/Prosthesis That Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Procedure Codes	Description
78.65	Removal of implanted devices from bone, femur
78.66	Removal of implanted devices from bone, patella
78.67	Removal of implanted devices from bone, tibia and fibula
80.05	Arthrotomy for removal of prosthesis without replacement, hip
80.06	Arthrotomy for removal of prosthesis without replacement, knee
80.09	Arthrotomy for removal of prosthesis without replacement, other specified sites

Risk Adjustment

Table D.2.9 – Risk Variables for THA/TKA Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by “X”)
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
Index admissions with an elective THA procedure	n/a	
Number of procedures (two vs. one)	n/a	
Other congenital deformity of hip (joint)	ICD-9 diagnosis code 755.63	
Post traumatic osteoarthritis	ICD-9 diagnosis codes 716.15, 716.16	
Morbid obesity	ICD-9 diagnosis code 278.01	
History of infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
	CC 6 Other infectious diseases	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Cancer	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Rheumatoid arthritis and inflammatory connective tissue disease	CC 38 Rheumatoid arthritis and inflammatory connective tissue disease	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Severe hematological disorders	CC 44 Severe hematological disorders	
Dementia or other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Polyneuropathy	CC 71 Polyneuropathy	
Congestive heart failure	CC 80 Congestive heart failure	X
Coronary atherosclerosis or angina	CC 83 Angina pectoris/old myocardial infarction	
	CC 84 Coronary atherosclerosis/other chronic ischemic heart disease	
Hypertensive heart and renal disease or encephalopathy; hypertension	CC 89 Hypertensive heart and renal disease or encephalopathy	
	CC 91 Hypertension	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	X

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	
Cellulitis, local skin infection	CC 152 Cellulitis, local skin infection	X
Other injuries	CC 162 Other injuries	X
Major symptoms, abnormalities	CC 166 Major symptoms, abnormalities	

Outcome

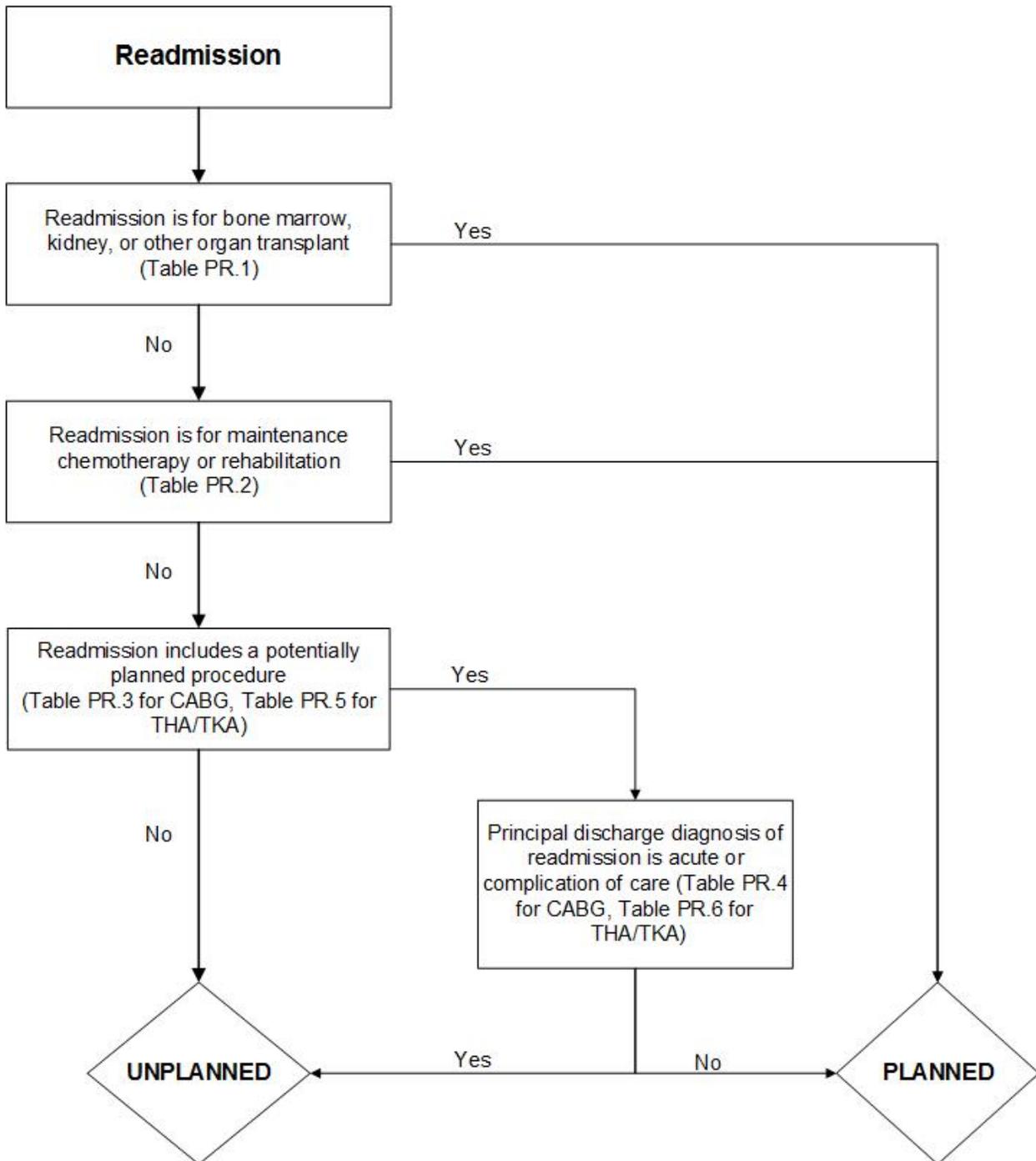
Outcome Criteria for the THA/TKA Readmission Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix E Planned Readmission Algorithm

