

2016 Measure Updates and Specifications Report Hospital-Level Risk-Standardized Payment Measures

Acute Myocardial Infarction – Version 5.0

Heart Failure – Version 3.0

Pneumonia – Version 3.0

**Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty
(TKA) – Version 2.0**

Submitted By:

Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation
(YNHHSC/CORE)

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Center for Outcomes Research & Evaluation (CORE) Project Team

Lesli S. Ott, M.A., M.A. – Lead Analyst for AMI, Pneumonia, and THA/TKA Payment Measures and Lead for Payment Measures Reevaluation

Nancy Kim, M.D., Ph.D.* – Measure Expert for Payment Measures Reevaluation

Angela Hsieh, Ph.D. – Lead Analyst for HF Payment Measure

Shengfan Zhou, M.S. – Supporting Analyst

Elizabeth George, M.P.H. – Project Coordinator

Loralee Crowder, B.S. – Research Associate

Maliha Tariq, B.A. – Research Assistant

Xiao Xu, M.A., Ph.D.* – Consulting Health Economist

Nihar Desai, M.D., M.P.H.* – Consulting Cardiologist

Susannah M. Bernheim, M.D., M.H.S. – Project Director

Harlan M. Krumholz, M.D., S.M.* – Principal Investigator

*Yale School of Medicine

Measure Reevaluation Team Contributors:

Karen Dorsey, M.D., Ph.D.* –Reevaluation Team Lead

Jo DeBuhr, R.N., B.S.N. – Technical Writer

Rachel Johnson-DeRycke, M.P.H. – Project Manager

Jaymie Simoes, M.P.H. – Lead Project Coordinator

Chi Ngo, M.P.H. – Supporting Research Associate

Jacqueline N. Grady, M.S. – Analyst

Ji Young Kwon, M.P.H. – Analyst

Sarah Deacon, B.A. – Supporting Research Associate

Madeline L. Parisi, B.A. – Supporting Research Assistant

Joanna Ackley, M.P.H. – Supporting Research Associate

Steven Susaña-Castillo, B.A. – Supporting Research Assistant

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) acute myocardial infarction (AMI), heart failure (HF), and pneumonia payment measures publicly reported on *Hospital Compare*. The measures report hospital-level risk-standardized payments (RSPs) associated with a 30-day episode of care. Additionally, this report describes CMS's total hip arthroplasty (THA) and/or total knee arthroplasty (TKA) payment measure. This measure estimates hospital-level RSPs associated with a 90-day episode of care for an elective primary THA and/or TKA procedure. **THA/TKA payment measure results will not be publicly reported on Hospital Compare in 2016.** However, hospitals will receive their results for this measure in the hospital-specific reports (HSRs) distributed through *QualityNet* and the measure will be included in the Hospital Inpatient Quality Reporting Program in fiscal year 2018.

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

Specifically, this report includes:

- **Section 2 – An overview of the AMI, HF, pneumonia, and THA/TKA payment measures:**
 - Background
 - Cohort inclusions and exclusions
 - included and excluded hospitalizations
 - how transferred patients are handled
 - Payment outcome
 - Risk-adjustment variables
 - Data sources
 - Payment calculation
 - Categorization of hospitals' payments
- **Section 3 – 2016 measure updates**
- **Section 4 – 2016 measure results**
- **Section 5 – Glossary**

The Appendices contain detailed measure information, including:

- Appendix A: Statistical approach to calculating RSPs;
- Appendix B: Data quality assurance (QA);
- Appendix C: Annual updates to the measures since measure development; and,
- Appendix D: Measure specifications.

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

- Hospital-level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for Acute Myocardial Infarction (Version 1.0)¹
- Hospital-level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for Heart Failure (Version 1.0)²
- Hospital-level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for Pneumonia (Version 1.0)³
- Hospital-level, Risk-Standardized Payment Associated with a 90-Day Episode of Care for Elective Primary Total Hip Arthroplasty and/or Total Knee Arthroplasty (Version 1.0)⁴
- 2013 Measure Updates and Specifications Report: Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 2.0)⁵
- 2014 Measure Updates and Specifications Report: Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 3.0)⁶
- 2015 Measure Updates and Specifications Report: Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 4.0), HF (Version 2.0), and pneumonia (Version 2.0)⁷

The AMI payment measure methodology is also described in the peer-reviewed medical literature.⁸

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Payment Measures

In December 2014, CMS began publicly reporting 30-day episode-of-care RSPs for AMI for the nation's non-federal short-term acute care hospitals (including Indian Health Services hospitals) and critical access hospitals.

In 2015, CMS began publicly reporting two additional hospital 30-day payment measures for HF and pneumonia.

Results for all three of these payment measures are posted on [*Hospital Compare*](#), which CMS updates annually.

In 2016, CMS will provide hospitals with HSRs for a hospital 90-day payment measure for elective primary THA/TKA. Public reporting of the THA/TKA payment measure is planned for 2017.

The payment measures are not intended to be interpreted in isolation but to be considered in the context of existing quality measures such as CMS's 30-day risk-standardized all-cause mortality measures for AMI, HF, and pneumonia and 90-day risk-standardized complication measure for THA/TKA.

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

2.2 Overview of Measure Methodology

The 2016 risk-adjusted payment measures use specifications from the initial measure methodology reports with refinements to the measures, as listed in [*Appendix C*](#) and described in the prior measures updates and specifications reports.^{1-6,9} An overview of the methodology is presented in this section.

2.2.1 Cohort

Index Admissions Included in the Measures

An index admission is the hospitalization that begins the episode-of-care payment window and includes admissions for patients:

- Having a principal discharge diagnosis of AMI, HF, or pneumonia, or qualifying elective primary THA/TKA procedure during the index admission;
- Enrolled in Medicare fee-for-service (FFS) Part A and Part B for the 12 months prior to the date of the admission, and enrolled in Part A and Part B during the index admission;
- Aged 65 or over; and,

- Not transferred from another acute care facility.

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

- Femur, hip, or pelvic fractures coded in the principal or secondary discharge diagnosis fields of the index admission;
- A concurrent partial hip arthroplasty procedure;
- A concurrent revision procedure;
- A concurrent resurfacing procedure;
- Mechanical complication coded in the principal discharge diagnosis field;
- Malignant neoplasm of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or a disseminated malignant neoplasm coded in the principal discharge diagnosis field;
- Removal of implanted devices/prostheses; or

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort inclusions for each measure are listed in [Appendix D](#) in [Table D.1.1](#), [Table D.2.1](#), [Table D.3.1](#), and [Table D.4.1](#), respectively.

Index Admissions Excluded from the Measures

The payment measures exclude index admissions for patients:

- Discharged against medical advice (AMA);
- Transferred to a federal hospital;
- Not matched to an admission in the AMI, HF, or pneumonia mortality measure or THA/TKA complication measure;
- With missing index diagnosis-related group (DRG) weight where the provider received no payment; or
- With incomplete administrative data in the 30 days (AMI, HF, pneumonia) or 90 days (THA/TKA) following the index admission if discharged alive.

Additional exclusion criteria for the AMI, HF, and pneumonia cohorts:

- Patients discharged alive on the day of admission or the following day who were not transferred to another acute care facility;
- Patients with inconsistent or unknown vital status or other unreliable demographic (age and gender) data; or
- Patients enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including on the first day of the index admission.

An additional exclusion criterion for the HF cohort is that patients with a procedure code for left ventricular assist device (LVAD) implantation or heart transplantation ([Table D.2.2](#)) either during the index admission or in the 12 months prior to the index admission are excluded as index admissions because these patients represent a clinically distinct, highly-selected group.

An additional exclusion criterion for the THA/TKA cohort is that patients with more than two THA/TKA procedure codes during the index hospitalization are excluded as index admissions.

For patients with more than one eligible admission for a given condition or procedure in a single year, only one index admission for that condition or procedure is randomly selected for inclusion in the cohort. Additional admissions within that year are excluded.

As a part of data processing prior to the measure calculation, records for non-short-term acute care facilities such as psychiatric facilities, rehabilitation facilities, or long-term care hospitals are not considered index admissions. Additional data cleaning steps include removing claims with overlapping dates and duplicate claims.

Admissions that occur within 30 days of a previous index admission for AMI, HF, and pneumonia are included in the payment outcome. However they are excluded as index admissions. Similarly, admissions within 90 days of a previous index admission for a THA/TKA are included in the payment outcome and excluded as index admissions.

Similarly for the three year combined data in the AMI, HF, and pneumonia measures, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in a measure, the measures include only the June admission. July admissions are excluded to avoid assigning payments for the same claims to two admissions.

The THA/TKA measure randomly selects one hospitalization per patient per year for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that year are excluded. Similarly, for the THA/TKA measure, when index admissions occur during the transition between measure reporting periods (March and April of each year) and both are randomly selected for inclusion in the measure, the measure includes only the March admission. April-June admissions within the 90-day outcome window of the March admission are excluded to avoid assigning payments for the same claims to two admissions.

The percentage of admissions excluded based on each criterion is shown in [Section 4](#) in [Figure 4.2.1](#), [Figure 4.3.1](#), [Figure 4.4.1](#), and [Figure 4.5.1](#) for AMI, HF, pneumonia, and THA/TKA, respectively.

Patients Transferred Between Hospitals

Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. To qualify as a transfer, the second inpatient admission must occur on the same day or the next calendar day following discharge from the first inpatient admission at a short-term acute care hospital.

Cases that meet the above criterion are considered transfers regardless of whether or not the first institution indicates intent to transfer the patient in the discharge disposition code, and regardless of whether the hospitalizations that follow the first (index) admission for a given condition or procedure meet the inclusion/exclusion criteria for that measure.

For patients transferred from one short-term acute care hospital to another, the measures calculate payments for the first admitting hospital from the date the patient is initially admitted as an inpatient. Thus, if a patient is admitted to Hospital A, and then is transferred to Hospital B, the episode of care is considered to be triggered by admission to Hospital A. The total payment includes payments for Hospital A, Hospital B, and other services provided during the episode of care. The total payment is assigned to Hospital A. This is consistent with CMS's AMI, HF, and pneumonia mortality measures and THA/TKA complications measure.^{10,11}

Medicare reduces payments when patients are transferred to another Inpatient Prospective Payment System (IPPS) hospital and have a length of stay at least one day less than the geometric mean length of stay for the DRG. However, when calculating the standardized payment, this rule is applied to all acute inpatient hospital providers. Under this policy, transferring hospitals are paid a per diem rate. For stays at the transferring hospital that are equal to or greater than the geometric mean length of stay for the DRG, transferring hospitals receive a full DRG payment.¹² The per diem rate or the full DRG rate is assigned to the transferring hospital where applicable and is then added to the payment for the hospital that received the transfer patient to calculate the payment for the index admission.

2.2.2 Outcome

Payments

Using administrative claims data, we measure RSPs for Medicare patients for an episode of care that begins with an index admission for AMI, HF, pneumonia, or THA/TKA. The measures capture payments for Medicare patients across multiple care settings, services, and supplies (that is, inpatient, outpatient, skilled nursing facility [SNF], home health, hospice, physician/clinical laboratory/ambulance services, durable medical equipment, prosthetics/orthotics, and supplies). Payment adjustments unrelated to clinical care decisions are not considered in the measure outcome.

To isolate payment variation that reflects practice patterns rather than CMS payment adjustments, payments are standardized for each setting using the CMS Standardization Methodology for Allowed Amount.¹³ Geographic differences and policy adjustments in payment rates for individual services are removed from the total payment for that service. Where geographic differences in payments cannot be removed, they are averaged across geographic areas. Standardizing the payment allows for a fair comparison across hospitals based solely on payments for decisions related to clinical care.

Time Frame

The AMI, HF, and pneumonia measures assess payments within a 30-day period from the date of the index admission. The measures use a 30-day time frame because payments accrued within 30 days of admission can be influenced by hospital care and the early transition to the non-acute care setting. Also, the 30-day time frame provides a standardized observation period for each hospital. Lastly, the 30-day time frame is consistent with other CMS AMI, HF, and pneumonia outcome measures endorsed by

NQF and publicly reported by CMS, which provides stakeholders with a consistent time period for assessing health care value.¹⁴

The THA/TKA measure assess payments within a 90-day period from the date of the index admission. Specifically, the measure includes all payments made for Medicare patients from the day of admission through day 30, and only payments related to the index procedure from day 31 through day 90 ([Appendix D.4](#)). The THA/TKA measure uses a 90-day time frame because payments accrued within 90 days of admission can be influenced by hospital care and the transition to the post-acute setting. The use of the 90-day time frame is a clinically reasonable time frame for multiple reasons:

1. THA and TKA procedures require ongoing post-discharge care.
2. The 90-day time frame incentivizes hospitals to optimize post-discharge care.
3. Mechanical complications and wound or joint infections, which are included in the CMS's 90-day THA/TKA complication measure, may present after 30 days.
4. The 90-day time frame is consistent with CMS's 90-day THA/TKA complication measure.

2.2.3 Risk-Adjustment Variables

In order to account for differences in patient mix among hospitals, the measures adjust for variables (for example, age, comorbid disease, and indicators of patient frailty) that are clinically relevant and have relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending 12 months prior to, and including, the index admission.

The measures adjust for case mix differences among hospitals based on the clinical status of the patient at the time of the index admission. Accordingly, only comorbidities that convey information about the patient at that time or in the 12 months prior, and not complications that arise during the course of the hospitalization, are included in the risk adjustment.

The measures do not adjust for socioeconomic status (SES) because the association between SES and health outcomes can be due, in part, to differences in the quality of healthcare that groups of patients with varying SES receive. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important payment differences. Additionally, recent analyses have shown that hospitals caring for high proportions of low-SES patients perform similarly on the measures to hospitals caring for low proportions of low-SES patients.^{15,16} Please note that the Office of the Assistant Secretary for Planning and Evaluation (ASPE) is conducting research to examine the impact of SES on quality measures, resource use, and other measures under the Medicare program as directed by the IMPACT Act. ASPE will issue an initial report to Congress by October 2016 and a final report to Congress by October 2019. The findings in these reports will be considered in future reevaluation of these measures.

Refer to [Table D.1.2](#), [Table D.2.3](#), [Table D.3.2](#), and [Table D.4.9](#) in [Appendix D](#) of this report for the list of comorbidity risk-adjustment variables and list of complications that are excluded from risk adjustment if occurring during the index admission, for AMI, HF, pneumonia, and THA/TKA, respectively.

2.2.4 Data Sources

The data sources for these analyses include Medicare administrative claims data and enrollment information for patients with hospitalizations between July 1, 2012 and June 30, 2015 for AMI, HF, and pneumonia and between April 1, 2012 and March 31, 2015 for THA/TKA. The period for the THA/TKA measure differs from the AMI, HF, and pneumonia measures due to the longer period of outcome assessment timeframe. This also aligns with the 90-day THA/TKA complication measure. Medicare administrative claims data for the 12 months prior to and during the index admission are used for risk adjustment.

