2017 Procedure-Specific Measure Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Mortality Measure

Isolated Coronary Artery Bypass Graft (CABG) Surgery – Version 4.0

Submitted By:

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Table of Contents

List of Tables

List of Figures

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) procedure-specific mortality measure used in the Hospital Inpatient Quality Reporting program and publicly reported on *Hospital Compare*. The measure reports hospital-level 30-day risk-standardized mortality rate (RSMR) following isolated coronary artery bypass graft (CABG) surgery. This report provides a single source of information about this measure for a wide range of readers. Reports describing other outcome measures can be found on *QualityNet*.

This report provides an overview of the measure methodology, methodology updates for 2017 public reporting, and the national results for 2017 public reporting. The appendices provide detailed specifications for the 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 mortality measure:**
  - Background
  - Cohort inclusions and exclusions
    - Included and excluded hospitalizations
    - How transferred patients are handled
  - Outcome
  - Risk-adjustment variables
  - Data sources
  - Mortality rate calculation
  - Categorization of hospitals' performance score

- **Section 3 - 2017 measure updates**

- **Section 4 - 2017 measure results**

- **Section 5 - Glossary**

The Appendices contain detailed measure information, consisting of:

- Appendix A: Statistical approach to calculating RSMRs;
- Appendix B: Data quality assurance (QA);
- Appendix C: Annual updates to the measure since measure development; and,
- Appendix D: Measure specifications, including hyperlinks to certain ICD-10 code lists that are posted in supplemental Excel files on *QualityNet*, due to volume.

The original measure methodology report and prior updates and specifications reports are available in the 'Measure Methodology' and 'Archived Resources' sections under the claims-based mortality measures page of *QualityNet*[1-3].

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Mortality Measure

In 2015, CMS began publicly reporting 30-day RSMRs for CABG surgery for the nation's non-federal short-term acute care hospitals (including Indian Health Services hospitals) and critical access hospitals.

Results for this measure are posted on *Hospital Compare*, which CMS updates annually.

CMS contracted with the Yale-New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE) to update the CABG surgery mortality measure for 2017 public reporting through a process of measure reevaluation. The 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 2017 risk-adjusted CABG surgery mortality measure uses specifications from the initial measure methodology report with refinements to the measure, as listed in Appendix C and described in prior measures updates and specifications reports[1-3]. An overview of the methodology is presented in this section.

2.2.1 Cohort

Index Admissions Included in the Measure

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

- Having a qualifying isolated CABG surgery 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 index admission, and enrolled in Part A during the index admission; and,
- Aged 65 or over.

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

The International Classification of Diseases, 10th Revision, Procedure Coding System (ICD-10-PCS) codes used to define a CABG surgery in claims for discharges on or after October 1, 2015 are listed in Appendix D, in Table D.1.1. The ICD-10-PCS codes for discharges on or after October 1, 2015 that are used to identify a concomitant valve or other major cardiac, vascular, or thoracic procedure and disqualify the admission from cohort inclusion are posted on *QualityNet* due to volume. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 procedure-specific mortality measure updates and specifications report posted on *QualityNet*.

Index Admissions Excluded from the Measure

The CABG surgery mortality measure excludes index admissions for patients:

- With inconsistent or unknown vital status or other unreliable demographic (age and gender) data; or,
- Discharged against medical advice.

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.

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, claims for patients not listed in the Medicare enrollment database, and records with invalid provider IDs.

The percentage of admissions excluded based on each criterion is shown in Section 4 in Figure 4.2.1.

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 different 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.

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 mortality risk, even among transferred patients. This is true also for patients that are transferred in from another hospital for their CABG surgery. Therefore, in a series of one or more transfers, the first admission where an eligible CABG procedure was done is included in the cohort, regardless of whether the patient is transferred in or transferred out. Furthermore, the measure assigns a death that occurs within 30 days of the procedure date to the hospital that performed the first ("index") CABG surgery. For

example, if a patient is admitted to Hospital A and undergoes CABG surgery, and then transferred to Hospital B, the Hospital A admission would be included in the cohort, and death within 30 days of the date of the procedure at Hospital A would be captured in Hospital A's mortality outcome. This is different than the other mortality measures that always consider the first hospitalization as the index admission and always assign a death to the hospital that initially admitted the patient.

2.2.2 Outcome

All-Cause Mortality

All deaths are considered an outcome, regardless of cause. There are a number of reasons for capturing deaths from any cause in the CABG surgery mortality measure. First, from a patient perspective, a death from any cause is an adverse event. In addition, making inferences about quality issues based solely on the documented cause of death is difficult. For example, a patient hospitalized for CABG surgery who develops a hospital-acquired infection may ultimately die of sepsis and multi-organ failure. In this context, considering the patient's death to be unrelated to the care the patient received for the CABG surgery during the index admission would be inappropriate.

30-Day Time Frame

The measure assesses mortality within a 30-day period from the procedure date. The procedure date is used because some patients who undergo CABG surgery might be admitted during the days before the procedure date rather than on the day of the procedure. For those patients, dating the measurement period from the day of admission would underestimate the period of risk.

The measure uses a 30-day time frame because older adult patients are more vulnerable to adverse health outcomes occurring during this time. Death within 30 days of the CABG surgery 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 mortality[4].

2.2.3 Risk-Adjustment Variables

In order to account for differences in case mix among hospitals, the measure adjusts for variables (for example, age, sex, 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 measure adjusts 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 measure does 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 measure to adjust for patient demographic and clinical characteristics while illuminating important quality differences.

Refer to Table D.1.3 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 only during the index admission. The Condition Categories (CCs) outlined in this table are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015. The ICD-10 code lists referenced in the table that are used to identify certain risk variables (for example, cardiogenic shock) in discharges on or after October 1, 2015 are posted on *QualityNet* due to volume. For a list of ICD-9 codes used to identify these variables in discharges prior to October 1, 2015, please refer to the 2016 procedure-specific mortality measure updates and specifications report posted on *QualityNet*.

Note that CC mappings to ICD-10-CM codes (for discharges on or after October 1, 2015) and ICD-9 codes (for discharges prior to October 1, 2015) are available on the *QualityNet* website.

2.2.4 Data Sources

The data sources for these analyses are Medicare administrative claims and enrollment information for patients with hospitalizations between July 1, 2013 and June 30, 2016. The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims for the 12 months prior to the index admission for patients admitted in this time period. Refer to the original methodology report for further descriptions of these data sources and an explanation of the three-year measurement period[1].

2.2.5 Measure Calculation

The measure estimates hospital-level 30-day all-cause RSMRs for CABG surgery using a hierarchical logistic regression model. In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals[5]. At the patient level, it models the log-odds of mortality within 30 days of the procedure date 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 mortality 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[5]. If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects should be identical across all hospitals.

The RSMR is calculated as the ratio of the number of "predicted" deaths to the number of "expected" deaths at a given hospital, multiplied by the national observed mortality rate. For each hospital, the numerator of the ratio is the number of deaths within 30

days predicted based on the hospital's performance with its observed case mix, and the denominator is the number of deaths 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 mortality rates or better quality, while a higher ratio indicates higher-than-expected mortality rates or worse quality.