Figure PR.1 – Planned Readmission Algorithm Version 4.0 Flowchart



Planned Readmission Algorithm Version 4.0 Tables – CABG and THA/TKA Measures

Table PR.1 – Procedure Categories That are Always Planned (Version 4.0— CABG and THA/TKA Populations)

AHRQ CCS Procedure	Description
64	Bone marrow transplant
105	Kidney transplant
134	Cesarean section (Included only in all-payer population, not Medicare)
135	Forceps; vacuum; and breech delivery (Included only in all-payer population, not Medicare)
176	Other organ transplantation

Table PR.2 – Diagnosis Categories That are Always Planned (Version 4.0— CABG and THA/TKA Populations)

AHRQ CCS Diagnosis	Description
45	Maintenance chemotherapy
194	Forceps delivery (Included only in all-payer population, not Medicare)
196	Normal pregnancy and/or delivery (Included only in all-payer population, not Medicare)
254	Rehabilitation (includes only V52.0, V52.1, V52.4, V52.8, V52.9, V53.8, and V58.82 - refer to Appendix C for more detail)

Table PR.3 – Potentially Planned Procedure Categories (Version 4.0 – CABG Population)

AHRQ CCS Procedure	Description
1	Incision and excision of CNS
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
59	Other OR procedures on vessels of head and neck
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
158	Spinal fusion
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
170	Excision of skin lesion

ICD-9 Procedure Codes	Description
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from AHRQ CCS Procedure category 42- Other OR Respiratory procedures on respiratory system and mediastinum)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from AHRQ CCS Procedure category 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from AHRQ CCS Procedure category 218- Psychological and psychiatric evaluation and therapy)

Table PR.4 – Acute Diagnosis Categories (Version 4.0 – CABG Population)

AHRQ CCS Diagnosis	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
99	Hypertension with complications
100	Acute myocardial infarction (with the exception of ICD-9 diagnosis codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis

AHRQ CCS Diagnosis	Description
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances

AHRQ CCS Diagnosis	Description
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
ICD-9 Diagnosis Codes	Description
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 97: Peri-; endo-; and myocarditis; cardiomyopathy	
032.82	Diphtheritic myocarditis
036.40	Meningococcal carditis, unspecified
036.41	Meningococcal pericarditis
036.42	Meningococcal endocarditis
036.43	Meningococcal myocarditis
074.20	Coxsackie carditis, unspecified
074.21	Coxsackie pericarditis
074.22	Coxsackie endocarditis
074.23	Coxsackie myocarditis
112.81	Candidal endocarditis
115.03	Infection by Histoplasma capsulatum, pericarditis
115.04	Infection by Histoplasma capsulatum, endocarditis
115.13	Infection by Histoplasma duboisii pericarditis
115.14	Histoplasma duboisii, endocarditis
115.93	Histoplasmosis, unspecified, pericarditis
115.94	Histoplasmosis, unspecified, endocarditis
130.3	Myocarditis due to toxoplasmosis