The datasets also contain price-standardized payments for Medicare patients across all Medicare settings, services, and supplies (that is, inpatient, outpatient, SNF, home health, hospice, physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies). For additional information, please refer to the CMS Standardization Methodology for Allowed Amount - V.4 report for the Medicare Spending per Beneficiary Measure on [QualityNet](#).¹³ The CMS Standardization Methodology for Allowed Amount for 2006 through 2014 was also applied to the 2015 claims to calculate the measures.

2.2.5 Measure Calculation

The measures estimate hospital-level episode-of-care RSPs for each condition using [hierarchical generalized linear models](#). In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals.¹⁷ At the patient level, the measures use a generalized linear model to model the total episode-of-care payment using age, selected clinical covariates, and a [hospital-specific effect](#). The AMI and THA/TKA RSPs are estimated using a log link and inverse Gaussian distribution. The HF RSPs are estimated using a log link and Gamma distribution. The pneumonia RSPs are estimated using an identity link and Gamma distribution. The choice of link function and distribution was based on the algorithm suggested by Manning and Mullahy and several model diagnostics.¹⁸

At the hospital level, the approach models the hospital-specific effects as arising from a normal distribution. The hospital effect represents the underlying episode-of-care payment 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.¹⁷ If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects should be identical across all hospitals.

The RSP is calculated as the ratio of the “[predicted](#)” payment to the “[expected](#)” payment at a given hospital, multiplied by the [national mean payment](#). For each hospital, the numerator of the ratio is the payment predicted based on the specific

hospital and its observed case mix, and the denominator is the payment expected based on the nation and the specific 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 payment, given its case mix, to be compared to an average hospital's payment for the same case mix. Thus, a ratio lower than one indicates a lower-than-expected episode-of-care payment, and a ratio higher than one indicates a higher-than-expected episode-of-care payment.

The "predicted" episode-of-care payment (the numerator) is calculated using the coefficients estimated by regressing the risk factors (found in [Table D.1.2](#), [Table D.2.3](#), [Table D.3.2](#), and [Table D.4.9](#) for the AMI, HF, pneumonia, and THA/TKA measures, respectively) and the hospital-specific effect on the payment outcome. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are summed over all patients attributed to a hospital to get a predicted value. The "expected" episode-of-care payment (the denominator) is obtained in the same manner, but a common effect using all hospitals in our sample is added in place of the hospital-specific effect. The results are summed over all patients in the hospital to get an expected value. To assess hospital payments for each reporting period, we re-estimate the model coefficients using the years of data in that period.

For each hospital, the ratio of "predicted" episode-of-care payment over "expected" episode-of-care payment is then multiplied by the national mean payment to get the RSP. This transforms the ratio of predicted over expected into a payment amount that is compared to the national mean payment. The hierarchical generalized linear regression models are described fully in [Appendix A](#) and in the original methodology reports.¹⁻⁴

2.2.6 Categorizing Hospital Payments

To categorize hospital payments, CMS estimates each hospital's RSP and the corresponding 95% interval estimate. CMS assigns hospitals to a payment category by comparing each hospital's RSP interval estimate to the national mean payment. Comparative payments for hospitals with 25 or more eligible cases are classified as follows:

- "No Different than the National Payment" if the 95% interval estimate surrounding the hospital's RSP includes the national mean payment.
- "Greater than the National Payment" if the entire 95% interval estimate surrounding the hospital's RSP is higher than the national mean payment.
- "Less than the National Payment" if the entire 95% interval estimate surrounding the hospital's RSP is lower than the national mean payment.

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 estimate the hospital's RSP. If a

hospital has fewer than 25 eligible cases, the hospital's RSP and interval estimate will not be reported for the measure.

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

3. UPDATES TO MEASURES FOR 2016

3.1 Rationale for Measure Updates

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

- Updated the HF cohort to exclude patients with a procedure code for LVAD implantation or heart transplantation during the index admission or in the 12 months prior to the index admission; and,
- Updated the THA/TKA payment calculation to include hip/knee joint manipulations under anesthesia that occur in days 31-90.

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

- Validated the performance of each payment model and its corresponding risk-adjustment variables in three recent one-year periods (For AMI, HF, and pneumonia: July 2012-June 2013, July 2013-June 2014, and July 2014-June 2015; For THA/TKA: April 2012-March 2013, April 2013-March 2014, April 2014-March 2015);
- Evaluated and validated model performance for the three years combined (For AMI, HF, and pneumonia: July 2012-June 2015; for THA/TKA: April 2012-March 2015); and,
- Updated the measures' SAS analytic package (SAS pack) and documentation.

Although hospitals are using International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) coding for discharges effective on or after October 1, 2015, ICD-10 codes for use in defining the cohorts and ICD-10-based Condition Category (CC) Groups for use in risk adjustment were not incorporated into the measure specifications this year, as the measurement periods for 2016 do not include claims data after June 30, 2015.

3.2 Detailed Discussion of Measure Updates

3.2.1 Update to HF Cohort Exclusions

Exclusion of LVADs and Heart Transplants from Cohort

The exclusion criteria for the HF measure have been expanded to remove patients with an ICD-9 procedure code for LVAD implantation or heart transplantation during the index admission or in the 12 months prior to the index admission from the HF measure cohort (Table D.2.2).

Rationale for LVAD/Heart Transplant Exclusion

Patients with HF who receive an LVAD or undergo heart transplantation represent a highly selected, clinically distinct group of patients that are appropriate exclusions for the measure. Over the past 5 – 10 years, there has been a marked increase in the use of LVADs, especially for “destination” therapy.¹⁹ These LVAD patients essentially define a new cohort of patients that did not exist when the heart failure mortality measure was originally developed and the heart failure payment measure was designed using the same cohort. This exclusion is being added to the HF mortality, readmission, and payment measures to ensure these measure cohorts are aligned. HF patients with an LVAD or who undergo heart transplantation have the most severe and clinically advanced heart failure and often complex co-existing medical conditions. As such, they are expected to have increased health care utilization.

Effect of LVAD/Heart Transplant Exclusion on Measure

Patients receiving an LVAD or heart transplant during the index admission or in the year prior to admission accounted for only 0.13% of the overall measure cohort. RSPs are not significantly different based on whether these admissions are included or excluded from the estimates.

3.2.2 Update to THA/TKA Measure

Inclusion of THA/TKA Joint Manipulation Procedures in Days 31-90 Outcome Calculation

For the 2016 HSRs, the calculation of THA/TKA payments in days 31-90 will include payments for hip/knee joint manipulations under anesthesia that occur in ambulatory surgical centers (ASCs) and outpatient hospital settings ([Table D.4.10](#)). The THA/TKA payment measure previously captured joint manipulations in days 0 through 30 of the THA/TKA episode of care but did not include them in the payment outcome in days 31 through 90.

Rationale for THA/TKA Joint Manipulation Inclusion

This change was suggested by the THA/TKA Payment Measure Technical Expert Panel (TEP) because joint manipulation procedures reflect care related to the original THA/TKA procedure.

Effect of THA/TKA Joint Manipulation Inclusion

Overall, claims for joint manipulation represent modest additional payments for 1.1% of the THA/TKA payment measure cohort. The update to the THA/TKA measure to include joint manipulations in days 31 through 90 will conceptually improve the measure without having a substantial impact on the measure results.

3.3 Changes to SAS Pack

We revised the measure calculation SAS pack to reflect all changes to the cohort definitions and the measure outcomes. The new SAS pack and documentation are available upon request by emailing cmsepisodepaymentmeasures@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 RSP calculation without the data files which contain longitudinal patient data from the entire national sample of acute care hospitals to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2016 REPORTING

4.1 Assessment of Updated Models

The payment measures estimate hospital-specific episode-of-care RSPs using hierarchical generalized linear models. See [Section 2](#) for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and technical reports for further details.¹⁻⁴

We evaluated the performance of the AMI, HF, and pneumonia models, using the July 2012 to June 2015 data for 2016 reporting. We evaluated the performance of the THA/TKA model, using April 2012 to March 2015 data. We examined differences in the frequency of patient risk factors and the model variable coefficients. Before evaluation, all payments were inflation-adjusted to 2014 dollars.

For each of the four payment measures, we assessed generalized linear model performance in terms of discriminant ability for each year of data and for the three-year combined period. We computed two summary statistics for assessing model performance: the predictive ratio and a quasi- R^2 .

A predictive ratio is an estimator's ratio of predicted outcome to observed outcome.²⁰ A predictive ratio close to 1.0 indicates an accurate prediction. A ratio substantially greater than 1.0 indicates over-prediction, and a ratio substantially less than 1.0 indicates under-prediction.

For a traditional linear model (that is, ordinary least squares regression), R^2 is interpreted as the amount of variation in the observed outcome that is explained by the predictor variables (patient-level risk factors). Generalized linear models, however, do not output an R^2 that is akin to the R^2 of a traditional linear model. We produced a "quasi- R^2 " by regressing the total payment outcome on the predicted outcome.²⁰ Specifically, we regressed the total payment on the payment predicted by the patient-level risk factors.

The results of these analyses for each of the four payment measures (AMI, HF, pneumonia, and THA/TKA) are presented in [Section 4.2](#), [Section 4.3](#), [Section 4.4](#), and [Section 4.5](#), respectively.

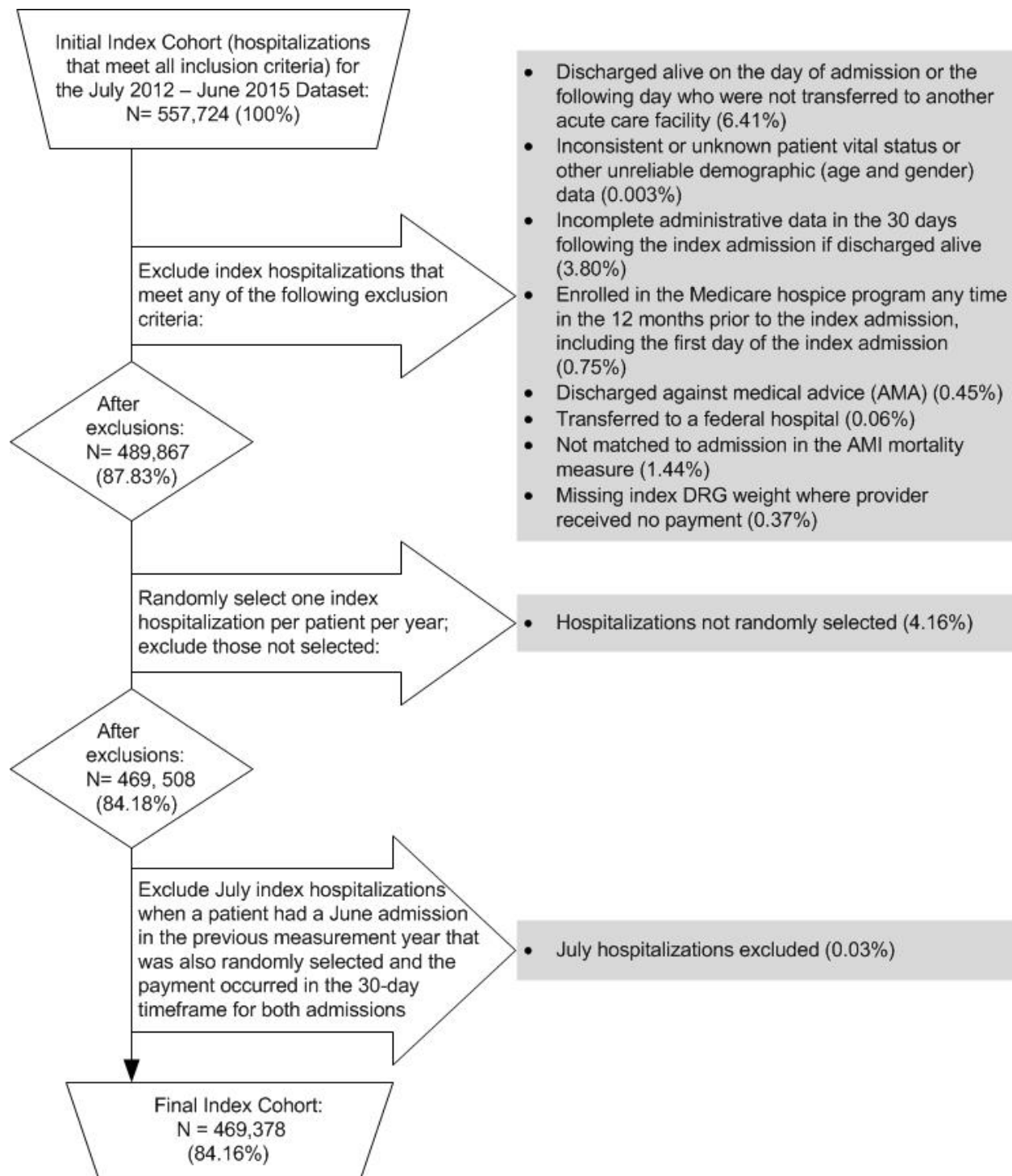
4.2 AMI Payment 2016 Model Results

4.2.1 Index Cohort Exclusions

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

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

Figure 4.2.1 AMI Cohort Exclusions in the July 2012-June 2015 Dataset



4.2.2 Frequency of AMI Model Variables

We examined the change in both observed payments and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the national mean payment decreased from \$22,853 to \$22,658. Notable changes in the frequencies for model variables include:

- Increase in Age (65-74) category (35.3% to 37.4%)

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

4.2.3 AMI Model Parameters and Performance

[Table 4.2.2](#) shows the hierarchical generalized linear regression model variable coefficients by individual year and for the combined three-year dataset.

[Table 4.2.3](#) shows the risk-adjusted payment ratios (PRs) and 95% confidence intervals (CIs) for the AMI payment model by individual year and for the combined three-year dataset. The quasi- R^2 for the AMI payment model was 0.07, suggesting that approximately 7% of the variation in payment can be explained by patient-level risk factors. This quasi- R^2 is in line with R^2 s from other patient-level risk-adjustment models for healthcare payment.²¹

Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the quasi- R^2 and predictive ratios ([Table 4.2.4](#)) remained similar to the model used for 2015 public reporting.

4.2.4 Distribution of Hospital Volumes and RSPs for AMI

[Table 4.2.5](#) shows the distribution of hospital admission volumes and [Table 4.2.6](#) shows the distribution of hospital RSPs. The mean RSP decreased over the three-year period, from \$22,875 between July 2012 and June 2013 to \$22,679 between July 2014 and June 2015. The median hospital RSP in the combined three-year dataset was \$22,632 (Interquartile Range [IQR] \$22,021 - \$23,410). [Table 4.2.7](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.008 (Standard Error [SE]: 0.0004). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

[Figure 4.2.2](#) shows the overall distribution of the hospital RSPs for the combined dataset. The expected 30-day RSP if treated at a hospital one standard deviation (SD) above the national average was 1.20 times higher than the expected 30-day RSP if treated at a hospital one standard deviation below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.¹⁷

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

Of 4,320 hospitals in the study cohort, 255 had a payment “Greater than the National Payment,” 1,971 had a payment “No Different than the National Payment,” and 182 had

a payment “Less than the National Payment.” 1,912 were classified as “Number of Cases Too Small” (fewer than 25) to reliably estimate the hospital’s RSP.