The "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors (Table D.1.3) and the hospital-specific effect on the risk of mortality. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log transformed and summed over all patients attributed to a hospital to calculate a predicted value. The "expected" number of deaths (the denominator) is obtained in the same manner except 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 attributed to a hospital to calculate an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period.

Multiplying the predicted over expected ratio by the national observed mortality rate transforms the ratio into a rate that can be compared to the national observed mortality rate. The hierarchical logistic regression model is described fully in Appendix A and in the original methodology report[1].

2.2.6 Categorizing Hospital Performance

To categorize hospital performance, CMS estimates each hospital's RSMR and the corresponding 95% interval estimate. CMS assigns hospitals to a performance category by comparing each hospital's RSMR interval estimate to the national observed mortality 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 mortality rate.
- "Worse than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed mortality rate.
- "Better than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed mortality 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 mortality rates and interval estimates will not be publicly reported for the measure.

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

3. UPDATES TO MEASURES FOR 2017 PUBLIC REPORTING

3.1 Rationale for Measure Updates

Annual measure reevaluation ensures that the risk-standardized mortality model is continually assessed and remain valid, given possible changes in clinical practice and coding standards over time. Modifications made to the measure cohort, risk model, and outcomes are informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, and empirical analyses including assessment of coding trends that reveal shifts in clinical practice or billing patterns. As this report describes, for 2017 public reporting, we made the following modifications to the measure:

- Revised the measure specifications to accommodate the implementation of ICD-10 coding:
  - Identified the ICD-10 codes used to define the measure cohort for discharges on or after October 1, 2015.
  - Re-specified the risk model, updating the CC-based risk variables to the ICD-10-compatible Hierarchical Condition Categories (HCC) system version 22 and applying ICD-10 codes for certain risk variables (for example, cardiogenic shock) to the model.

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

- Evaluated and validated model performance for the three years combined (July 2013-June 2016);
- Evaluated the stability of the risk-adjustment model over the three-year measurement period by examining the model variable frequencies, model coefficients, and the performance of the risk-adjustment model in each year (July 2013-June 2014, July 2014-June 2015, and July 2015-June 2016); and,
- Updated the measure's SAS analytic package (SAS pack) and documentation.

3.2 Detailed Discussion of Measure Updates

3.2.1 Updates to ICD-10-Based Measure Specifications

Measure Re-specification

We re-specified the measure to accommodate the implementation of ICD-10 coding. Specifically:

- We expanded the cohort definition to include ICD-10 codes for use with discharges on or after October 1, 2015. (Previously-specified ICD-9 codes continue to be used for discharges before October 1, 2015.)
- We re-specified the risk model:
  - The CC-based risk variables were updated to the ICD-10-compatible HCC system version 22, maintained by RTI International; and,
  - Certain risk variables (for example, cardiogenic shock) previously defined using ICD-9 codes were re-defined using ICD-10 codes, for use with inpatient,

outpatient, and/or physician Medicare administrative claims on or after October 1, 2015.

Rationale for Measure Re-specification

On October 1, 2015, the ICD-9 code sets used to report medical diagnoses and inpatient procedures were replaced by ICD-10 code sets. The Department of Health and Human Services (HHS) has mandated that ICD-10 codes be used by all HIPAA-covered entities for medical coding, effective for October 1, 2015+ discharges. More information on ICD-10 coding can be found on the CMS website.

The CABG surgery mortality measure uses Medicare FFS claims to define the measure cohort and identify patient comorbidities for measure risk adjustment. In public reporting years prior to 2017, the measure exclusively used ICD-9 codes from claims. However, the measurement period for 2017 public reporting requires data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification of both of the above components was warranted to accommodate ICD-10 coding.

The goal of this re-specification was to maintain the intent and validity of the measure.

The ICD-10 Transition Process

In developing the ICD-10 code lists that define the cohort for the measure, we created cohort crosswalks using the General Equivalence Mappings (GEMs), a tool created by CMS and the Centers for Disease Control and Prevention (CDC) to assist with the conversion of ICD-9 codes to ICD-10 codes. To validate the cohort crosswalks, we compared the cohort size using ICD-10 codes in a set of claims submitted between October 2015 and March 2016 with the cohort size using previously-defined ICD-9 codes in a set of claims submitted between October 2014 and March 2015. We conducted clinical review to identify those codes appropriate for cohort definition.

The risk variables were updated to the ICD-10-compatible HCC version 22 map. The intent was to keep the risk-adjustment model as similar as possible to the model previously defined using HCC version 12. Specifically:

- Experts examined the ICD-9 code-based HCC version 12 and version 22 maps and reviewed shifts that occurred (where an ICD-9 code had moved from one CC to another). Based on these examinations, they recommended new risk variables using version 22 CCs.
- Following re-specification of the risk variables using the HCC version 22 map, we ran risk-adjustment models on several outcome measures, to ensure testing of all variables where shifts in the ICD-9 codes included in the CCs had occurred.
- For each tested measure, we used the same claims dataset to calculate and compare two separate sets of measure results using two separate risk-adjustment models: One set using the previously-specified version 12 risk variables, and the other using the newly-specified version 22 risk variables. For this analysis we used the ICD-9-coded data from the 2016 measurement period.

- We compared the frequencies and model coefficients of the two sets of risk-adjustment variables, to ensure that they were similar.
- We compared the performance of each risk-adjustment model by calculating each model's c-statistic and predictive ability.
- We examined the correlation in the risk-standardized outcome rates produced by the two risk-adjustment models, to ensure that they produced similar measure results.
- We examined the degree to which the models produced similar risk-standardized outcome rates at the hospital level by assessing whether individual hospitals' risk-standardized rates fell into the same quintile in the distribution of risk-standardized rates calculated by each of the two models.
- Based on the results of these analyses, we made minor modifications to the re-specified risk-adjustment variables to ensure that the performance of the risk-adjustment model was as similar as possible to the performance of the previously-specified model, and that the hospital-level results were as similar as possible.

The updated measure specifications can be found in Appendix D.

3.3 Changes to SAS Pack

We revised the measure calculation SAS pack to reflect the re-specifications done to accommodate the implementation of ICD-10 coding. The new SAS pack and documentation are available upon request by emailing cmsmortalitymeasures@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 RSMR 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 2017 PUBLIC REPORTING

4.1 Assessment of Updated Model

The CABG surgery mortality measure estimates hospital-specific 30-day all-cause RSMRs using a hierarchical logistic regression model. Refer to Section 2 for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and technical reports for further details[1-3].

We evaluated the performance of the model using the July 2013 to June 2016 data for the 2017 public reporting period. We examined the differences in the frequencies of patient risk factors and the model variable coefficients.