AHRQ CCS Diagnosis	Description
391.0	Acute rheumatic pericarditis
391.1	Acute rheumatic endocarditis
391.2	Acute rheumatic myocarditis
391.8	Other acute rheumatic heart disease, unspecified
391.9	Acute rheumatic heart disease, unspecified
392.0	Rheumatic chorea with heart involvement
398.0	Rheumatic myocarditis
398.90	Rheumatic heart disease, unspecified
398.99	Other rheumatic heart diseases
420.0	Acute pericarditis in diseases classified elsewhere
420.90	Acute pericarditis, unspecified
420.91	Acute idiopathic pericarditis
420.99	Other acute pericarditis
421.0	Acute and subacute bacterial endocarditis
421.1	Acute and subacute infective endocarditis in diseases classified elsewhere
421.9	Acute endocarditis, unspecified
422.0	Acute myocarditis in diseases classified elsewhere
422.90	Acute myocarditis, unspecified
422.91	Idiopathic myocarditis
422.92	Septic myocarditis
422.93	Toxic myocarditis
422.99	Other acute myocarditis
423.0	Hemopericardium
423.1	Adhesive pericarditis
423.2	Constrictive pericarditis
423.3	Cardiac tamponade
429.0	Myocarditis, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 105: Conduction disorders	
426.0	Atrioventricular block, complete
426.10	Atrioventricular block, unspecified
426.11	First degree atrioventricular block
426.12	Mobitz (type) II atrioventricular block
426.13	Other second degree atrioventricular block
426.2	Left bundle branch hemiblock
426.3	Other left bundle branch block
426.4	Right bundle branch block
426.50	Bundle branch block, unspecified
426.51	Right bundle branch block and left posterior fascicular block
426.52	Right bundle branch block and left anterior fascicular block
426.53	Other bilateral bundle branch block
426.54	Trifascicular block

AHRQ CCS Diagnosis	Description
426.6	Other heart block
426.7	Anomalous atrioventricular excitation
426.81	Lown-Ganong-Levine syndrome
426.82	Long QT syndrome
426.9	Conduction disorder, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 106: Dysrhythmia	
427.2	Paroxysmal tachycardia, unspecified
427.69	Other premature beats
427.89	Other specified cardiac dysrhythmias
427.9	Cardiac dysrhythmia, unspecified
785.0	Tachycardia, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 108: Congestive heart failure; nonhypertensive	
398.91	Rheumatic heart failure (congestive)
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 149: Biliary tract disease	
574.00	Calculus of gallbladder with acute cholecystitis, without mention of obstruction
574.01	Calculus of gallbladder with acute cholecystitis, with obstruction
574.30	Calculus of bile duct with acute cholecystitis, without mention of obstruction
574.31	Calculus of bile duct with acute cholecystitis, with obstruction
574.60	Calculus of gallbladder and bile duct with acute cholecystitis, without mention of obstruction
574.61	Calculus of gallbladder and bile duct with acute cholecystitis, with obstruction
574.80	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, without mention of obstruction
574.81	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, with obstruction
575.0	Acute cholecystitis
575.12	Acute and chronic cholecystitis
576.1	Cholangitis
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 152: Pancreatic disorders	
577.0	Acute pancreatitis

Table PR.5 – Potentially Planned Procedure Categories (Version 4.0—THA/TKA Population)

AHRQ CCS Procedure	Description
1	Incision and excision of CNS
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on, unspecified; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs

AHRQ CCS Procedure	Description
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
170	Excision of skin lesion
172	Skin graft
ICD-9 Procedure Codes	Description
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from AHRQ CCS Procedure category 42- Other OR Rx procedures on respiratory system and mediastinum)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from AHRQ CCS Procedure category 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from AHRQ CCS Procedure category CCS 218- Psychological and psychiatric evaluation and therapy)

Table PR.6 – Acute Diagnosis Categories (Version 4.0—THA/TKA Population)

AHRQ CCS Diagnosis	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
99	Hypertension with complications
100	Acute myocardial infarction (with the exception of ICD-9 diagnosis codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis

AHRQ CCS Diagnosis	Description
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
201	Infective arthritis and osteomyelitis
204	Other non-traumatic joint injuries
207	Pathological fractures
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
231	Other fractures
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
236	Open wounds of extremities
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care