Table 4.2.1 Frequency of AMI Model Variable Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	162,419	153,207	153,752	469,378
Mean payment (\$2014)	22,853	22,664	22,658	22,727
Age (65 – 74)	35.3	36.8	37.4	36.5
Age (75 – 84)	37.1	36.8	36.1	36.7
Age (>=85)	27.6	26.4	26.5	26.9
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	17.2	17.7	18.7	17.8
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	12.2	11.8	12.0	12.0
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	3.7	3.8	3.7	3.7
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	47.0	47.3	47.3	47.2
Protein-calorie malnutrition (CC 21)	6.4	6.1	6.2	6.2
Other significant endocrine and metabolic disorders (CC 22)	9.7	9.7	9.9	9.8
Other endocrine/metabolic/nutritional disorders (CC 24)	86.9	87.7	88.2	87.6
Other gastrointestinal disorders (CC 36)	54.2	54.3	55.0	54.5
Osteoporosis and other bone/cartilage disorders (CC 41)	16.5	15.8	15.6	16.0
Iron deficiency or other unspecified anemias and blood disease (CC 47)	47.3	46.6	46.6	46.8
Delirium and encephalopathy (CC 48)	4.5	4.6	4.7	4.6
Dementia (CC 49)	18.4	17.6	17.3	17.8
Drug/alcohol psychosis (CC 51)	1.1	1.0	1.1	1.1
Drug/alcohol abuse/dependence (CC 52-53)	15.9	16.5	17.0	16.4
Severe mental illness (CC 54-55)	4.8	4.9	4.9	4.9
Reactive and unspecified psychosis (CC 56)	3.7	3.5	3.6	3.6
Depression/anxiety (CC 58-59)	16.4	16.7	17.2	16.8
Congestive heart failure (CC 80)	29.7	28.7	28.4	29.0

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Angina pectoris/old myocardial infarction (CC 83)	26.6	26.3	26.9	26.6
Heart infection/inflammation, except rheumatic (CC 85)	1.9	1.9	2.0	1.9
Valvular or rheumatic heart disease (CC 86)	31.7	31.3	31.9	31.7
Congenital cardiac/circulatory defects (CC 87-88)	1.0	1.0	1.0	1.0
Hypertension and hypertension complications (CC 89-91)	89.6	89.5	89.9	89.7
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	15.9	15.2	14.9	15.4
Vascular disease and complications (CC 104-105)	27.4	26.9	26.7	27.0
Other lung disorders (CC 115)	25.6	24.7	24.4	24.9
Legally blind (CC 116)	1.1	1.1	1.1	1.1
Dialysis status (CC 130)	3.4	3.4	3.5	3.4
Internal injuries (CC 160)	1.0	1.0	1.0	1.0

Table 4.2.2 Hierarchical Generalized Linear Regression Model Variable Coefficients for AMI Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	9.824	9.785	9.783	9.795
Age (65 – 74)	0.185	0.194	0.194	0.192
Age (75 – 84)	0.175	0.181	0.175	0.177
Age (>=85) (reference group)	--	--	--	--
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	-0.059	-0.052	-0.061	-0.059
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	-0.188	-0.194	-0.195	-0.192
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	-0.091	-0.092	-0.087	-0.091
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.074	0.089	0.072	0.078
Protein-calorie malnutrition (CC 21)	0.185	0.190	0.177	0.183
Other significant endocrine and metabolic disorders (CC 22)	0.064	0.051	0.065	0.060

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.014	-0.022	-0.007	-0.014
Other gastrointestinal disorders (CC 36)	-0.025	-0.028	-0.024	-0.025
Osteoporosis and other bone/cartilage disorders (CC 41)	-0.051	-0.040	-0.055	-0.048
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.195	0.202	0.205	0.198
Delirium and encephalopathy (CC 48)	-0.049	-0.026	-0.050	-0.043
Dementia (CC 49)	-0.078	-0.083	-0.081	-0.080
Drug/alcohol psychosis (CC 51)	0.130	0.120	0.132	0.126
Drug/alcohol abuse/dependence (CC 52-53)	0.012	0.026	0.011	0.016
Severe mental illness (CC 54-55)	0.023	0.011	0.005	0.010
Reactive and unspecified psychosis (CC 56)	0.004	0.006	0.001	0.004
Depression/anxiety (CC 58-59)	-0.025	-0.029	-0.028	-0.027
Congestive heart failure (CC 80)	-0.059	-0.046	-0.045	-0.049
Angina pectoris/old myocardial infarction (CC 83)	-0.030	-0.036	-0.036	-0.033
Heart infection/inflammation, except rheumatic (CC 85)	0.203	0.191	0.208	0.198
Valvular or rheumatic heart disease (CC 86)	0.082	0.080	0.074	0.078
Congenital cardiac/circulatory defects (CC 87-88)	0.110	0.107	0.088	0.101
Hypertension and hypertension complications (CC 89-91)	-0.038	-0.020	-0.015	-0.024
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	0.013	0.010	0.017	0.013
Vascular disease and complications (CC 104-105)	-0.002	-0.004	-0.005	-0.005
Other lung disorders (CC 115)	0.056	0.060	0.058	0.057
Legally blind (CC 116)	-0.052	-0.032	-0.037	-0.041
Dialysis status (CC 130)	0.109	0.130	0.094	0.109
Internal injuries (CC 160)	0.131	0.160	0.114	0.133

Table 4.2.3 Adjusted PR and 95% CIs for the AMI Hierarchical Generalized Linear Regression Model Over Different Time Periods

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Age (65 – 74)	1.20 (1.19, 1.22)	1.21 (1.20, 1.23)	1.21 (1.20, 1.23)	1.21 (1.20, 1.22)
Age (75 – 84)	1.19 (1.18, 1.20)	1.20 (1.19, 1.21)	1.19 (1.18, 1.20)	1.19 (1.19, 1.20)

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Age (>=85) (reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	0.94 (0.93, 0.95)	0.95 (0.94, 0.96)	0.94 (0.93, 0.95)	0.94 (0.94, 0.95)
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	0.83 (0.82, 0.84)	0.82 (0.82, 0.83)	0.82 (0.81, 0.83)	0.83 (0.82, 0.83)
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	0.91 (0.90, 0.93)	0.91 (0.90, 0.93)	0.92 (0.90, 0.93)	0.91 (0.90, 0.92)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.08 (1.07, 1.08)	1.09 (1.09, 1.10)	1.08 (1.07, 1.08)	1.08 (1.08, 1.09)
Protein-calorie malnutrition (CC 21)	1.20 (1.18, 1.22)	1.21 (1.19, 1.23)	1.19 (1.17, 1.21)	1.20 (1.19, 1.21)
Other significant endocrine and metabolic disorders (CC 22)	1.07 (1.05, 1.08)	1.05 (1.04, 1.07)	1.07 (1.05, 1.08)	1.06 (1.05, 1.07)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.99 (0.98, 1.00)	0.98 (0.97, 0.99)	0.99 (0.98, 1.00)	0.99 (0.98, 0.99)
Other gastrointestinal disorders (CC 36)	0.98 (0.97, 0.98)	0.97 (0.97, 0.98)	0.98 (0.97, 0.98)	0.98 (0.97, 0.98)
Osteoporosis and other bone/cartilage disorders (CC 41)	0.95 (0.94, 0.96)	0.96 (0.95, 0.97)	0.95 (0.94, 0.96)	0.95 (0.95, 0.96)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.22 (1.21, 1.22)	1.22 (1.21, 1.23)	1.23 (1.22, 1.24)	1.22 (1.21, 1.22)
Delirium and encephalopathy (CC 48)	0.95 (0.94, 0.97)	0.97 (0.96, 0.99)	0.95 (0.93, 0.97)	0.96 (0.95, 0.97)
Dementia (CC 49)	0.93 (0.92, 0.93)	0.92 (0.91, 0.93)	0.92 (0.91, 0.93)	0.92 (0.92, 0.93)
Drug/alcohol psychosis (CC 51)	1.14 (1.10, 1.18)	1.13 (1.08, 1.17)	1.14 (1.10, 1.19)	1.13 (1.11, 1.16)
Drug/alcohol abuse/dependence (CC 52-53)	1.01 (1.00, 1.02)	1.03 (1.02, 1.04)	1.01 (1.00, 1.02)	1.02 (1.01, 1.02)
Severe mental illness (CC 54-55)	1.02 (1.01, 1.04)	1.01 (0.99, 1.03)	1.01 (0.99, 1.02)	1.01 (1.00, 1.02)
Reactive and unspecified psychosis (CC 56)	1.00 (0.98, 1.02)	1.01 (0.99, 1.03)	1.00 (0.98, 1.02)	1.00 (0.99, 1.02)
Depression/anxiety (CC 58-59)	0.98 (0.97, 0.98)	0.97 (0.96, 0.98)	0.97 (0.96, 0.98)	0.97 (0.97, 0.98)
Congestive heart failure (CC 80)	0.94 (0.93, 0.95)	0.95 (0.95, 0.96)	0.96 (0.95, 0.97)	0.95 (0.95, 0.96)
Angina pectoris/old myocardial Infarction (CC 83)	0.97 (0.96, 0.98)	0.96 (0.96, 0.97)	0.96 (0.96, 0.97)	0.97 (0.96, 0.97)
Heart infection/inflammation, except rheumatic (CC 85)	1.22 (1.19, 1.26)	1.21 (1.18, 1.25)	1.23 (1.20, 1.27)	1.22 (1.20, 1.24)

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Valvular or rheumatic heart disease (CC 86)	1.09 (1.08, 1.09)	1.08 (1.07, 1.09)	1.08 (1.07, 1.09)	1.08 (1.08, 1.09)
Congenital cardiac/circulatory defects (CC 87-88)	1.12 (1.07, 1.16)	1.11 (1.07, 1.16)	1.09 (1.05, 1.13)	1.11 (1.08, 1.13)
Hypertension and hypertension complications (CC 89-91)	0.96 (0.95, 0.97)	0.98 (0.97, 0.99)	0.99 (0.97, 1.00)	0.98 (0.97, 0.98)
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.02 (1.01, 1.03)	1.01 (1.01, 1.02)
Vascular disease and complications (CC 104-105)	1.00 (0.99, 1.01)	1.00 (0.99, 1.00)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)
Other lung disorders (CC 115)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)	1.06 (1.05, 1.06)
Legally blind (CC 116)	0.95 (0.92, 0.98)	0.97 (0.94, 1.00)	0.96 (0.93, 1.00)	0.96 (0.94, 0.98)
Dialysis status (CC 130)	1.12 (1.09, 1.14)	1.14 (1.11, 1.17)	1.10 (1.07, 1.13)	1.11 (1.10, 1.13)
Internal injuries (CC 160)	1.14 (1.10, 1.18)	1.17 (1.13, 1.22)	1.12 (1.08, 1.17)	1.14 (1.12, 1.17)

Table 4.2.4 AMI Generalized Linear Model Performance Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	0.95-0.93	0.95-0.94	0.95-0.92	0.95-0.93
Quasi-R ²	0.07	0.07	0.07	0.07

Table 4.2.5 Distribution of Hospital AMI Admission Volumes Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,982	3,905	3,812	4,320
Mean number of admissions (SD)	41 (55)	39 (53)	40 (54)	109 (156)
Range (min. – max.)	1-498	1-462	1-487	1-1,447
25 th percentile	4	3	4	7
50 th percentile	18	16	17	36
75 th percentile	60	57	59	158

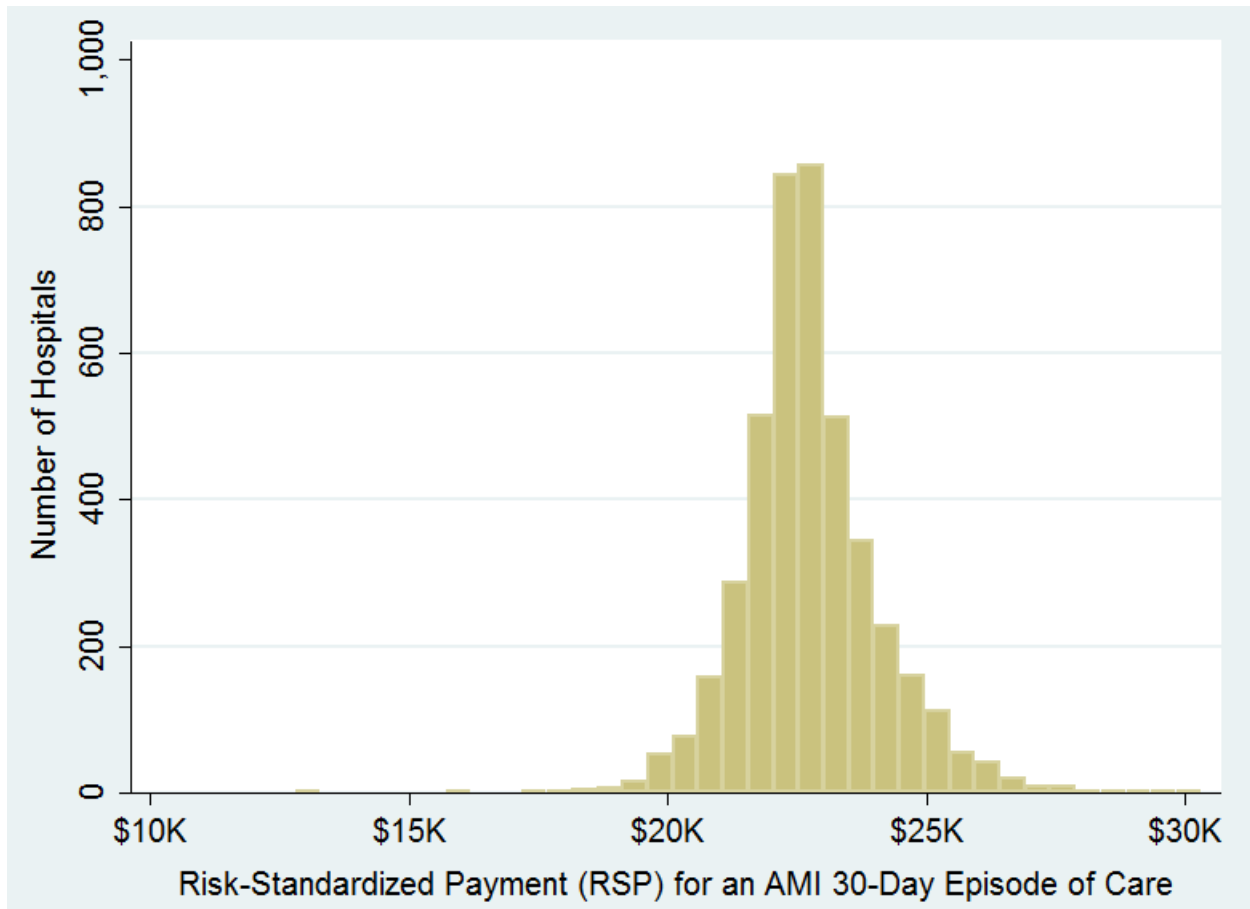
Table 4.2.6 Distribution of Hospital AMI RSPs Over Different Time Periods (\$2014)