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). We also computed between-hospital variance for each year of data and for the three-year combined period. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

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

4.2 CABG Surgery Mortality 2017 Model Results

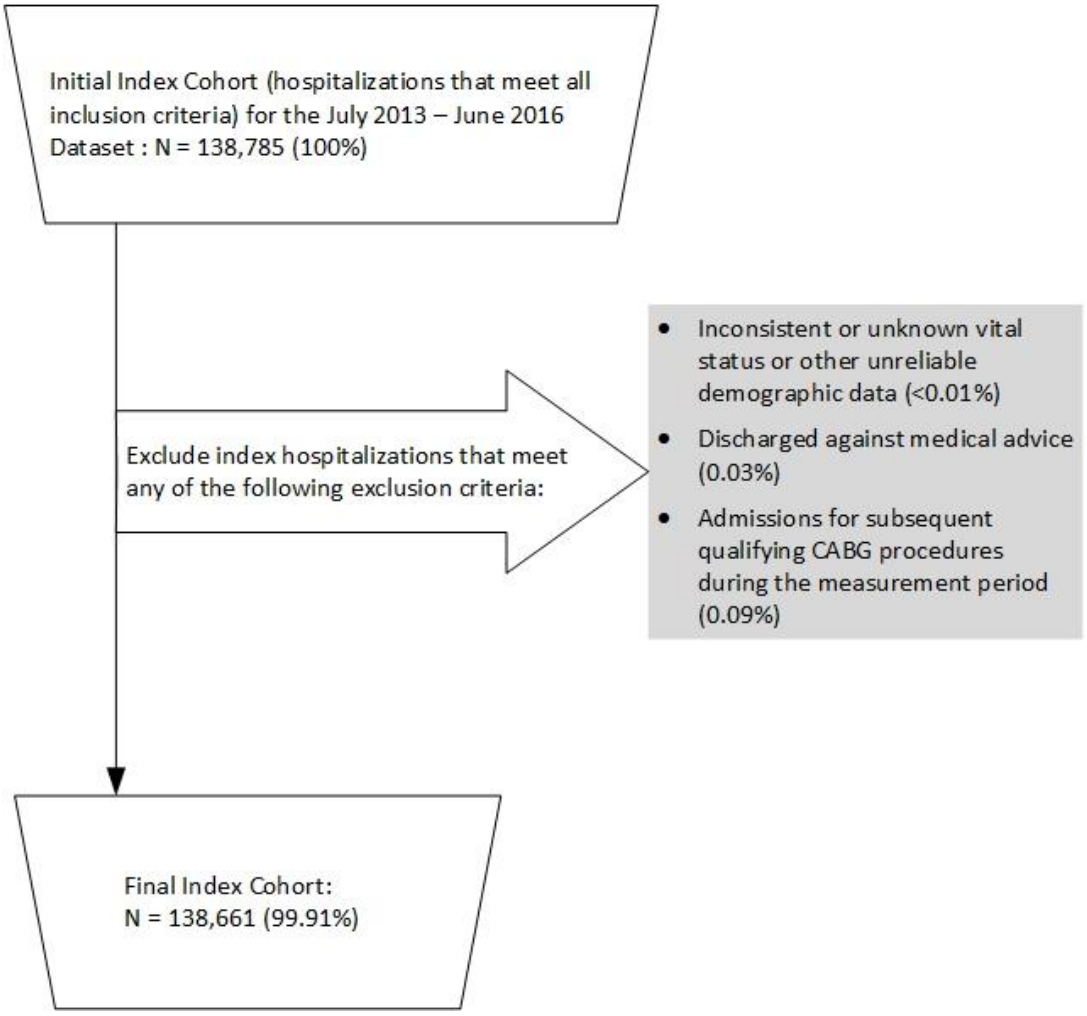
4.2.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in Section 2.2.1. The percentage of CABG surgery admissions that met each exclusion criterion in the July 2013-June 2016 dataset is presented in Figure 4.2.1.

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

- Aged 65 or over;
- With a qualifying isolated CABG procedure; and,
- 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.

Figure 4.2.1– CABG Surgery Cohort Exclusions in the July 2013-June 2016 Dataset



4.2.2 Frequency of CABG Surgery Model Variables

We examined the change in the frequencies of clinical and demographic variables. Frequencies of model variables were stable over the measurement period. The largest changes in the frequencies (those greater than 2% absolute change) include:

- An increase in Renal failure (27.6% - 29.7%)
- Decreases in Angina; old myocardial infarction (42.4% - 37.7%) and Unstable angina and other acute ischemic heart disease (42.3% - 35.7%)

Refer to Table 4.2.1 for more detail. Note that the increases and decreases in some model variables may reflect not only changes in rates of comorbidities in the Medicare FFS population, but also changes due to ICD-10 code implementation effective with October 1, 2015+ discharges.

4.2.3 CABG Surgery Model Parameters and Performance

Table 4.2.2 shows hierarchical logistic 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 surgery mortality 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 0.77 to 0.78 (Table 4.2.4).

4.2.4 Distribution of Hospital Volumes and Mortality Rates for CABG Surgery

The national *observed* mortality rate in the combined three-year dataset was 3.2%. Over the three years, the observed rate increased slightly from 3.1% (between July 2013 and June 2014) to 3.3% (between July 2014 and June 2015) but then decreased to 3.1% (between July 2015 and June 2016).

Table 4.2.5 shows the distribution of hospital admission volumes, and Table 4.2.6 shows the distribution of hospital RSMRs. Over the three years, the mean RSMR increased slightly from 3.2% (between July 2013 and June 2014) to 3.4% (between July 2014 and June 2015) but then decreased to 3.2% (between July 2015 and June 2016). The median hospital RSMR in the combined three-year dataset was 3.1% (interquartile range [IQR]: 2.7% - 3.7%). Table 4.2.7 shows the between-hospital variance by individual year, as well as for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.219 (Standard Error [SE]: 0.023).

Figure 4.2.2 shows the overall distribution of the hospital RSMRs for the combined three-year dataset. The odds of all-cause mortality if a patient is treated at a hospital one standard deviation (SD) above the national rate were 2.55 times higher than odds of all-cause mortality 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[5].

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

Of 1,185 hospitals in the study cohort, 17 performed “Better than the National Rate,” 1,004 performed “No Different from the National Rate,” and 18 performed “Worse than the

National Rate." 146 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	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Total N	46,279	46,123	46,259	138,661
Mean age minus 65 (SD)	8.8 (5.7)	8.7 (5.7)	8.7 (5.6)	8.7 (5.7)
Male (%)	71.4	71.8	71.9	71.7
Cardiogenic shock	5.6	6.4	6.1	6.0
Coronary atherosclerosis	86.7	87.0	87.7	87.1
History of coronary artery bypass graft (CABG) or valve surgery	5.3	5.1	5.5	5.3
Cancer; metastatic cancer and acute leukemia (CC 8-14)	19.0	18.9	19.3	19.1
Protein-calorie malnutrition (CC 21)	4.6	4.5	4.2	4.4
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	93.1	93.7	94.1	93.6
Liver or biliary disease (CC 27-32)	6.5	6.7	7.1	6.8
Other gastrointestinal disorders (CC 38)	55.8	56.7	57.0	56.5
Dementia or other specified brain disorders (CC 51-53)	5.7	5.6	6.0	5.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	2.5	2.6	2.7	2.6
Congestive heart failure (CC 85)	20.6	20.3	20.2	20.4
Acute myocardial infarction (CC 86)	17.6	17.5	19.1	18.1
Unstable angina and other acute ischemic heart disease (CC 87)	42.3	41.7	35.7	39.9
Angina; old myocardial infarction (CC 88 plus ICD-10-CM code I25.2, for discharges on or after October 1, 2015; CC 88 plus ICD-9-CM code 412, for discharges prior to October 1, 2015)	42.4	42.2	37.7	40.8
Hypertension (CC 95)	89.1	89.1	89.7	89.3
Stroke (CC 99-100)	4.7	5.0	4.4	4.7
Vascular or circulatory disease (CC 106-109)	33.9	33.5	32.8	33.4
Chronic obstructive pulmonary disease (COPD) (CC 111)	26.0	25.4	25.0	25.5
Pneumonia (CC 114-116)	12.7	12.8	12.5	12.6
Dialysis status (CC 134)	2.0	2.1	2.2	2.1
Renal failure (CC 135-140)	27.6	28.9	29.7	28.7
Decubitus ulcer or chronic skin ulcer (CC 157-161)	3.7	3.7	3.6	3.6