AHRQ CCS Diagnosis	Description
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnesic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
ICD-9 Diagnosis Codes	Description
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 97: Peri-; endo-; and myocarditis; cardiomyopathy	
032.82	Diphtheritic myocarditis
036.40	Meningococcal carditis, unspecified
036.41	Meningococcal pericarditis
036.42	Meningococcal endocarditis
036.43	Meningococcal myocarditis
074.20	Coxsackie carditis, unspecified
074.21	Coxsackie pericarditis
074.22	Coxsackie endocarditis
074.23	Coxsackie myocarditis
112.81	Candidal endocarditis
115.03	Infection by Histoplasma capsulatum, pericarditis
115.04	Infection by Histoplasma capsulatum, endocarditis
115.13	Infection by Histoplasma duboisii pericarditis

AHRQ CCS Diagnosis	Description
115.14	Histoplasma duboisii, endocarditis
115.93	Histoplasmosis, unspecified, pericarditis
115.94	Histoplasmosis, unspecified, endocarditis
130.3	Myocarditis due to toxoplasmosis
391.0	Acute rheumatic pericarditis
391.1	Acute rheumatic endocarditis
391.2	Acute rheumatic myocarditis
391.8	Other acute rheumatic heart disease, unspecified
391.9	Acute rheumatic heart disease, unspecified
392.0	Rheumatic chorea with heart involvement
398.0	Rheumatic myocarditis
398.90	Rheumatic heart disease, unspecified
398.99	Other rheumatic heart diseases
420.0	Acute pericarditis in diseases classified elsewhere
420.90	Acute pericarditis, unspecified
420.91	Acute idiopathic pericarditis
420.99	Other acute pericarditis
421.0	Acute and subacute bacterial endocarditis
421.1	Acute and subacute infective endocarditis in diseases classified elsewhere
421.9	Acute endocarditis, unspecified
422.0	Acute myocarditis in diseases classified elsewhere
422.90	Acute myocarditis, unspecified
422.91	Idiopathic myocarditis
422.92	Septic myocarditis
422.93	Toxic myocarditis
422.99	Other acute myocarditis
423.0	Hemopericardium
423.1	Adhesive pericarditis
423.2	Constrictive pericarditis
423.3	Cardiac tamponade
429.0	Myocarditis, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 105: Conduction disorders	
426.0	Atrioventricular block, complete
426.10	Atrioventricular block, unspecified
426.11	First degree atrioventricular block
426.12	Mobitz (type) II atrioventricular block
426.13	Other second degree atrioventricular block
426.2	Left bundle branch hemiblock
426.3	Other left bundle branch block
426.4	Right bundle branch block
426.50	Bundle branch block, unspecified

AHRQ CCS Diagnosis	Description
426.51	Right bundle branch block and left posterior fascicular block
426.52	Right bundle branch block and left anterior fascicular block
426.53	Other bilateral bundle branch block
426.54	Trifascicular block
426.6	Other heart block
426.7	Anomalous atrioventricular excitation
426.81	Lown-Ganong-Levine syndrome
426.82	Long QT syndrome
426.9	Conduction disorder, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 106: Dysrhythmia	
427.2	Paroxysmal tachycardia, unspecified
427.69	Premature beats
427.89	Other specified cardiac dysrhythmias
427.9	Cardiac dysrhythmia, unspecified
785.0	Tachycardia, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 108: Congestive heart failure; nonhypertensive	
398.91	Rheumatic heart failure (congestive)
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 149: Biliary tract disease	
574.00	Calculus of gallbladder with acute cholecystitis, without mention of obstruction
574.01	Calculus of gallbladder with acute cholecystitis, with obstruction
574.30	Calculus of bile duct with acute cholecystitis, without mention of obstruction
574.31	Calculus of bile duct with acute cholecystitis, with obstruction
574.60	Calculus of gallbladder and bile duct with acute cholecystitis, without mention of obstruction
574.61	Calculus of gallbladder and bile duct with acute cholecystitis, with obstruction
574.80	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, without mention of obstruction
574.81	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, with obstruction
575.0	Acute cholecystitis
575.12	Acute and chronic cholecystitis
576.1	Cholangitis

AHRQ CCS Diagnosis	Description
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 152: Pancreatic disorders	
577.0	Acute pancreatitis