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,982	3,905	3,812	4,320
Mean (SD)	22,875 (1,004)	22,686 (1,003)	22,679 (984)	22,765 (1,314)
Range (min. – max.)	16,179-28,656	17,153-28,462	15,765-29,332	12,814-30,334
25 th percentile	22,368	22,186	22,199	22,021
50 th percentile	22,752	22,575	22,568	22,632
75 th percentile	23,308	23,132	23,114	23,410

Table 4.2.7 Between-Hospital Variance for AMI

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.007 (0.0005)	0.007 (0.0005)	0.007 (0.0005)	0.008 (0.0004)

Figure 4.2.2 Distribution of Hospital 30-Day AMI Episode-of-Care Episode-of-Care RSPs Between July 2012 and June 2015 (\$2014)



N= 4,320 hospitals

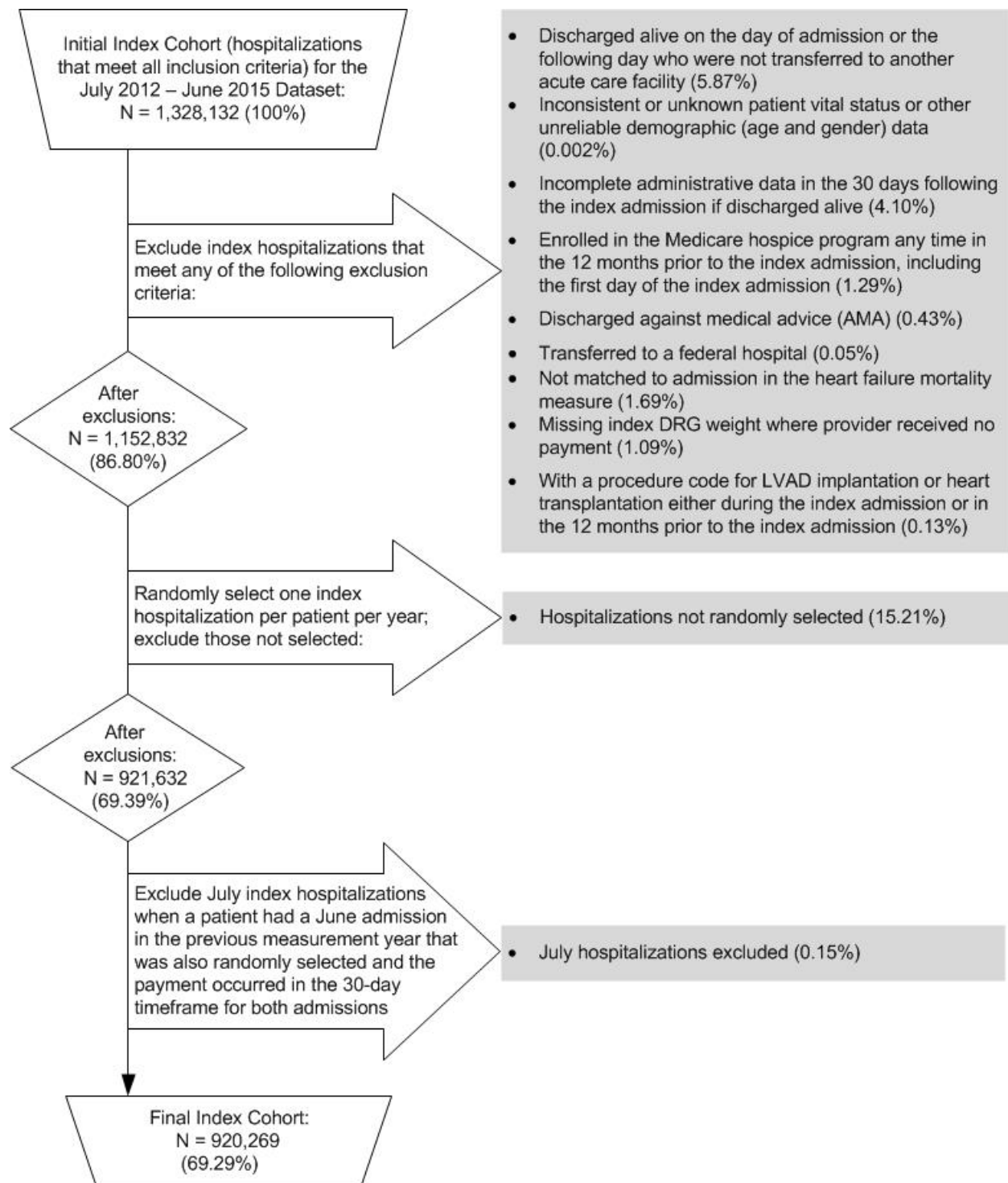
4.3 HF Payment 2016 Model Results

4.3.1 Index Cohort Exclusions

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

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

Figure 4.3.1 HF Cohort Exclusions in the July 2012-June 2015 Dataset



4.3.2 Frequency of HF Model Variables

We examined the change in both observed payments and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the mean national payment decreased from \$16,102 to \$15,873. Notable changes in the frequencies for model variables include:

- Increases in Other psychiatric disorders (19.3% to 21.9%) and Respiratory arrest/cardiorespiratory failure/respirator dependence (26.6% to 29.1%)

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

4.3.3 HF Model Parameters and Performance

[Table 4.3.2](#) shows hierarchical generalized linear regression model variable coefficients by individual year and for the combined three-year dataset.

[Table 4.3.3](#) shows the risk-adjusted PRs and 95% CIs for the HF payment model by individual year and for the combined three-year dataset. The quasi- R^2 for the HF payment model was 0.03, suggesting that approximately 3% of the variation in payment can be explained by patient-level risk factors. This quasi- R^2 is in line with R^2 s from other patient-level risk-adjustment models for healthcare payment.²¹

Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the quasi- R^2 and predictive ratios ([Table 4.3.4](#)) remained similar to the model used for 2015 public reporting.

4.3.4 Distribution of Hospital Volumes and RSPs for HF

[Table 4.3.5](#) shows the distribution of hospital admission volumes and [Table 4.3.6](#) shows the distribution of hospital RSPs. The mean RSP decreased over the three-year period, from \$16,131 between July 2012 and June 2013 to \$15,902 between July 2014 and June 2015. The median hospital RSP in the combined three-year dataset was \$15,891 (IQR \$15,131 -\$16,787). [Table 4.3.7](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.011 (SE: 0.0004). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

[Figure 4.3.2](#) shows the overall distribution of the hospital RSPs for the combined dataset. The expected 30-day RSP treated at a hospital one standard deviation above the national average was 1.23 times higher than the expected 30-day RSP if treated at a hospital one standard deviation below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.¹⁷

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

Of 4,635 hospitals in the study cohort, 617 had a payment “Greater than the National Payment,” 2,702 had a payment “No Different than the National Payment,” and 377 had

a payment “Less than the National Payment.” 939 were classified as “Number of Cases Too Small” (fewer than 25) to reliably estimate the hospital’s RSP.

Table 4.3.1 Frequency of HF Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	307,483	301,950	310,836	920,269
Mean payment (\$2014)	16,102	15,902	15,873	15,959
Age (65 – 74)	24.9	25.7	25.8	25.5
Age (75 – 84)	37.4	37.0	36.6	37.0
Age (>=85)	37.7	37.3	37.6	37.5
Severe infection (CC 1, 3-5)	1.7	1.7	1.7	1.7
Other infectious diseases (CC 6)	37.7	37.3	37.2	37.4
Protein-calorie malnutrition (CC 21)	10.2	9.9	9.9	10.0
Other significant endocrine and metabolic disorders (CC 22)	14.1	14.1	14.0	14.1
Other endocrine/metabolic/nutritional disorders (CC 24)	88.5	89.3	90.2	89.3
Other gastrointestinal disorders (CC 36)	63.3	63.3	64.0	63.6
Bone/joint/muscle infections/necrosis (CC 37)	2.5	2.6	2.6	2.6
Other musculoskeletal and connective tissue disorders (CC 43)	75.5	75.5	76.0	75.7
Delirium and encephalopathy (CC 48)	8.3	8.8	9.3	8.8
Dementia or other specified brain disorders (CC 49-50)	24.7	24.2	23.9	24.3
Severe mental illness (CC 54-55)	6.4	6.4	6.4	6.4
Other psychiatric disorders (CC 60)	19.3	20.6	21.9	20.6
Respiratory arrest/ cardiorespiratory failure/ respirator dependence (CC 77-79)	26.6	27.8	29.1	27.8
Angina pectoris/old myocardial infarction (CC 83)	30.2	29.8	29.4	29.8
Heart infection/inflammation, except rheumatic (CC 85)	3.6	3.7	3.8	3.7
Major congenital cardiac/circulatory defect (CC 87)	1.7	1.7	1.8	1.7
Hypertension (CC 91)	87.1	87.3	87.4	87.3
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	66.8	67.1	67.5	67.1

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 97-99)	22.7	22.1	21.3	22.0
Vascular or circulatory disease (CC 104-106)	52.3	52.0	51.9	52.1
Pneumonia (CC 111-113)	45.4	44.7	44.8	45.0
Other ear, nose, throat, and mouth disorders (CC 127)	31.7	32.0	31.9	31.9
Dialysis status (CC 130)	4.5	4.3	4.3	4.4
Renal failure (CC 131)	49.4	50.1	50.9	50.1
Decubitus ulcer of skin (CC 148)	5.7	5.6	5.5	5.6
Chronic ulcer of skin, except decubitus (CC 149)	11.3	11.4	11.3	11.3
Cellulitis, local skin infection (CC 152)	17.8	17.6	17.3	17.6
Hip fracture/dislocation (CC 158)	3.7	3.7	3.6	3.7
Internal injuries (CC 160)	1.6	1.7	1.6	1.6

Table 4.3.2 Hierarchical Generalized Linear Regression Model Variable Coefficients for HF Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	9.553	9.525	9.532	9.533
Age (65 – 74)	0.073	0.076	0.069	0.075
Age (75 – 84)	0.055	0.058	0.055	0.058
Age (>=85) (reference group)	--	--	--	--
Severe infection (CC 1, 3-5)	0.061	0.070	0.046	0.058
Other infectious diseases (CC 6)	0.015	0.020	0.019	0.017
Protein-calorie malnutrition (CC 21)	0.137	0.137	0.135	0.135
Other significant endocrine and metabolic disorders (CC 22)	0.064	0.071	0.069	0.067
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.009	0.004	0.003	-0.003
Other gastrointestinal disorders (CC 36)	0.006	0.004	0.007	0.007
Bone/joint/muscle infections/necrosis (CC 37)	0.047	0.034	0.047	0.043
Other musculoskeletal and connective tissue disorders (CC 43)	0.002	0.001	0.005	0.003
Delirium and encephalopathy (CC 48)	0.020	0.013	0.015	0.014
Dementia or other specified brain disorders (CC 49-50)	0.038	0.045	0.039	0.040

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Severe mental illness (CC 54-55)	0.045	0.042	0.041	0.040
Other psychiatric disorders (CC 60)	0.009	0.007	0.007	0.007
Respiratory arrest/ cardiorespiratory failure/ respirator dependence (CC 77-79)	0.020	0.017	0.024	0.020
Angina pectoris/old myocardial infarction (CC 83)	-0.018	-0.015	-0.020	-0.018
Heart infection/inflammation, except rheumatic (CC 85)	0.092	0.078	0.067	0.077
Major congenital cardiac/circulatory defect (CC 87)	0.048	0.051	0.022	0.039
Hypertension (CC 91)	-0.052	-0.051	-0.051	-0.051
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	-0.037	-0.029	-0.034	-0.034
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 97-99)	0.014	0.022	0.013	0.016
Vascular or circulatory disease (CC 104-106)	0.013	0.018	0.015	0.014
Pneumonia (CC 111-113)	0.112	0.105	0.098	0.105
Other ear, nose, throat, and mouth disorders (CC 127)	-0.016	-0.018	-0.017	-0.017
Dialysis status (CC 130)	0.146	0.148	0.141	0.143
Renal failure (CC 131)	0.024	0.018	0.024	0.022
Decubitus ulcer of skin (CC 148)	0.034	0.031	0.034	0.032
Chronic ulcer of skin, except decubitus (CC 149)	0.064	0.066	0.066	0.065
Cellulitis, local skin infection (CC 152)	0.003	0.009	0.011	0.007
Hip fracture/dislocation (CC 158)	0.039	0.039	0.035	0.038
Internal injuries (CC 160)	0.080	0.071	0.065	0.070

Table 4.3.3 Adjusted PR and 95% CIs for the HF Hierarchical Generalized Linear Regression Model Over Different Time Periods

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Age (65 – 74)	1.08 (1.07, 1.08)	1.08 (1.07, 1.09)	1.07 (1.06, 1.08)	1.08 (1.07, 1.08)
Age (75 – 84)	1.06 (1.05, 1.06)	1.06 (1.05, 1.07)	1.06 (1.05, 1.06)	1.06 (1.06, 1.06)
Age (>=85) (reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
Severe infection (CC 1, 3-5)	1.06 (1.04, 1.08)	1.07 (1.05, 1.09)	1.05 (1.03, 1.07)	1.06 (1.05, 1.07)
Other infectious diseases (CC 6)	1.01 (1.01, 1.02)	1.02 (1.01, 1.03)	1.02 (1.01, 1.03)	1.02 (1.01, 1.02)

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Protein-calorie malnutrition (CC 21)	1.15 (1.14, 1.16)	1.15 (1.14, 1.16)	1.15 (1.14, 1.15)	1.14 (1.14, 1.15)
Other significant endocrine and metabolic disorders (CC 22)	1.07 (1.06, 1.07)	1.07 (1.06, 1.08)	1.07 (1.06, 1.08)	1.07 (1.06, 1.07)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.99 (0.98, 1.00)	1.00 (1.00, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.00)
Other gastrointestinal disorders (CC 36)	1.01 (1.00, 1.01)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)
Bone/joint/muscle infections/necrosis (CC 37)	1.05 (1.03, 1.07)	1.03 (1.02, 1.05)	1.05 (1.03, 1.07)	1.04 (1.03, 1.05)
Other musculoskeletal and connective tissue disorders (CC 43)	1.00 (1.00, 1.01)	1.00 (0.99, 1.01)	1.01 (1.00, 1.01)	1.00 (1.00, 1.01)
Delirium and encephalopathy (CC 48)	1.02 (1.01, 1.03)	1.01 (1.00, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)
Dementia or other specified brain disorders (CC 49-50)	1.04 (1.03, 1.04)	1.05 (1.04, 1.05)	1.04 (1.03, 1.05)	1.04 (1.04, 1.05)
Severe mental illness (CC 54-55)	1.05 (1.04, 1.06)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)
Other psychiatric disorders (CC 60)	1.01 (1.00, 1.02)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)
Respiratory arrest/cardiopulmonary failure/respirator dependence (CC 77-79)	1.02 (1.01, 1.03)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.02)
Angina pectoris/old myocardial infarction (CC 83)	0.98 (0.98, 0.99)	0.98 (0.98, 0.99)	0.98 (0.97, 0.99)	0.98 (0.98, 0.99)
Heart infection/inflammation, except rheumatic (CC 85)	1.10 (1.08, 1.11)	1.08 (1.07, 1.10)	1.07 (1.06, 1.08)	1.08 (1.07, 1.09)
Major congenital cardiac/circulatory defect (CC 87)	1.05 (1.03, 1.07)	1.05 (1.03, 1.07)	1.02 (1.00, 1.04)	1.04 (1.03, 1.05)
Hypertension (CC 91)	0.95 (0.94, 0.96)	0.95 (0.94, 0.96)	0.95 (0.94, 0.96)	0.95 (0.95, 0.95)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.96 (0.96, 0.97)	0.97 (0.97, 0.98)	0.97 (0.96, 0.97)	0.97 (0.96, 0.97)
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 97-99)	1.01 (1.01, 1.02)	1.02 (1.02, 1.03)	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)
Vascular or circulatory disease (CC 104-106)	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)
Pneumonia (CC 111-113)	1.12 (1.11, 1.12)	1.11 (1.10, 1.12)	1.10 (1.10, 1.11)	1.11 (1.11, 1.11)
Other ear, nose, throat, and mouth disorders (CC 127)	0.98 (0.98, 0.99)	0.98 (0.98, 0.99)	0.98 (0.98, 0.99)	0.98 (0.98, 0.99)
Dialysis status (CC 130)	1.16 (1.14, 1.17)	1.16 (1.14, 1.18)	1.15 (1.14, 1.17)	1.15 (1.14, 1.16)