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

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Intercept	-3.896	-4.015	-4.110	-4.044
Age minus 65 (years above 65, continuous)	0.063	0.064	0.058	0.062
Male	-0.283	-0.445	-0.409	-0.374
Cardiogenic shock	1.810	2.026	2.005	1.973
Coronary atherosclerosis	0.085	0.115	0.248	0.169
History of coronary artery bypass graft (CABG) or valve surgery	0.372	0.433	0.234	0.344
Cancer; metastatic cancer and acute leukemia (CC 8-14)	-0.159	-0.022	-0.108	-0.086
Protein-calorie malnutrition (CC 21)	0.584	0.453	0.582	0.543
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	-0.339	-0.158	-0.481	-0.310

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Liver or biliary disease (CC 27-32)	0.397	0.501	0.322	0.406
Other gastrointestinal disorders (CC 38)	-0.245	-0.251	-0.281	-0.262
Dementia or other specified brain disorders (CC 51-53)	0.216	0.287	0.280	0.257
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	0.377	0.173	0.233	0.258
Congestive heart failure (CC 85)	0.171	0.162	0.118	0.158
Acute myocardial infarction (CC 86)	0.244	0.157	0.114	0.181
Unstable angina and other acute ischemic heart disease (CC 87)	-0.135	-0.281	-0.027	-0.138
Angina; old myocardial infarction (CC 88 plus ICD-10-CM code I25.2, for discharges on or after October 1, 2015; CC 88 plus ICD-9-CM code 412, for discharges prior to October 1, 2015)	-0.185	-0.078	-0.175	-0.143
Hypertension (CC 95)	-0.290	-0.286	-0.041	-0.210
Stroke (CC 99-100)	0.005	0.198	-0.037	0.058
Vascular or circulatory disease (CC 106-109)	0.123	0.146	0.165	0.149
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.312	0.287	0.406	0.322
Pneumonia (CC 114-116)	0.250	0.444	0.139	0.274
Dialysis status (CC 134)	0.636	0.516	0.790	0.652
Renal failure (CC 135-140)	0.339	0.224	0.420	0.331
Decubitus ulcer or chronic skin ulcer (CC 157-161)	0.084	0.131	0.100	0.107

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

Variable	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2015-06/2016 OR (95% CI)	07/2013-06/2016 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.07 (1.06 - 1.08)	1.07 (1.06 - 1.08)	1.06 (1.05 - 1.07)	1.06 (1.06 - 1.07)
Male	0.75 (0.67 - 0.85)	0.64 (0.57 - 0.72)	0.66 (0.59 - 0.75)	0.69 (0.64 - 0.74)
Cardiogenic shock	6.11 (5.36 - 6.97)	7.59 (6.70 - 8.59)	7.43 (6.54 - 8.43)	7.20 (6.68 - 7.75)
Coronary atherosclerosis	1.09 (0.90 - 1.31)	1.12 (0.93 - 1.36)	1.28 (1.04 - 1.58)	1.18 (1.06 - 1.33)
History of coronary artery bypass graft (CABG) or valve surgery	1.45 (1.17 - 1.80)	1.54 (1.24 - 1.91)	1.26 (1.01 - 1.57)	1.41 (1.24 - 1.60)
Cancer; metastatic cancer and acute leukemia (CC 8-14)	0.85 (0.74 - 0.99)	0.98 (0.85 - 1.13)	0.90 (0.78 - 1.04)	0.92 (0.84 - 1.00)
Protein-calorie malnutrition (CC 21)	1.79 (1.51 - 2.14)	1.57 (1.32 - 1.88)	1.79 (1.49 - 2.15)	1.72 (1.55 - 1.91)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	0.71 (0.59 - 0.86)	0.85 (0.70 - 1.04)	0.62 (0.51 - 0.76)	0.73 (0.66 - 0.82)
Liver or biliary disease (CC 27-32)	1.49 (1.24 - 1.79)	1.65 (1.38 - 1.97)	1.38 (1.15 - 1.66)	1.50 (1.35 - 1.67)
Other gastrointestinal disorders (CC 38)	0.78 (0.70 - 0.88)	0.78 (0.70 - 0.87)	0.76 (0.67 - 0.85)	0.77 (0.72 - 0.82)
Dementia or other specified brain disorders (CC 51-53)	1.24 (1.02 - 1.51)	1.33 (1.10 - 1.61)	1.32 (1.09 - 1.60)	1.29 (1.16 - 1.45)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1.46 (1.10 - 1.93)	1.19 (0.90 - 1.58)	1.26 (0.95 - 1.67)	1.29 (1.10 - 1.52)
Congestive heart failure (CC 85)	1.19 (1.04 - 1.36)	1.18 (1.03 - 1.34)	1.13 (0.98 - 1.29)	1.17 (1.08 - 1.27)
Acute myocardial infarction (CC 86)	1.28 (1.12 - 1.46)	1.17 (1.02 - 1.34)	1.12 (0.98 - 1.28)	1.20 (1.11 - 1.29)

Variable	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2015-06/2016 OR (95% CI)	07/2013-06/2016 OR (95% CI)
Unstable angina and other acute ischemic heart disease (CC 87)	0.87 (0.78 - 0.98)	0.76 (0.67 - 0.85)	0.97 (0.87 - 1.10)	0.87 (0.81 - 0.93)
Angina; old myocardial infarction (CC 88 plus ICD-10-CM code I25.2, for discharges on or after October 1, 2015; CC 88 plus ICD-9-CM code 412, for discharges prior to October 1, 2015)	0.83 (0.74 - 0.94)	0.93 (0.82 - 1.04)	0.84 (0.74 - 0.95)	0.87 (0.81 - 0.93)
Hypertension (CC 95)	0.75 (0.64 - 0.88)	0.75 (0.64 - 0.88)	0.96 (0.81 - 1.14)	0.81 (0.74 - 0.89)
Stroke (CC 99-100)	1.01 (0.79 - 1.28)	1.22 (0.98 - 1.52)	0.96 (0.75 - 1.24)	1.06 (0.92 - 1.22)
Vascular or circulatory disease (CC 106-109)	1.13 (1.00 - 1.27)	1.16 (1.03 - 1.31)	1.18 (1.04 - 1.33)	1.16 (1.08 - 1.24)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.37 (1.21 - 1.54)	1.33 (1.18 - 1.50)	1.50 (1.33 - 1.69)	1.38 (1.29 - 1.48)
Pneumonia (CC 114-116)	1.28 (1.12 - 1.48)	1.56 (1.36 - 1.78)	1.15 (1.00 - 1.33)	1.32 (1.21 - 1.43)
Dialysis status (CC 134)	1.89 (1.46 - 2.45)	1.68 (1.29 - 2.19)	2.20 (1.72 - 2.83)	1.92 (1.66 - 2.23)
Renal failure (CC 135-140)	1.40 (1.24 - 1.59)	1.25 (1.11 - 1.41)	1.52 (1.35 - 1.72)	1.39 (1.30 - 1.49)
Decubitus ulcer or chronic skin ulcer (CC 157-161)	1.09 (0.85 - 1.39)	1.14 (0.90 - 1.44)	1.11 (0.86 - 1.42)	1.11 (0.97 - 1.28)

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

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Predictive ability, % (lowest decile – highest decile)	0.5 - 13.4	0.3 - 15.1	0.4 - 13.8	0.4 - 14.0
c-statistic	0.77	0.79	0.78	0.78

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

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	1,158	1,150	1,151	1,185
Mean number of admissions (SD)	40.0 (35.2)	40.1 (35.6)	40.2 (36.3)	117.0 (105.6)
Range (min. – max.)	1 - 269	1 - 279	1 - 287	1 - 835
25th percentile	16	15	15	45
50th percentile	30	30	30	86
75th percentile	53	53	55	154

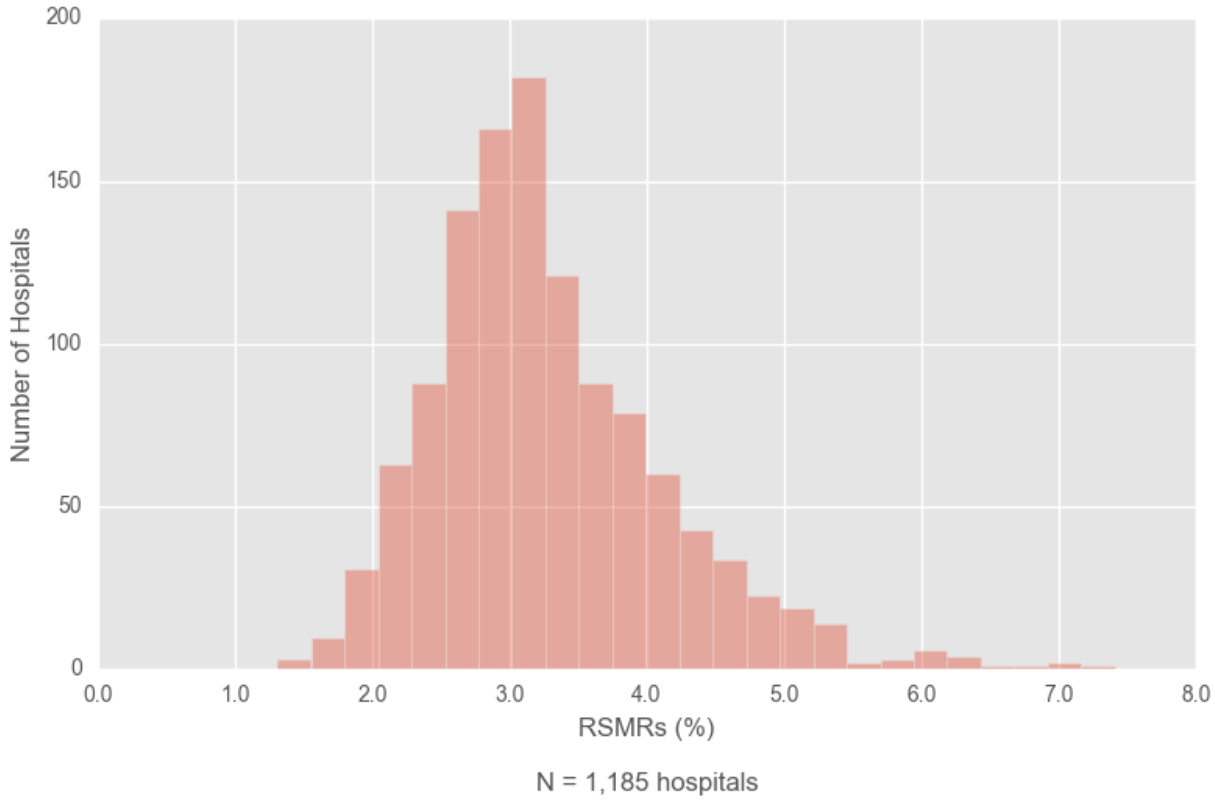
Table 4.2.6 – Distribution of Hospital CABG Surgery RSMRs over Different Time Periods

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	1,158	1,150	1,151	1,185
Mean (SD)	3.2 (0.5)	3.4 (0.7)	3.2 (0.7)	3.3 (0.9)
Range (min. – max.)	1.9 - 6.0	1.8 - 6.7	1.4 - 6.8	1.3 - 7.4
25th percentile	2.9	2.9	2.7	2.7
50th percentile	3.1	3.2	3.0	3.1
75th percentile	3.4	3.7	3.5	3.7

Table 4.2.7 – Between-Hospital Variance for CABG Surgery

	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Between-hospital variance (SE)	0.159 (0.040)	0.240 (0.043)	0.269 (0.047)	0.219 (0.023)

Figure 4.2.2 – Distribution of Hospital 30-Day CABG Surgery RSMRs between July 2013 and June 2016



5. GLOSSARY

C-statistic: An indicator of the model's discriminant ability or ability to correctly classify those who have and have not died within 30 days of the procedure date. Potential values range from 0.5, meaning no better than chance, to 1.0, an indication of perfect prediction. Perfect prediction implies that patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in their patients' outcomes.

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

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

Comorbidities: Medical conditions 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/ICD-10-CM diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system[6,7]. CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Mappings which show the assignment of ICD-9 and ICD-10 codes to the CCs are available on the *QualityNet* website.

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 mortality: The number of deaths 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. This statistical model accounts for the hierarchical structure of the data (patients clustered within hospitals are assumed to be correlated) and accommodates modeling of the association between outcomes and patient characteristics. Based on the hierarchical model, we can evaluate: (1) how much variation in hospital mortality 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 mortality risk.

Hospital-specific effect: A measure of the hospital quality of care calculated through hierarchical logistic regression, taking into consideration how many patients were eligible for the cohort, these patients' risk factors, and how many died. 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" mortality.

Index admission: Any admission included in the measure calculation as the initial admission for an episode of CABG surgery 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 mortality rate indicates there is 95% confidence that the true value of the rate lies between the lower and the upper limit of the interval.

Medicare fee-for-service (FFS): Original Medicare plan in which providers receive a fee or payment 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 mortality 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 CABG surgery mortality measure, the outcome is mortality within 30 days of the procedure date.