Variable	07/2012-06/2013 PR (95% CI)	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2012-06/2015 PR (95% CI)
Renal failure (CC 131)	1.02 (1.02, 1.03)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)
Decubitus ulcer of skin (CC 148)	1.03 (1.02, 1.05)	1.03 (1.02, 1.04)	1.03 (1.02, 1.05)	1.03 (1.03, 1.04)
Chronic ulcer of skin, except decubitus (CC 149)	1.07 (1.06, 1.08)	1.07 (1.06, 1.08)	1.07 (1.06, 1.08)	1.07 (1.06, 1.07)
Cellulitis, local skin infection (CC 152)	1.00 (1.00, 1.01)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.01 (1.00, 1.01)
Hip fracture/dislocation (CC 158)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.02, 1.05)	1.04 (1.03, 1.05)
Internal injuries (CC 160)	1.08 (1.06, 1.10)	1.07 (1.05, 1.10)	1.07 (1.05, 1.09)	1.07 (1.06, 1.08)

Table 4.3.4 HF Generalized Linear Model Performance Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	1.02-1.01	1.02-1.02	1.01-1.01	1.02-1.02
Quasi-R ²	0.04	0.03	0.03	0.03

Table 4.3.5 Distribution of Hospital HF Admission Volumes Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,519	4,486	4,454	4,635
Mean number of admissions (SD)	68 (83)	67 (83)	70 (87)	199 (250)
Range (min. – max.)	1 - 906	1 - 937	1 - 1,028	1 - 2,871
25 th percentile	12	12	11	32
50 th percentile	35	34	35	96
75 th percentile	96	95	99	280

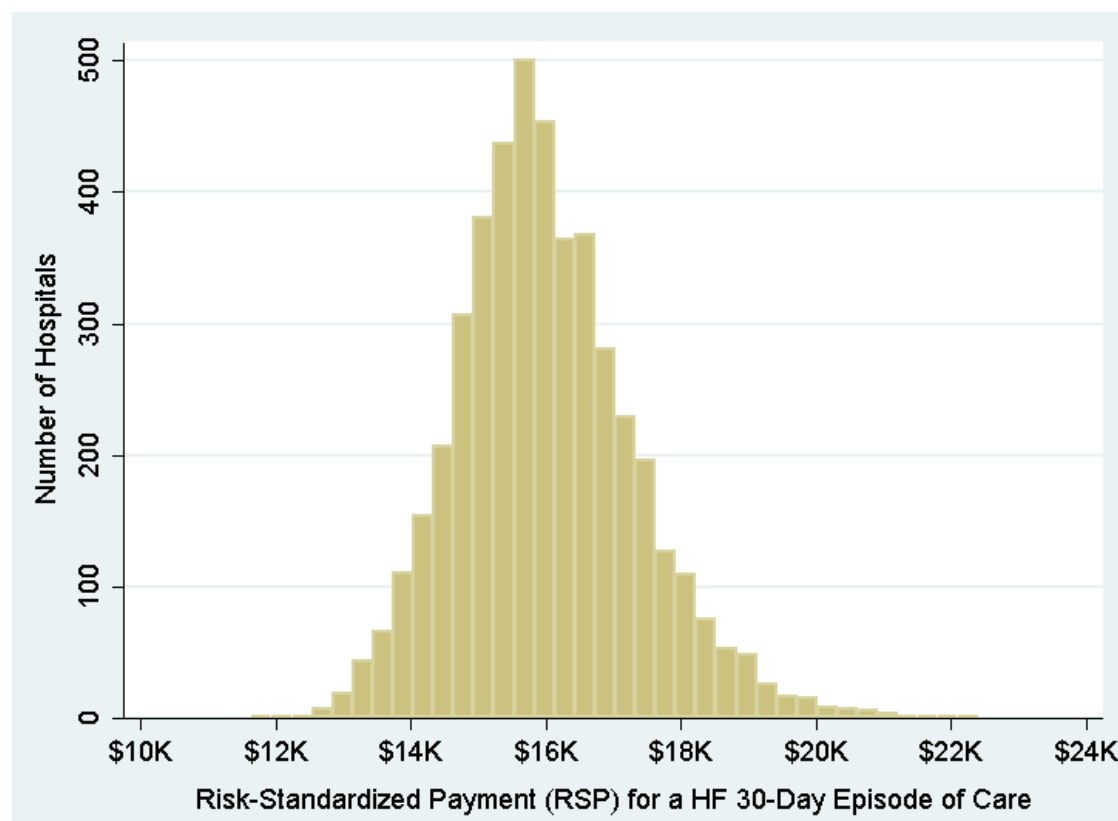
Table 4.3.6 Distribution of Hospital HF RSPs Over Different Time Periods (\$2014)

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,519	4,486	4,454	4,635
Mean (SD)	16,131 (986)	15,928 (933)	15,902 (966)	16,013 (1,326)
Range (min. – max.)	13,072 - 21,764	12,828 - 21,047	12,975 - 20,389	11,648 - 22,416
25 th percentile	15,506	15,339	15,314	15,131
50 th percentile	15,996	15,829	15,778	15,891
75 th percentile	16,640	16,414	16,422	16,787

Table 4.3.7 Between-Hospital Variance for HF

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.009 (0.0004)	0.008 (0.0004)	0.009 (0.0004)	0.011 (0.0004)

Figure 4.3.2 Distribution of Hospital HF 30-Day Episode-of-Care RSPs between July 2012 and June 2015 (\$2014)



N= 4,635 hospitals

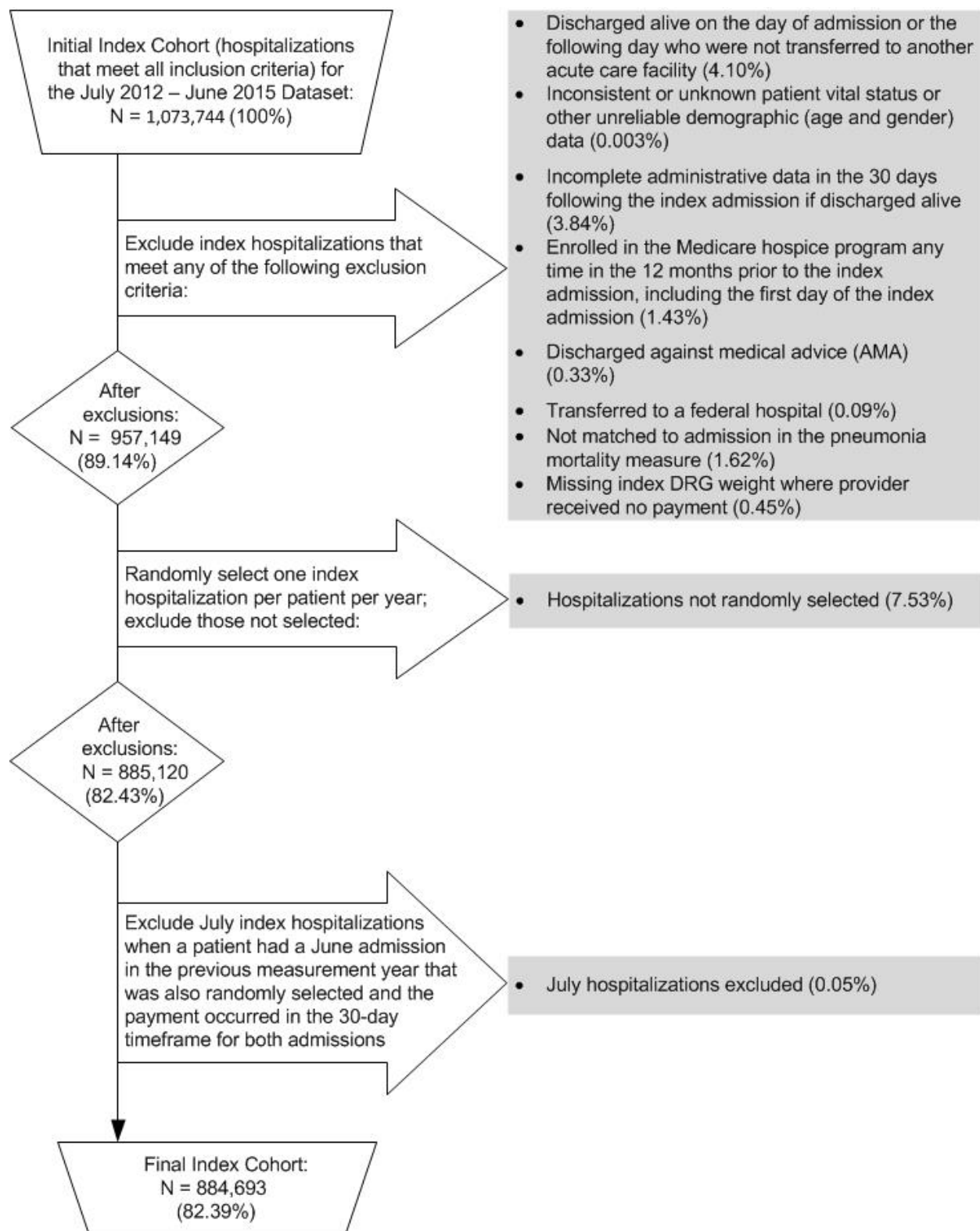
4.4 Pneumonia Payment 2016 Model Results

4.4.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in [Section 2.2.1](#). The percentage of pneumonia admissions meeting each exclusion criterion in the July 2012-June 2015 dataset is presented in [Figure 4.4.1](#).

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

Figure 4.4.1 Pneumonia Cohort Exclusions in the July 2012-June 2015 Dataset



4.4.2 Frequency of Pneumonia Model Variables

We examined the change in both observed payments and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the national mean payment decreased from \$14,964 to \$14,605. Notable changes in the frequencies for model variables include:

- Increases in Other endocrine/metabolic/nutritional disorders (81.4% to 83.6%) and Respiratory arrest/cardiorespiratory failure/respirator dependence (21.5% to 23.6%)

Refer to [Table 4.4.1](#) for more detail.

4.4.3 Pneumonia Model Parameters and Performance

[Table 4.4.2](#) shows hierarchical generalized linear regression model variable coefficients and 95% CIs for the pneumonia payment model by individual year and for the combined three-year dataset. The pneumonia payment model coefficients can be directly interpreted as dollars. The quasi- R^2 for the pneumonia payment model was 0.08, suggesting that approximately 8% of the variation in payment can be explained by patient-level risk factors. This quasi- R^2 is in line with R^2 s from other patient-level risk-adjustment models for healthcare payment.²¹

Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the quasi- R^2 and predictive ratios ([Table 4.4.3](#)) remained similar to the model used for 2015 public reporting.

4.4.4 Distribution of Hospital Volumes and RSPs for Pneumonia

[Table 4.4.4](#) shows the distribution of hospital admission volumes and [Table 4.4.5](#) shows the distribution of hospital RSPs. The mean RSP decreased over the three-year period, from \$14,949 between July 2012 and June 2013 to \$14,594 between July 2014 and June 2015. The median hospital RSP in the combined three-year dataset was \$ 14,708 (IQR \$13,900 -\$15,584). [Table 4.4.6](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was \$2,654,436 (SE: \$86,958). If there were no systematic differences between hospitals, the between-hospital variance would be \$0.

[Figure 4.4.2](#) shows the overall distribution of the hospital RSPs for the combined dataset. The expected 30-day RSP if treated at a hospital one standard deviation above the national average was \$3,258 higher than the expected 30-day RSP if treated at a hospital one standard deviation below the national average payment. If there were no systematic differences between hospitals, this difference would be \$0.¹⁷

4.4.5 Distribution of Hospitals by Payment Category in the Three-Year Dataset

Of 4,680 hospitals in the study cohort, 541 had a payment “Greater than the National Payment,” 2,968 had a payment “No Different than the National Payment,” and 673 had

a payment “Less than the National Payment.” 498 were classified as “Number of Cases Too Small” (fewer than 25) to reliably estimate the hospital’s RSP.

Table 4.4.1 Frequency of Pneumonia Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	321,967	275,821	286,905	884,693
Mean payment (\$2014)	14,964	14,867	14,605	14,817
Age (65 – 74)	27.8	29.4	28.1	28.4
Age (75 – 84)	37.8	37.4	37.1	37.4
Age (>=85)	34.4	33.2	34.9	34.2
Severe infection (CC 1, 3-5)	2.6	2.8	2.6	2.7
Other infectious diseases (CC 6)	36.6	36.7	36.5	36.6
Metastatic cancer or acute leukemia (CC 7)	5.0	5.2	4.9	5.0
Lung, upper digestive tract, and other severe cancers (CC 8)	6.7	7.1	6.7	6.8
Lymphatic, head and neck, brain, and other major cancers (CC 9)	6.0	6.3	6.1	6.1
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	41.9	42.5	41.9	42.1
Protein-calorie malnutrition (CC 21)	12.7	12.7	12.5	12.7
Other significant endocrine and metabolic disorders (CC 22)	11.8	12.2	12.2	12.1
Other endocrine/metabolic/nutritional disorders (CC 24)	81.4	82.9	83.6	82.6
Other gastrointestinal disorders (CC 36)	65.4	66.2	66.1	65.8
Bone/joint/muscle infections/necrosis (CC 37)	1.9	2.0	2.0	2.0
Osteoporosis and other bone/cartilage disorders (CC 41)	24.2	23.7	23.5	23.8
Severe hematological disorders (CC 44)	2.3	2.2	2.0	2.2
Iron deficiency or other unspecified anemias and blood disease (CC 47)	57.4	58.0	56.1	57.2
Delirium and encephalopathy (CC 48)	8.1	8.7	9.1	8.6
Dementia or other specified brain disorders (CC 49-50)	30.6	29.9	29.8	30.1
Drug/alcohol dependence/psychosis (CC 51-52)	3.2	3.4	3.4	3.3
Drug/alcohol abuse, without dependence (CC 53)	14.4	15.1	15.0	14.8
Major psychiatric disorders (CC 54-56)	13.7	13.8	13.9	13.8

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Hemiplegia, paraplegia, paralysis, spinal cord disorder and amputation (CC 67-69, 100-101, 177-178)	6.5	6.5	6.4	6.4
Muscular dystrophy and/or polyneuropathy (CC 70-71)	12.6	13.4	13.6	13.2
Multiple sclerosis and Parkinson's (CC 72-73)	4.4	4.3	4.3	4.3
Coma, brain compression/anoxic damage (CC 75)	0.7	0.7	0.7	0.7
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 77-79)	21.5	23.3	23.6	22.7
Congestive heart failure (CC 80)	37.8	38.1	37.5	37.8
Angina pectoris/old myocardial infarction (CC 83)	17.0	17.1	16.7	17.0
Heart infection/inflammation, except rheumatic (CC 85)	2.1	2.1	2.1	2.1
Valvular or rheumatic heart disease (CC 86)	25.7	26.1	26.2	26.0
Hypertension (CC 91)	83.7	84.0	83.9	83.9
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	44.2	45.0	45.0	44.7
Stroke (CC 95-96)	8.7	8.6	8.6	8.6
Vascular or circulatory disease (CC 104-106)	42.1	42.7	42.2	42.3
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	53.8	54.3	52.7	53.6
Fibrosis of lung or other chronic lung disorders (CC 109)	14.2	13.9	13.2	13.8
Asthma (CC 110)	11.7	11.9	11.9	11.9
Aspiration and specified bacterial pneumonias (CC 111)	6.7	6.8	6.4	6.6
Pleural effusion/pneumothorax (CC 114)	16.2	16.7	16.3	16.4
Other ear, nose, throat, and mouth disorders (CC 127)	36.6	37.2	37.0	36.9
Dialysis status (CC 130)	3.4	3.6	3.6	3.5
Renal failure (CC 131)	29.7	31.1	31.6	30.7
Decubitus ulcer or chronic skin ulcer (CC 148-149)	11.1	11.1	10.9	11.0
Head injury (CC 154-156)	8.4	8.7	9.2	8.7
Vertebral fractures (CC 157)	5.1	5.2	5.3	5.2
Hip fracture/dislocation (CC 158)	4.1	4.1	4.0	4.1
Major fracture, except of skull, vertebrae, or hip (CC 159)	2.6	2.6	2.7	2.6

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Internal injuries (CC 160)	1.2	1.2	1.1	1.2
Major symptoms, abnormalities (CC 166)	82.2	82.7	82.2	82.3

Table 4.4.2 Hierarchical Generalized Linear Regression Model Variable Coefficients and 95% CIs for Pneumonia Over Different Time Periods

Variable	07/2012-06/2013 \$ (95% CI)	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2012-06/2015 \$ (95% CI)
Intercept	10,660	10,669	10,550	10,761
Age (65 – 74)	-1,178 (-1,272, -1,084)	-1,036 (-1,138, -935)	-1,300 (-1,397, -1,203)	-1,112 (-1,168, -1,055)
Age (75 – 84)	-702 (-785, -619)	-653 (-744, -562)	-821 (-907, -735)	-688 (-738, -637)
Age (>=85; reference group)	--	--	--	--
Severe infection (CC 1, 3-5)	2,383 (2,110, 2,656)	1,758 (1,482, 2,034)	1,835 (1,565, 2,105)	1,977 (1,819, 2,135)
Other infectious diseases (CC 6)	409 (331, 487)	388 (303, 472)	383 (302, 464)	377 (330, 424)
Metastatic cancer or acute leukemia (CC 7)	1,298 (1,098, 1,497)	1,570 (1,355, 1,785)	1,705 (1,496, 1,915)	1,488 (1,367, 1,608)
Lung, upper digestive tract, and other severe cancers (CC 8)	754 (586, 922)	805 (628, 982)	518 (347, 688)	676 (576, 775)
Lymphatic, head and neck, brain, and other major cancers (CC 9)	843 (684, 1,002)	823 (654, 992)	558 (397, 720)	702 (607, 796)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	478 (406, 550)	453 (374, 531)	531 (456, 606)	485 (442, 529)
Protein-calorie malnutrition (CC 21)	3,696 (3,555, 3,836)	3,386 (3,237, 3,536)	3,090 (2,948, 3,232)	3,361 (3,278, 3,445)
Other significant endocrine and metabolic disorders (CC 22)	1,152 (1,015, 1,288)	1,267 (1,120, 1,414)	1,166 (1,027, 1,305)	1,175 (1,094, 1,257)
Other endocrine/metabolic/nutritional disorders (CC 24)	-118 (-204, -31)	-140 (-237, -43)	-48 (-142, 45)	-117 (-170, -63)
Other gastrointestinal disorders (CC 36)	-127 (-200, -55)	-197 (-276, -118)	-149 (-225, -74)	-147 (-191, -103)
Bone/joint/muscle infections/necrosis (CC 37)	865 (550, 1,180)	1,045 (710, 1,379)	783 (465, 1,100)	890 (703, 1,076)
Osteoporosis and other bone/cartilage disorders (CC 41)	-216 (-298, -134)	-235 (-325, -145)	-162 (-249, -75)	-206 (-256, -156)
Severe hematological disorders (CC 44)	1,019 (746, 1,293)	1,238 (935, 1,541)	1,100 (799, 1,401)	1,118 (949, 1,287)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1,318 (1,245, 1,391)	1,247 (1,168, 1,326)	1,224 (1,148, 1,300)	1,249 (1,205, 1,293)
Delirium and encephalopathy (CC 48)	390 (226, 554)	324 (153, 494)	262 (101, 423)	294 (199, 390)
Dementia or other specified brain disorders (CC 49-50)	1,288 (1,201, 1,375)	1,230 (1,135, 1,324)	1,179 (1,089, 1,270)	1,204 (1,152, 1,257)
Drug/alcohol dependence/psychosis (CC 51-52)	893 (671, 1,115)	738 (508, 967)	888 (667, 1,110)	864 (734, 995)

Variable	07/2012-06/2013 \$ (95% CI)	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2012-06/2015 \$ (95% CI)
Drug/alcohol abuse, without dependence (CC 53)	123 (19, 227)	110 (-2, 221)	90 (-16, 197)	114 (52, 177)
Major psychiatric disorders (CC 54-56)	965 (849, 1,081)	941 (817, 1,066)	864 (745, 983)	884 (815, 954)
Hemiplegia, paraplegia, paralysis, spinal cord disorder and amputation (CC 67-69, 100-101, 177-178)	1,394 (1,217, 1,570)	1,367 (1,177, 1,557)	1,066 (885, 1,247)	1,262 (1,157, 1,368)
Muscular dystrophy and/or polyneuropathy (CC 70-71)	619 (504, 735)	420 (300, 541)	538 (422, 654)	517 (449, 585)
Multiple sclerosis and Parkinson's (CC 72-73)	1,290 (1,100, 1,480)	1,264 (1,058, 1,470)	1,489 (1,288, 1,689)	1,309 (1,194, 1,424)
Coma, brain compression/anoxic damage (CC 75)	1,105 (534, 1,677)	1,504 (890, 2,117)	1,409 (816, 2,002)	1,268 (926, 1,610)
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 77-79)	999 (893, 1,106)	798 (686, 909)	874 (767, 980)	872 (810, 935)
Congestive heart failure (CC 80)	647 (561, 734)	751 (657, 845)	684 (594, 775)	693 (640, 745)
Angina pectoris/old myocardial infarction (CC 83)	-249 (-345, -153)	-301 (-405, -197)	-224 (-325, -123)	-255 (-314, -197)
Heart infection/inflammation, except rheumatic (CC 85)	1,129 (838, 1,421)	1,264 (953, 1,575)	1,143 (842, 1,444)	1,185 (1,011, 1,360)
Valvular or rheumatic heart disease (CC 86)	544 (456, 632)	596 (501, 691)	526 (435, 616)	543 (491, 596)
Hypertension (CC 91)	-117 (-207, -27)	-26 (-125, 72)	-31 (-125, 63)	-71 (-126, -17)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	202 (126, 279)	128 (45, 210)	132 (53, 212)	154 (107, 200)
Stroke (CC 95-96)	316 (173, 459)	385 (229, 541)	397 (247, 546)	347 (260, 433)
Vascular or circulatory disease (CC 104-106)	77 (1, 153)	121 (38, 203)	177 (98, 257)	117 (71, 163)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	882 (809, 955)	737 (658, 817)	760 (684, 836)	777 (733, 821)
Fibrosis of lung or other chronic lung disorders (CC 109)	337 (231, 443)	451 (336, 566)	383 (271, 496)	378 (314, 442)
Asthma (CC 110)	-752 (-852, -651)	-885 (-993, -778)	-749 (-852, -645)	-796 (-857, -736)
Aspiration and specified bacterial pneumonias (CC 111)	449 (272, 626)	173 (-14, 360)	192 (7, 377)	278 (172, 384)
Pleural effusion/pneumothorax (CC 114)	472 (354, 591)	559 (432, 685)	469 (347, 591)	498 (427, 569)
Other ear, nose, throat, and mouth disorders (CC 127)	-510 (-580, -441)	-425 (-500, -349)	-558 (-630, -485)	-497 (-539, -455)
Dialysis status (CC 130)	3,347 (3,040, 3,653)	3,097 (2,779, 3,414)	3,337 (3,031, 3,642)	3,218 (3,039, 3,398)
Renal failure (CC 131)	510 (419, 602)	498 (401, 595)	442 (349, 534)	478 (424, 532)

Variable	07/2012-06/2013 \$ (95% CI)	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2012-06/2015 \$ (95% CI)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1,152 (1,015, 1,288)	1,213 (1,066, 1,360)	1,147 (1,005, 1,289)	1,156 (1,074, 1,238)
Head injury (CC 154-156)	296 (155, 437)	315 (164, 466)	307 (166, 448)	303 (219, 386)
Vertebral fractures (CC 157)	1,006 (826, 1,187)	1,249 (1,054, 1,443)	1,095 (909, 1,281)	1,104 (996, 1,213)
Hip fracture/dislocation (CC 158)	401 (197, 605)	634 (410, 857)	685 (468, 903)	586 (461, 710)
Major fracture, except of skull, vertebrae, or hip (CC 159)	824 (580, 1,069)	714 (453, 975)	660 (412, 908)	748 (603, 894)
Internal injuries (CC 160)	1,603 (1,195, 2,010)	1,728 (1,295, 2,162)	1,697 (1,268, 2,126)	1,625 (1,380, 1,870)
Major symptoms, abnormalities (CC 166)	732 (649, 816)	693 (601, 785)	825 (738, 913)	729 (678, 780)

Table 4.4.3 Pneumonia Generalized Linear Model Performance Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	1.05-1.05	1.06-1.05	1.05-1.06	1.05-1.05
Quasi-R ²	0.09	0.08	0.08	0.08

Table 4.4.4 Distribution of Hospital Pneumonia Admission Volumes Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,594	4,556	4,524	4,680
Mean number of admissions (SD)	70 (72)	61 (63)	63 (66)	189 (198)
Range (min. – max.)	1 - 782	1 - 673	1 - 658	1 – 2,113
25 th percentile	21	18	19	54
50 th percentile	46	40	42	124
75 th percentile	96	84	86	260

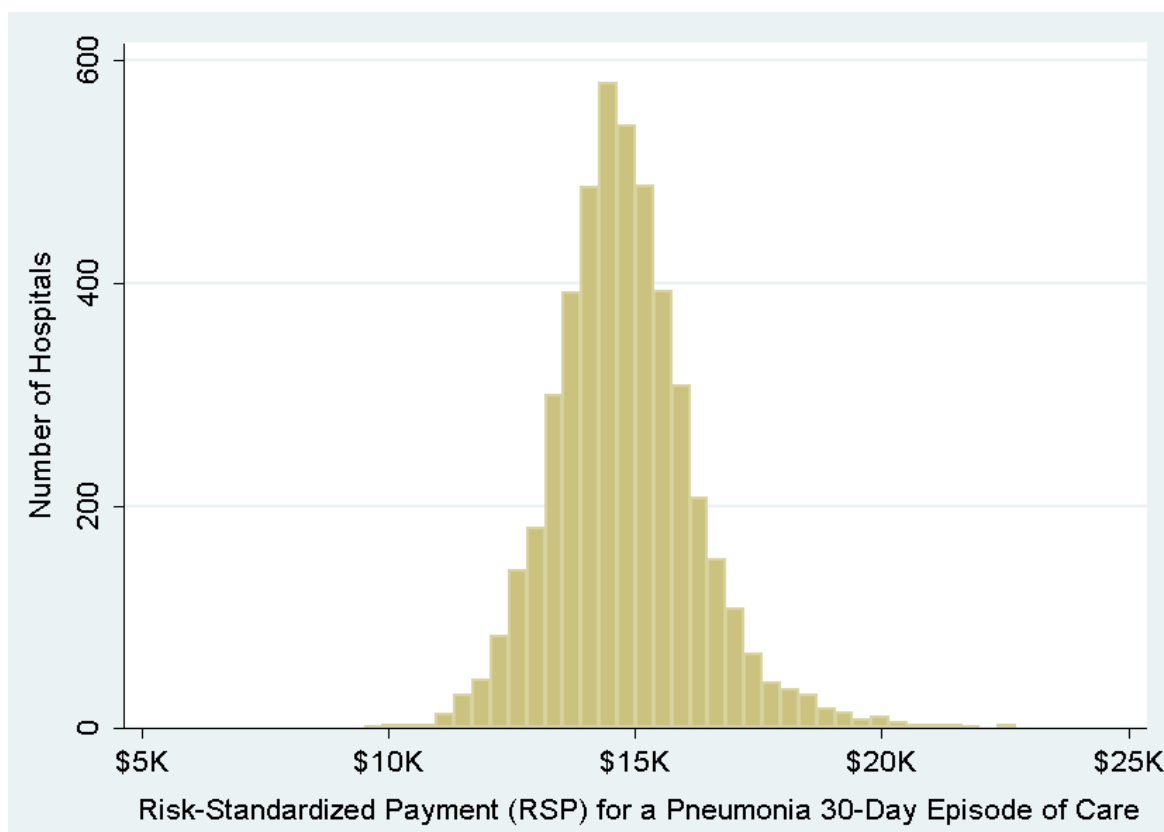
Table 4.4.5 Distribution of Hospital Pneumonia RSPs Over Different Time Periods (\$2014)

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,594	4,556	4,524	4,680
Mean (SD)	14,949 (1,179)	14,854 (1,148)	14,594 (1,056)	14,798 (1,431)
Range (min. – max.)	10,860 - 22,385	10,599 - 19,794	9,870 - 19,727	9,502 - 22,737
25 th percentile	14,201	14,118	13,914	13,900
50 th percentile	14,896	14,800	14,522	14,708
75 th percentile	15,632	15,570	15,207	15,584

Table 4.4.6 Between-Hospital Variance for Pneumonia

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between hospital-variance (SE) (\$)	2,424,325 (103,897)	2,434,792 (111,607)	2,089,401 (98,880)	2,654,436 (86,958)