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

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

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7. APPENDICES

Appendix A. Statistical Approach to RSMRs for CABG Surgery Measure

We estimate the hospital-specific RSMRs using a hierarchical generalized linear model. 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 mortality as a function of patient age, sex, clinically relevant comorbidities, and history of CABG surgery with an intercept for the hospital-specific random effect.

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

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

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

Where h(.) is a logit link, Y_{ij} is whether the j^{th} patient in the i^{th} hospital died (equal to 1 if death within 30 days, zero otherwise); α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \ldots, Z_{pij})$ 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[8]. This model separates within-hospital variation from between-hospital variation. The hierarchical logistic regression model is 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, $\hat{\mu}$, $\{\hat{\alpha}_i, \hat{\alpha}_2, \ldots, \hat{\alpha}_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$ where i is the total number of hospitals. We calculate a standardized outcome measure, RSMR, for each hospital by computing the ratio of the predicted mortality to the expected mortality, multiplied by the national observed mortality rate, $\bar{y}$. Specifically, we calculate

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

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

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

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

If the "predicted" mortality is higher (or lower) than the "expected" mortality for a given hospital, its $\widehat{RSMR}$ will be higher (or lower) than the national observed mortality rate. For each hospital, we compute an interval estimate of $RSMR_i$ 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, $\widehat{RSMR}_i$) 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. The estimated regression coefficients of the risk factors, $\hat{\beta}^{(b)}$.
    b. The parameters governing the random effects, hospital adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$.
    c. The set of hospital-specific intercepts and corresponding variances,

$$\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1,2,\dots,I\}$$

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 $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \widehat{var}(\hat{\alpha}_i^{(b)}))$ 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 $\widehat{RSMR}_i(Z)^{(B)}$ 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[9]).

Appendix B. Data QA

This production year required revision of all SAS packs to account for the ICD-10 code transition. In order to assure the quality of measure output, we utilized a multi-phase approach to QA of the CABG surgery mortality measure.

This section represents QA for the subset of the work CORE conducted to maintain and report the CABG surgery mortality measure. 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 another contractor conducts that work.

Phase I

The first step in this year's QA process started prior to the SAS pack revisions. We tested the conversion of the HCC map from version 12 to version 22 to ensure that the risk variables were well-aligned in both coding schemes. Following risk variable testing, we tested the impact of ICD-10 coding on the cohort inclusion and exclusion criteria, outcomes, and risk factors. We drew comparisons between the first six months of data from the start of the ICD-10 transition and the same six months in the prior year for ICD-9.

In general, we used both manual scan and descriptive analyses to conduct data validity checks, including cross-checking mortality information, distributions of ICD-9/ICD-10 codes, and frequencies of key variables.

Phase II

Using a finalized list of ICD-10 coding changes, we updated the existing SAS pack to accommodate the post-transition data. To assure accuracy in the SAS pack revisions, two to three analysts/programmers independently wrote SAS code for any changes made in calculating the CABG surgery mortality measure: data preparation, cohort construction, hierarchical modeling, and calculation of RSMRs. This process highlighted any programming errors in syntax or logic and checked that new ICD-10 codes had been properly applied. Once this parallel programming process was complete, the analysts cross-checked their codes by analyzing datasets in parallel, checking for consistency of output, and reconciling any discrepancies. Finally, an additional analyst reviewed the finalized SAS code and recommended changes to the coding and readability of the SAS pack, where appropriate.

Phase III

The last phase of QA involved reviewing the year-to-year changes in the risk variable frequencies, beta coefficients, and outcome rates for the measures. This was especially important this year as the final year of the three-year reporting period encompasses a large proportion of ICD-10 claims. This phase served as a final check, to ensure the ICD-10 code-based cohort, risk factor and outcome changes did not have an adverse impact on measure results.

Appendix C. Annual Updates

Prior annual updates for the measure 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 reports are considered Version 1.0 for each measure. The measures receive a new version number for each subsequent year of public reporting.

2017

2017 Measures Updates and Specifications Report (Version 4.0 - CABG)

1. Revised the measure specifications to accommodate the implementation of ICD-10 coding:
   - Identified the ICD-10 codes used to define the measure cohort for discharges on or after October 1, 2015.
   - Re-specified the risk model, updating the CC-based risk variables to the ICD-10-compatible HCC system version 22 and applying ICD-10 codes for certain risk variables (for example, history of PTCA) to the model.
     - Rationale: The ICD-9 code sets used to report medical diagnoses and inpatient procedures were replaced by ICD-10 code sets on October 1, 2015. HHS mandated that ICD-10 codes be used for medical coding, effective October 1, 2015 discharges. The measurement period for 2017 public reporting required data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification was warranted to accommodate ICD-10 coding.

2016

2016 Measures Updates and Specifications Report (Version 3.0 - CABG)

1. The exclusion criterion that addresses multiple CABG surgery admissions in a measurement period was corrected in the cohort exclusion descriptions and re-coded in the 2016 version of the SAS code.
   - Rationale: The 2015 updates and specifications report and the original methodology report incorrectly described the handling of multiple CABG surgery cases as a process where one CABG surgery admission is randomly selected per patient per year. This is discordant with the intentions of the measure development team to select the first CABG surgery admission for any patient with more than one CABG surgery within the measurement period and exclude the subsequent CABG surgery admissions. This error also existed in the SAS code prior to 2016. Analyses of the impact of this error demonstrated that these cases were extremely rare, and that recalculations were not warranted, as national results and overall measure performance rates would not change.

2015

2015 Measures Updates and Specifications Report (Version 2.0 - CABG)

No updates were made to the specifications of the CABG surgery mortality measure for 2015 public reporting.

Appendix D. Measure Specifications

Appendix D.1 Hospital-Level 30-Day RSMR following CABG Surgery (NQF #2558)

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. **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 CABG 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 (ICD-10-PCS code list):
   - 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. **Inconsistent or unknown vital status or other unreliable demographic data**
   Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
2. **Discharged against medical advice**
   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-10-PCS Codes Used to Identify Eligible CABG Procedures

Table D.1.1 below outlines the ICD-10-PCS codes used to identify CABG procedures in claims for discharges on or after October 1, 2015. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 procedure-specific mortality measure updates and specifications report posted on *QualityNet*.