Figure 4.4.2 Distribution of Hospital Pneumonia 30-Day Episode-of-Care RSPs Between July 2012 and June 2015 (\$2014)



N= 4,680 hospitals

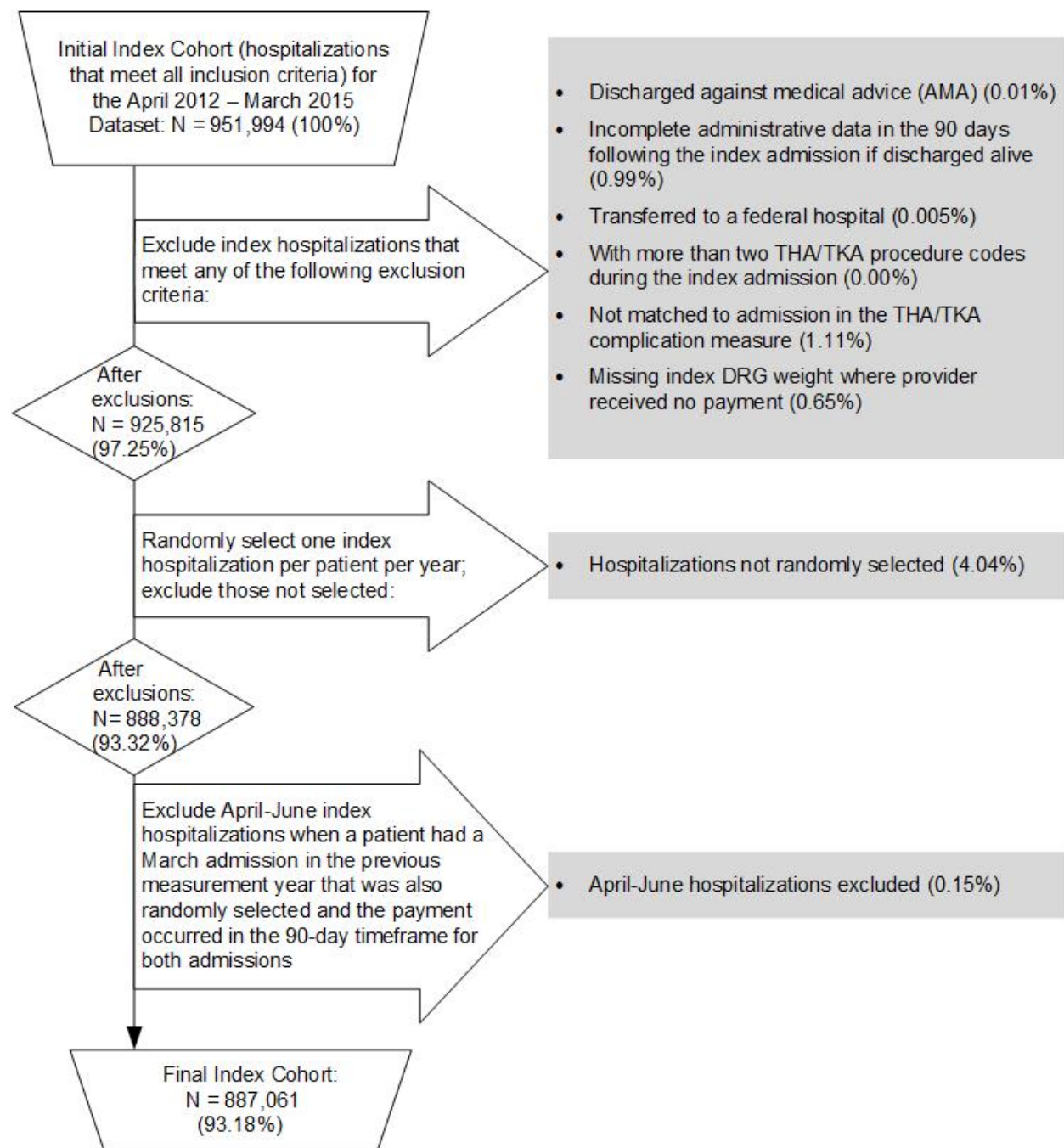
4.5 THA/TKA Payment 2016 Model Results

4.5.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in [Section 2.2.1](#). The percentage of THA/TKA admissions meeting each exclusion criterion in the April 2012-March 2015 dataset is presented in [Figure 4.5.1](#).

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

Figure 4.5.1 THA/TKA Cohort Exclusions in the April 2012-March 2015 Dataset



4.5.2 Frequency of THA/TKA Model Variables

We examined the change in both observed payments and frequency of clinical and demographic variables. Between April 2012-March 2013 and April 2014-March 2015, the national mean payment decreased from \$23,706 to \$22,338. Notable changes in the frequencies for model variables include:

- Increase in Other psychiatric disorders (11.9% to 14.3%)

Refer to [Table 4.5.1](#) for more detail.

4.5.3 THA/TKA Model Parameters and Performance

[Table 4.5.2](#) shows the hierarchical generalized linear model variable coefficients by individual year and for the combined three-year dataset.

[Table 4.5.3](#) shows the risk-adjusted PRs and 95% CIs for the THA/TKA payment model by individual year and for the combined three-year dataset. The quasi- R^2 for the THA/TKA payment model was 0.21, suggesting that approximately 21% of the variation in payment can be explained by patient-level risk factors. This quasi- R^2 is in line with R^2 s from other patient-level risk-adjustment models for healthcare payment.²¹

Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the quasi- R^2 and predictive ratios ([Table 4.5.4](#)) remained similar to the model used during development.

4.5.4 Distribution of Hospital Volumes and RSPs for THA/TKA

[Table 4.5.5](#) shows the distribution of hospital admission volumes and [Table 4.5.6](#) shows the distribution of hospital RSPs. The mean RSP decreased over the three-year period, from \$23,825 between April 2012 and March 2013 to \$22,449 between April 2014 and March 2015. The median hospital RSP in the combined three-year dataset was \$22,844 (IQR \$21,353 - \$24,656). [Table 4.5.7](#) shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.013 (SE: 0.0005). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

[Figure 4.5.2](#) shows the overall distribution of the hospital RSPs for the combined dataset. The expected 90-day RSP if treated at a hospital one standard deviation above the national average was 1.26 times higher than the expected 90-day RSP if treated at a hospital one standard deviation below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.¹⁷

4.5.5 Distribution of Hospitals by Payment Category in the Three-Year Dataset

Of 3,481 hospitals in the study cohort, 702 had a payment “Greater than the National Payment,” 1,065 had a payment “No Different than the National Payment,” and 1,024 had a payment “Less than the National Payment.” 690 were classified as “Number of Cases Too Small” (fewer than 25) to reliably estimate the hospital’s RSP.

Table 4.5.1 Frequency of THA/TKA Model Variables Over Different Time Periods

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Total N	288,086	300,576	298,399	887,061
Mean payment (\$2014)	23,706	22,987	22,338	23,002
Age minus 65 (years above 65, continuous)	9.3	9.1	9.0	9.1
Male (%)	36.5	37.0	37.2	36.9
Index admissions with an elective THA procedure	30.7	30.9	32.2	31.3
Procedure type (bilateral joint replacement)	2.5	2.4	2.2	2.4
Procedure type (staged joint replacements)	0.8	0.8	0.9	0.8
Procedure type (single joint replacement)	96.8	96.8	96.9	96.8
Morbid obesity (ICD-9 diagnosis code 278.01)	5.6	6.0	6.3	6.0
Congestive heart failure (CC 80)	8.6	8.4	8.3	8.5
Acute coronary syndrome (CC 81-82)	27.7	26.6	25.8	26.7
Valvular or rheumatic heart disease (CC 86)	14.8	14.6	14.3	14.6
Hypertension and hypertension complications (CC 89-91)	83.0	82.6	81.8	82.5
History of infection (CC 1, 3-6)	17.8	17.7	17.6	17.7
Metastatic cancer or acute leukemia (CC 7)	0.6	0.6	0.6	0.6
Cancer (CC 8-12)	18.6	18.5	18.4	18.5
Benign neoplasms of skin, breast, eye (CC 14)	18.4	18.8	19.3	18.8
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	28.8	28.3	28.2	28.4
Protein-calorie malnutrition (CC 21)	0.8	0.7	0.7	0.7
Other significant endocrine and metabolic disorders (CC 22)	4.2	4.2	4.2	4.2
Obesity/disorders of thyroid, cholesterol, lipids (CC 24, excluding ICD-9 diagnosis code 278.01)	70.3	70.6	70.9	70.6
Appendicitis (CC 35)	0.1	0.1	0.1	0.1
Bone/joint/muscle infections/necrosis (CC 37)	2.7	2.7	2.7	2.7
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	9.2	9.2	9.3	9.2

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Disorders of the vertebrae and spinal discs (CC 39)	29.3	29.2	29.4	29.3
Osteoarthritis of hip or knee (CC 40)	96.3	96.2	96.2	96.2
Other musculoskeletal and connective tissue disorders (CC 43)	89.5	89.6	89.9	89.7
Severe hematological disorders (CC 44)	0.5	0.4	0.4	0.4
Coagulation defects and other specified hematological disorders (CC 46)	4.6	4.6	4.7	4.6
Delirium and encephalopathy (CC 48)	1.0	1.0	1.0	1.0
Dementia or other specified brain disorders (CC 49-50)	4.3	4.2	4.1	4.2
Major psychiatric disorders; personality disorders (CC 54-57)	4.6	4.7	4.8	4.7
Depression/anxiety (CC 58-59)	15.9	16.5	17.4	16.6
Other psychiatric disorders (CC 60)	11.9	13.2	14.3	13.2
Mental retardation or developmental disability (CC 61-65)	0.1	0.1	0.1	0.1
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.7	1.6	1.6	1.6
Polyneuropathy (CC 71)	7.0	7.1	7.4	7.2
Multiple sclerosis (CC 72)	0.2	0.2	0.3	0.2
Parkinson's and Huntington's disease (CC 73)	1.1	1.0	1.0	1.0
Seizure disorders and convulsions (CC 74)	1.5	1.5	1.5	1.5
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	23.8	24.0	24.3	24.0
Stroke (CC 95-96)	2.1	2.1	2.1	2.1
Vascular or circulatory disease (CC 104-106)	22.2	21.8	21.6	21.9
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	13.6	13.0	12.7	13.1
Pleural effusion/pneumothorax (CC 114)	1.5	1.5	1.4	1.4
Other lung disorders (CC 115)	16.8	16.5	15.1	16.1
Legally blind (CC 116)	0.2	0.2	0.2	0.2
Dialysis status (CC 130)	0.2	0.2	0.2	0.2
Renal failure (CC 131)	8.6	8.9	9.3	8.9
Incontinence (CC 134)	5.6	5.7	5.8	5.7

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Urinary tract infection (CC 135)	15.6	15.3	15.0	15.3
Other urinary tract disorders (CC 136)	13.0	12.8	12.7	12.9
Decubitus ulcer or chronic skin ulcer (CC 148-149)	2.4	2.4	2.4	2.4
Cellulitis, local skin infection (CC 152)	7.6	7.3	7.2	7.3
Other dermatological disorders (CC 153)	39.4	40.0	40.8	40.1
Trauma (CC 154-156, 158-161)	4.7	4.7	4.8	4.7
Vertebral fractures (CC 157)	1.2	1.2	1.2	1.2
Other injuries (CC 162)	28.1	27.8	28.0	28.0
Major symptoms, abnormalities (CC 166)	51.3	50.5	49.3	50.4
Minor symptoms, signs, findings (CC 167)	80.4	81.0	81.0	80.8

Table 4.5.2 Hierarchical Generalized Linear Regression Model Variable Coefficients for THA/TKA Over Different Time Periods

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Intercept	9.683	9.666	9.643	9.672
Age minus 65 (years above 65, continuous)	0.015	0.014	0.015	0.015
Male	-0.068	-0.070	-0.067	-0.068
Index admissions with an elective THA procedure	0.007	0.002	0.003	0.004
Procedure type (bilateral joint replacement)	0.545	0.548	0.569	0.554
Procedure type (staged joint replacements)	0.559	0.569	0.559	0.561
Procedure type (single joint replacement; reference group)	--	--	--	--
Morbid obesity (ICD-9 diagnosis code 278.01)	0.119	0.113	0.117	0.115
Congestive heart failure (CC 80)	0.064	0.057	0.053	0.058
Acute coronary syndrome (CC 81-82)	0.018	0.020	0.019	0.019
Valvular or rheumatic heart disease (CC 86)	0.009	0.007	0.008	0.007
Hypertension and hypertension complications (CC 89-91)	0.026	0.026	0.030	0.028
History of infection (CC 1, 3-6)	0.044	0.044	0.043	0.044
Metastatic cancer or acute leukemia (CC 7)	0.025	0.027	0.032	0.028
Cancer (CC 8-12)	-0.008	-0.007	-0.004	-0.007

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Benign neoplasms of skin, breast, eye (CC 14)	-0.016	-0.020	-0.021	-0.020
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.055	0.051	0.052	0.052
Protein-calorie malnutrition (CC 21)	0.190	0.139	0.153	0.163
Other significant endocrine and metabolic disorders (CC 22)	0.024	0.026	0.025	0.025
Obesity/disorders of thyroid, cholesterol, lipids (CC 24, excluding ICD-9 diagnosis code 278.01)	-0.010	-0.010	-0.009	-0.009
Appendicitis (CC 35)	-0.062	-0.048	0.006	-0.035
Bone/joint/muscle infections/necrosis (CC 37)	0.044	0.044	0.041	0.043
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	0.022	0.021	0.028	0.024
Disorders of the vertebrae and spinal discs (CC 39)	0.008	0.008	0.007	0.008
Osteoarthritis of hip or knee (CC 40)	0.076	0.079	0.072	0.076
Other musculoskeletal and connective tissue disorders (CC 43)	0.034	0.031	0.029	0.031
Severe hematological disorders (CC 44)	0.092	0.083	0.087	0.090
Coagulation defects and other specified hematological disorders (CC 46)	0.014	0.015	0.019	0.016
Delirium and encephalopathy (CC 48)	0.034	0.049	0.041	0.042
Dementia or other specified brain disorders (CC 49-50)	0.107	0.108	0.107	0.107
Major psychiatric disorders; personality disorders (CC 54-57)	0.091	0.082	0.086	0.087
Depression/anxiety (CC 58-59)	0.042	0.040	0.034	0.038
Other psychiatric disorders (CC 60)	0.019	0.021	0.020	0.019
Mental retardation or developmental disability (CC 61-65)	0.288	0.209	0.246	0.247
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.065	0.058	0.071	0.065
Polyneuropathy (CC 71)	0.036	0.041	0.046	0.040
Multiple sclerosis (CC 72)	0.109	0.099	0.122	0.110
Parkinson's and Huntington's disease (CC 73)	0.177	0.160	0.173	0.170