ICD-10-PCS Codes	Description
0210093	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Venous Tissue, Open Approach
0210098	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0210099	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Venous Tissue, Open Approach
021009C	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Venous Tissue, Open Approach
021009F	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Venous Tissue, Open Approach
021009W	Bypass Coronary Artery, One Artery from Aorta with Autologous Venous Tissue, Open Approach
02100A3	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Arterial Tissue, Open Approach
02100A8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02100A9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02100AC	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02100AF	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02100AW	Bypass Coronary Artery, One Artery from Aorta with Autologous Arterial Tissue, Open Approach
02100J3	Bypass Coronary Artery, One Artery from Coronary Artery with Synthetic Substitute, Open Approach
02100J8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Synthetic Substitute, Open Approach
02100J9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Synthetic Substitute, Open Approach
02100JC	Bypass Coronary Artery, One Artery from Thoracic Artery with Synthetic Substitute, Open Approach
02100JF	Bypass Coronary Artery, One Artery from Abdominal Artery with Synthetic Substitute, Open Approach
02100JW	Bypass Coronary Artery, One Artery from Aorta with Synthetic Substitute, Open Approach
02100K3	Bypass Coronary Artery, One Artery from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02100K8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach

ICD-10-PCS Codes	Description
02100K9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02100KC	Bypass Coronary Artery, One Artery from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02100KF	Bypass Coronary Artery, One Artery from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02100KW	Bypass Coronary Artery, One Artery from Aorta with Nonautologous Tissue Substitute, Open Approach
02100Z3	Bypass Coronary Artery, One Artery from Coronary Artery, Open Approach
02100Z8	Bypass Coronary Artery, One Artery from Right Internal Mammary, Open Approach
02100Z9	Bypass Coronary Artery, One Artery from Left Internal Mammary, Open Approach
02100ZC	Bypass Coronary Artery, One Artery from Thoracic Artery, Open Approach
02100ZF	Bypass Coronary Artery, One Artery from Abdominal Artery, Open Approach
0210493	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0210498	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0210499	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021049C	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021049F	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021049W	Bypass Coronary Artery, One Artery from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02104A3	Bypass Coronary Artery, One Artery from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104A8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104A9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AC	Bypass Coronary Artery, One Artery from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AF	Bypass Coronary Artery, One Artery from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104AW	Bypass Coronary Artery, One Artery from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02104J3	Bypass Coronary Artery, One Artery from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104J8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02104J9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JC	Bypass Coronary Artery, One Artery from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JF	Bypass Coronary Artery, One Artery from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02104JW	Bypass Coronary Artery, One Artery from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach

ICD-10-PCS Codes	Description
02104K3	Bypass Coronary Artery, One Artery from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104K8	Bypass Coronary Artery, One Artery from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104K9	Bypass Coronary Artery, One Artery from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KC	Bypass Coronary Artery, One Artery from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KF	Bypass Coronary Artery, One Artery from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104KW	Bypass Coronary Artery, One Artery from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02104Z3	Bypass Coronary Artery, One Artery from Coronary Artery, Percutaneous Endoscopic Approach
02104Z8	Bypass Coronary Artery, One Artery from Right Internal Mammary, Percutaneous Endoscopic Approach
02104Z9	Bypass Coronary Artery, One Artery from Left Internal Mammary, Percutaneous Endoscopic Approach
02104ZC	Bypass Coronary Artery, One Artery from Thoracic Artery, Percutaneous Endoscopic Approach
02104ZF	Bypass Coronary Artery, One Artery from Abdominal Artery, Percutaneous Endoscopic Approach
0211093	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0211098	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0211099	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
021109C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach
021109F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021109W	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Venous Tissue, Open Approach
02110A3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02110A8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02110A9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02110AC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02110AF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02110AW	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02110J3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02110J8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach

ICD-10-PCS Codes	Description
02110J9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02110JC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02110JF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02110JW	Bypass Coronary Artery, Two Arteries from Aorta with Synthetic Substitute, Open Approach
02110K3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02110K8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02110K9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02110KC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02110KF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02110KW	Bypass Coronary Artery, Two Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02110Z3	Bypass Coronary Artery, Two Arteries from Coronary Artery, Open Approach
02110Z8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary, Open Approach
02110Z9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary, Open Approach
02110ZC	Bypass Coronary Artery, Two Arteries from Thoracic Artery, Open Approach
02110ZF	Bypass Coronary Artery, Two Arteries from Abdominal Artery, Open Approach
0211493	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0211498	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0211499	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021149C	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021149F	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021149W	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02114A3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114A8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114A9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02114AW	Bypass Coronary Artery, Two Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach

ICD-10-PCS Codes	Description
02114J3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114J8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02114J9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02114JW	Bypass Coronary Artery, Two Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02114K3	Bypass Coronary Artery, Two Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114K8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114K9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KC	Bypass Coronary Artery, Two Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KF	Bypass Coronary Artery, Two Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114KW	Bypass Coronary Artery, Two Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02114Z3	Bypass Coronary Artery, Two Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02114Z8	Bypass Coronary Artery, Two Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02114Z9	Bypass Coronary Artery, Two Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach
02114ZC	Bypass Coronary Artery, Two Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02114ZF	Bypass Coronary Artery, Two Arteries from Abdominal Artery, Percutaneous Endoscopic Approach
0212093	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0212098	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach
0212099	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
021209C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach
021209F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021209W	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Venous Tissue, Open Approach
02120A3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02120A8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach

ICD-10-PCS Codes	Description
02120A9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02120AC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02120AF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02120AW	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02120J3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02120J8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach
02120J9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02120JC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02120JF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02120JW	Bypass Coronary Artery, Three Arteries from Aorta with Synthetic Substitute, Open Approach
02120K3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02120K8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02120K9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02120KC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02120KF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02120KW	Bypass Coronary Artery, Three Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02120Z3	Bypass Coronary Artery, Three Arteries from Coronary Artery, Open Approach
02120Z8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary, Open Approach
02120Z9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary, Open Approach
02120ZC	Bypass Coronary Artery, Three Arteries from Thoracic Artery, Open Approach
02120ZF	Bypass Coronary Artery, Three Arteries from Abdominal Artery, Open Approach
0212493	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0212498	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0212499	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021249C	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021249F	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021249W	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach

ICD-10-PCS Codes	Description
02124A3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124A8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124A9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124AW	Bypass Coronary Artery, Three Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02124J3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124J8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02124J9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02124JW	Bypass Coronary Artery, Three Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02124K3	Bypass Coronary Artery, Three Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124K8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124K9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KC	Bypass Coronary Artery, Three Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KF	Bypass Coronary Artery, Three Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124KW	Bypass Coronary Artery, Three Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02124Z3	Bypass Coronary Artery, Three Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02124Z8	Bypass Coronary Artery, Three Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02124Z9	Bypass Coronary Artery, Three Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach
02124ZC	Bypass Coronary Artery, Three Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02124ZF	Bypass Coronary Artery, Three Arteries from Abdominal Artery, Percutaneous Endoscopic Approach
0213093	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Venous Tissue, Open Approach
0213098	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Venous Tissue, Open Approach

ICD-10-PCS Codes	Description
0213099	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Venous Tissue, Open Approach
021309C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Venous Tissue, Open Approach
021309F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Venous Tissue, Open Approach
021309W	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Venous Tissue, Open Approach
02130A3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Arterial Tissue, Open Approach
02130A8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Arterial Tissue, Open Approach
02130A9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Arterial Tissue, Open Approach
02130AC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Arterial Tissue, Open Approach
02130AF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Arterial Tissue, Open Approach
02130AW	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Arterial Tissue, Open Approach
02130J3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Synthetic Substitute, Open Approach
02130J8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Synthetic Substitute, Open Approach
02130J9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Synthetic Substitute, Open Approach
02130JC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Synthetic Substitute, Open Approach
02130JF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Synthetic Substitute, Open Approach
02130JW	Bypass Coronary Artery, Four or More Arteries from Aorta with Synthetic Substitute, Open Approach
02130K3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Nonautologous Tissue Substitute, Open Approach
02130K8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02130K9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Open Approach
02130KC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Open Approach
02130KF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Open Approach
02130KW	Bypass Coronary Artery, Four or More Arteries from Aorta with Nonautologous Tissue Substitute, Open Approach
02130Z3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery, Open Approach
02130Z8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary, Open Approach
02130Z9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary, Open Approach
02130ZC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery, Open Approach

ICD-10-PCS Codes	Description
02130ZF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery, Open Approach
0213493	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0213498	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
0213499	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021349C	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021349F	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Venous Tissue, Percutaneous Endoscopic Approach
021349W	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Venous Tissue, Percutaneous Endoscopic Approach
02134A3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134A8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134A9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134AW	Bypass Coronary Artery, Four or More Arteries from Aorta with Autologous Arterial Tissue, Percutaneous Endoscopic Approach
02134J3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134J8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02134J9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Synthetic Substitute, Percutaneous Endoscopic Approach
02134JW	Bypass Coronary Artery, Four or More Arteries from Aorta with Synthetic Substitute, Percutaneous Endoscopic Approach
02134K3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134K8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134K9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach
02134KW	Bypass Coronary Artery, Four or More Arteries from Aorta with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach

ICD-10-PCS Codes	Description
02134Z3	Bypass Coronary Artery, Four or More Arteries from Coronary Artery, Percutaneous Endoscopic Approach
02134Z8	Bypass Coronary Artery, Four or More Arteries from Right Internal Mammary, Percutaneous Endoscopic Approach
02134Z9	Bypass Coronary Artery, Four or More Arteries from Left Internal Mammary, Percutaneous Endoscopic Approach
02134ZC	Bypass Coronary Artery, Four or More Arteries from Thoracic Artery, Percutaneous Endoscopic Approach
02134ZF	Bypass Coronary Artery, Four or More Arteries from Abdominal Artery, Percutaneous Endoscopic Approach

Risk Adjustment

Table D.1.2 – Risk Variables for CABG Surgery Measure

The CCs outlined in Table D.1.2 below are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015.

The ICD-10 codes used to identify certain variables (for example, Cardiogenic shock) in discharges on or after October 1, 2015 are posted on *QualityNet* due to volume; hyperlinks to these lists are provided in the table. For a list of ICD-9 codes used to identify these variables in discharges prior to October 1, 2015, please refer to the 2016 procedure-specific mortality measure updates and specifications report posted on *QualityNet*.

Description of Risk Variable	CCs and/or ICD Codes Included	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	
Cardiogenic shock	ICD-10-CM code list	
Coronary atherosclerosis	ICD-10-CM code list	
History of coronary artery bypass graft (CABG) or valve surgery	ICD-10-CM code list and ICD-10-PCS code list	
Cancer; metastatic cancer and acute leukemia (CC 8-14)	Metastatic cancer or acute leukemia (CC 8)	
	Lung and other severe cancers (CC 9)	
	Lymphoma and other cancers (CC 10)	
	Colorectal, bladder, and other cancers (CC 11)	
	Breast, prostate, and other cancers and tumors (CC 12)	
	Other respiratory and heart neoplasms (CC 13)	
	Other digestive and urinary neoplasms (CC 14)	
Protein-calorie malnutrition (CC 21)	Protein-calorie malnutrition (CC 21)	
	Morbid obesity (CC 22)	

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	Disorders of lipoid metabolism (CC 25)	
	Other endocrine/metabolic/nutritional disorders (CC 26)	
Liver or biliary disease (CC 27-32)	End-stage liver disease (CC 27)	
	Cirrhosis of liver (CC 28)	
	Chronic hepatitis (CC 29)	
	Acute liver failure/disease (CC 30)	X
	Other hepatitis and liver disease (CC 31)	
	Gallbladder and biliary tract disorders (CC 32)	
Other gastrointestinal disorders (CC 38)	Other gastrointestinal disorders (CC 38)	
Dementia or other specified brain disorders (CC 51-53)	Dementia with complications (CC 51)	
	Dementia without complications (CC 52)	
	Nonpsychotic organic brain syndromes/conditions (CC 53)	
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	Quadriplegia (CC 70)	
	Paraplegia (CC 71)	
	Spinal cord disorders/injuries (CC 72)	
	Amyotrophic lateral sclerosis and other motor neuron disease (CC 73)	
	Cerebral palsy (CC 74)	
	Hemiplegia/hemiparesis (CC 103)	X
	Monoplegia, other paralytic syndromes (CC 104)	X
	Amputation status, lower limb/amputation complications (CC 189)	X
	Amputation status, upper limb (CC 190)	X
Congestive heart failure (CC 85)	Congestive heart failure (CC 85)	X
Acute myocardial infarction (CC 86)	Acute myocardial infarction (CC 86)	
Unstable angina and other acute ischemic heart disease (CC 87)	Unstable angina and other acute ischemic heart disease (CC 87)	
Angina; old myocardial infarction	Angina; old myocardial infarction (CC 88 plus ICD-10-CM code I25.2, for discharges on or after October 1, 2015; CC 88 plus ICD-9-CM code 412, for discharges prior to October 1, 2015)	
Hypertension (CC 95)	Hypertension (CC 95)	
Stroke (CC 99-100)	Cerebral hemorrhage (CC 99)	X

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
	Ischemic or unspecified stroke (CC 100)	X
Vascular or circulatory disease (CC 106-109)	Atherosclerosis of the extremities with ulceration or gangrene (CC 106)	X
	Vascular disease with complications (CC 107)	X
	Vascular disease (CC 108)	X
	Other circulatory disease (CC 109)	X
Chronic obstructive pulmonary disease (COPD) (CC 111)	Chronic obstructive pulmonary disease (COPD) (CC 111)	
Pneumonia (CC 114-116)	Aspiration and specified bacterial pneumonias (CC 114)	X
	Pneumococcal pneumonia, empyema, lung abscess (CC 115)	X
	Viral and unspecified pneumonia, pleurisy (CC 116)	
Dialysis status (CC 134)	Dialysis status (CC 134)	X
Renal failure (CC 135-140)	Acute renal failure (CC 135)	X
	Chronic kidney disease, stage 5 (CC 136)	
	Chronic kidney disease, severe (stage 4) (CC 137)	
	Chronic kidney disease, moderate (stage 3) (CC 138)	
	Chronic kidney disease, mild or unspecified (stages 1-2 or unspecified) (CC 139)	
	Unspecified renal failure (CC 140)	X
Decubitus ulcer or chronic skin ulcer (CC 157-161)	Pressure ulcer of skin with necrosis through to muscle, tendon, or bone (CC 157)	X
	Pressure ulcer of skin with full thickness skin loss (CC 158)	X
	Pressure ulcer of skin with partial thickness skin loss (CC 159)	X
	Pressure pre-ulcer skin changes or unspecified stage (CC 160)	X
	Chronic ulcer of skin, except pressure (CC 161)	

Outcome

Outcome Criteria for CABG Surgery Measure

Death, from any cause, within 30 days from the index admission.
Rationale: From a patient perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the procedure date can be influenced by hospital care and 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 mortality.