Variable	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Seizure disorders and convulsions (CC 74)	0.060	0.065	0.074	0.067
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.013	0.014	0.015	0.014
Stroke (CC 95-96)	0.042	0.033	0.035	0.036
Vascular or circulatory disease (CC 104-106)	0.026	0.028	0.025	0.026
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.045	0.046	0.052	0.048
Pleural effusion/pneumothorax (CC 114)	-0.025	-0.021	-0.011	-0.019
Other lung disorders (CC 115)	0.013	0.014	0.013	0.015
Legally blind (CC 116)	0.133	0.114	0.120	0.123
Dialysis status (CC 130)	0.335	0.340	0.337	0.335
Renal failure (CC 131)	0.046	0.043	0.039	0.041
Incontinence (CC 134)	0.051	0.050	0.051	0.051
Urinary tract infection (CC 135)	0.009	0.011	0.016	0.013
Other urinary tract disorders (CC 136)	0.013	0.010	0.008	0.011
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.083	0.083	0.082	0.083
Cellulitis, local skin infection (CC 152)	0.023	0.023	0.025	0.024
Other dermatological disorders (CC 153)	-0.014	-0.011	-0.012	-0.013
Trauma (CC 154-156, 158-161)	0.049	0.061	0.054	0.054
Vertebral fractures (CC 157)	0.032	0.043	0.042	0.039
Other injuries (CC 162)	0.011	0.011	0.011	0.011
Major symptoms, abnormalities (CC 166)	0.031	0.035	0.033	0.033
Minor symptoms, signs, findings (CC 167)	0.020	0.018	0.021	0.020

Table 4.5.3 Adjusted PR and 95% CIs for the THA/TKA Hierarchical Generalized Linear Regression Model Over Different Time Periods

Variable	04/2012-03/2013 PR (95% CI)	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2012-03/2015 PR (95% CI)
Age minus 65 (years above 65, continuous)	1.01 (1.01, 1.02)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)
Male	0.93 (0.93, 0.94)	0.93 (0.93, 0.93)	0.93 (0.93, 0.94)	0.93 (0.93, 0.94)
Index admissions with an elective THA procedure	1.01 (1.00, 1.01)	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)	1.00 (1.00, 1.01)
Procedure type (bilateral joint replacement)	1.72 (1.71, 1.74)	1.73 (1.71, 1.75)	1.77 (1.75, 1.79)	1.74 (1.73, 1.75)
Procedure type (staged joint replacements)	1.75 (1.72, 1.78)	1.77 (1.74, 1.80)	1.75 (1.72, 1.78)	1.75 (1.73, 1.77)

Variable	04/2012-03/2013 PR (95% CI)	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2012-03/2015 PR (95% CI)
Procedure type (single joint replacement; reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
Morbid obesity (ICD-9 diagnosis code 278.01)	1.13 (1.12, 1.13)	1.12 (1.11, 1.13)	1.12 (1.12, 1.13)	1.12 (1.12, 1.13)
Congestive heart failure (CC 80)	1.07 (1.06, 1.07)	1.06 (1.05, 1.06)	1.05 (1.05, 1.06)	1.06 (1.06, 1.06)
Acute coronary syndrome (CC 81-82)	1.02 (1.01, 1.02)	1.02 (1.02, 1.02)	1.02 (1.02, 1.02)	1.02 (1.02, 1.02)
Valvular or rheumatic heart disease (CC 86)	1.01 (1.01, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.01, 1.01)
Hypertension and hypertension complications (CC 89-91)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.03, 1.03)	1.03 (1.03, 1.03)
History of infection (CC 1, 3-6)	1.04 (1.04, 1.05)	1.05 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)
Metastatic cancer or acute leukemia (CC 7)	1.03 (1.01, 1.04)	1.03 (1.01, 1.05)	1.03 (1.02, 1.05)	1.03 (1.02, 1.04)
Cancer (CC 8-12)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)	1.00 (0.99, 1.00)	0.99 (0.99, 1.00)
Benign neoplasms of skin, breast, eye (CC 14)	0.98 (0.98, 0.99)	0.98 (0.98, 0.98)	0.98 (0.98, 0.98)	0.98 (0.98, 0.98)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.06 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)
Protein-calorie malnutrition (CC 21)	1.21 (1.19, 1.23)	1.15 (1.13, 1.17)	1.17 (1.14, 1.19)	1.18 (1.16, 1.19)
Other significant endocrine and metabolic disorders (CC 22)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)
Obesity/disorders of thyroid, cholesterol, lipids (CC 24, excluding ICD-9 diagnosis code 278.01)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)
Appendicitis (CC 35)	0.94 (0.90, 0.98)	0.95 (0.92, 0.99)	1.01 (0.97, 1.05)	0.97 (0.94, 0.99)
Bone/joint/muscle infections/necrosis (CC 37)	1.04 (1.04, 1.05)	1.05 (1.04, 1.05)	1.04 (1.03, 1.05)	1.04 (1.04, 1.05)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 38)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)
Disorders of the vertebrae and spinal discs (CC 39)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.00, 1.01)	1.01 (1.01, 1.01)
Osteoarthritis of hip or knee (CC 40)	1.08 (1.07, 1.09)	1.08 (1.07, 1.09)	1.07 (1.07, 1.08)	1.08 (1.07, 1.08)
Other musculoskeletal and connective tissue disorders (CC 43)	1.03 (1.03, 1.04)	1.03 (1.03, 1.04)	1.03 (1.03, 1.03)	1.03 (1.03, 1.03)
Severe hematological disorders (CC 44)	1.10 (1.07, 1.12)	1.09 (1.06, 1.11)	1.09 (1.07, 1.12)	1.09 (1.08, 1.11)
Coagulation defects and other specified hematological disorders (CC 46)	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	1.02 (1.01, 1.03)	1.02 (1.01, 1.02)

Variable	04/2012-03/2013 PR (95% CI)	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2012-03/2015 PR (95% CI)
Delirium and encephalopathy (CC 48)	1.03 (1.02, 1.05)	1.05 (1.04, 1.07)	1.04 (1.03, 1.06)	1.04 (1.03, 1.05)
Dementia or other specified brain disorders (CC 49-50)	1.11 (1.10, 1.12)	1.11 (1.11, 1.12)	1.11 (1.10, 1.12)	1.11 (1.11, 1.12)
Major psychiatric disorders; personality disorders (CC 54-57)	1.09 (1.09, 1.10)	1.09 (1.08, 1.09)	1.09 (1.08, 1.10)	1.09 (1.09, 1.09)
Depression/anxiety (CC 58-59)	1.04 (1.04, 1.05)	1.04 (1.04, 1.04)	1.03 (1.03, 1.04)	1.04 (1.04, 1.04)
Other psychiatric disorders (CC 60)	1.02 (1.02, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.02)	1.02 (1.02, 1.02)
Mental retardation or developmental disability (CC 61-65)	1.33 (1.27, 1.39)	1.23 (1.18, 1.28)	1.28 (1.23, 1.34)	1.28 (1.25, 1.31)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.07 (1.06, 1.08)	1.06 (1.05, 1.07)	1.07 (1.06, 1.09)	1.07 (1.06, 1.07)
Polyneuropathy (CC 71)	1.04 (1.03, 1.04)	1.04 (1.04, 1.05)	1.05 (1.04, 1.05)	1.04 (1.04, 1.04)
Multiple sclerosis (CC 72)	1.12 (1.08, 1.15)	1.10 (1.07, 1.14)	1.13 (1.10, 1.16)	1.12 (1.10, 1.14)
Parkinson's and Huntington's disease (CC 73)	1.19 (1.18, 1.21)	1.17 (1.16, 1.19)	1.19 (1.17, 1.21)	1.19 (1.18, 1.20)
Seizure disorders and convulsions (CC 74)	1.06 (1.05, 1.07)	1.07 (1.06, 1.08)	1.08 (1.06, 1.09)	1.07 (1.06, 1.08)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	1.01 (1.01, 1.02)
Stroke (CC 95-96)	1.04 (1.03, 1.05)	1.03 (1.02, 1.04)	1.04 (1.03, 1.05)	1.04 (1.03, 1.04)
Vascular or circulatory disease (CC 104-106)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.05 (1.04, 1.05)	1.05 (1.04, 1.05)	1.05 (1.05, 1.06)	1.05 (1.05, 1.05)
Pleural effusion/pneumothorax (CC 114)	0.98 (0.96, 0.99)	0.98 (0.97, 0.99)	0.99 (0.98, 1.00)	0.98 (0.97, 0.99)
Other lung disorders (CC 115)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)
Legally blind (CC 116)	1.14 (1.11, 1.18)	1.12 (1.09, 1.16)	1.13 (1.09, 1.16)	1.13 (1.11, 1.15)
Dialysis status (CC 130)	1.40 (1.34, 1.46)	1.41 (1.35, 1.46)	1.40 (1.35, 1.46)	1.40 (1.37, 1.43)
Renal failure (CC 131)	1.05 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.03, 1.04)	1.04 (1.04, 1.05)
Incontinence (CC 134)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)
Urinary tract infection (CC 135)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.02 (1.01, 1.02)	1.01 (1.01, 1.01)
Other urinary tract disorders (CC 136)	1.01 (1.01, 1.02)	1.01 (1.01, 1.01)	1.01 (1.00, 1.01)	1.01 (1.01, 1.01)

Variable	04/2012-03/2013 PR (95% CI)	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2012-03/2015 PR (95% CI)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.09 (1.08, 1.10)	1.09 (1.08, 1.10)	1.09 (1.08, 1.10)	1.09 (1.08, 1.09)
Cellulitis, local skin infection (CC 152)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)
Other dermatological disorders (CC 153)	0.99 (0.98, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)
Trauma (CC 154-156, 158-161)	1.05 (1.04, 1.06)	1.06 (1.06, 1.07)	1.06 (1.05, 1.06)	1.06 (1.05, 1.06)
Vertebral fractures (CC 157)	1.03 (1.02, 1.05)	1.04 (1.03, 1.06)	1.04 (1.03, 1.06)	1.04 (1.03, 1.05)
Other injuries (CC 162)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)
Major symptoms, abnormalities (CC 166)	1.03 (1.03, 1.03)	1.04 (1.03, 1.04)	1.03 (1.03, 1.04)	1.03 (1.03, 1.04)
Minor symptoms, signs, findings (CC 167)	1.02 (1.02, 1.02)	1.02 (1.01, 1.02)	1.02 (1.02, 1.02)	1.02 (1.02, 1.02)

Table 4.5.4 THA/TKA Generalized Linear Model Performance Over Different Time Periods

Characteristic	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Predictive ability, % (lowest decile – highest decile)	0.99-1.01	0.98-1.01	0.99-1.01	0.99-1.01
Quasi-R ²	0.22	0.21	0.21	0.21

Table 4.5.5 Distribution of Hospital THA/TKA Admission Volumes Over Different Time Periods

Characteristic	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Number of hospitals	3,334	3,312	3,297	3,481
Mean number of admissions (SD)	86 (123)	91 (129)	91 (129)	255 (372)
Range (min. – max.)	1 – 2,903	1 – 2,876	1 – 2,856	1 – 8,635
25 th percentile	15	15	14	37
50 th percentile	45	47	46	124
75 th percentile	114	121	119	338

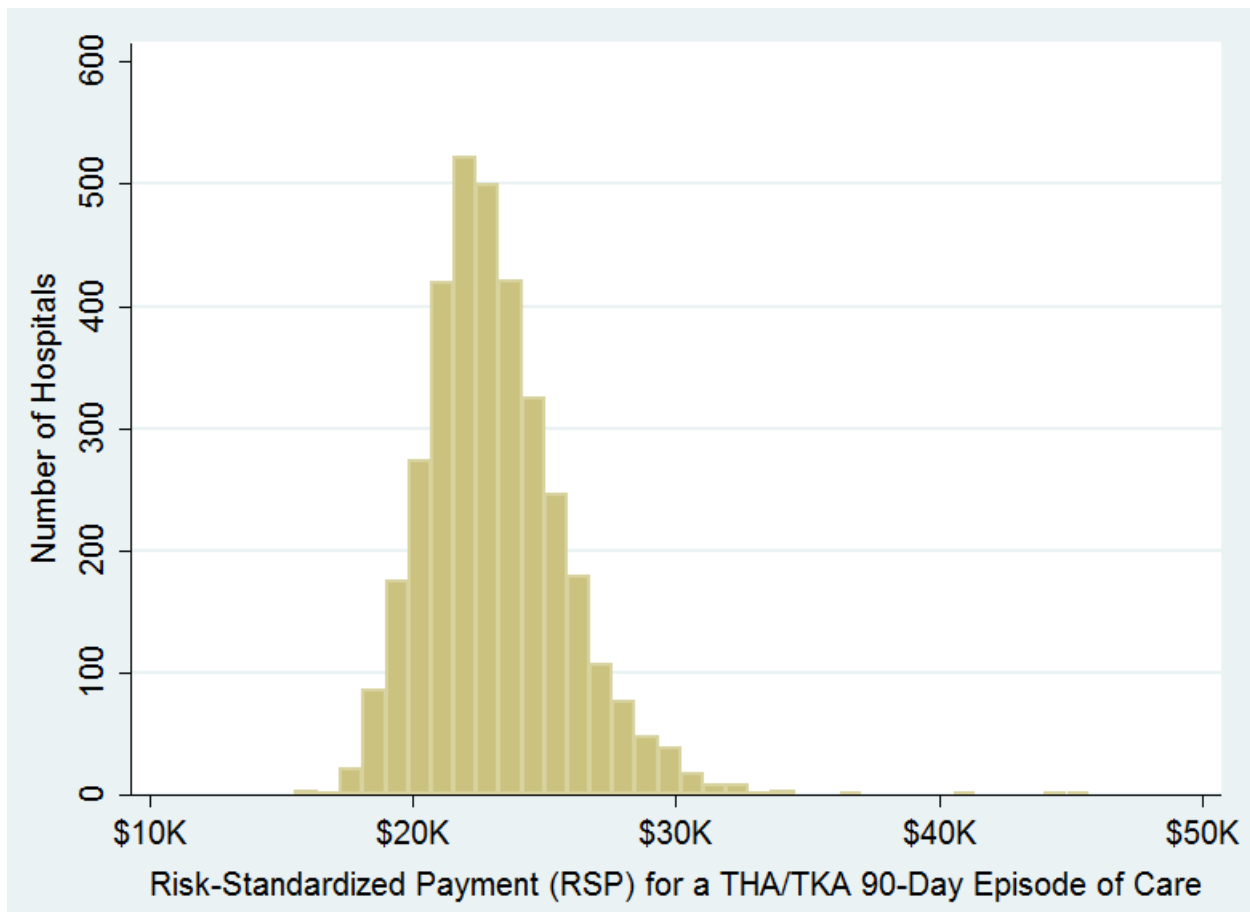
Table 4.5.6 Distribution of Hospital THA/TKA RSPs Over Different Time Periods (\$2014)

Characteristic	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Number of hospitals	3,334	3,312	3,297	3,481
Mean (SD)	23,825 (2,421)	23,104 (2,371)	22,449 (2,275)	23,146 (2,645)
Range (min. – max.)	16,280 – 42,212	16,803 – 45,927	14,646 – 46,713	15,522 – 45,741
25 th percentile	22,229	21,506	20,922	21,353
50 th percentile	23,607	22,912	22,260	22,844
75 th percentile	25,256	24,468	23,762	24,656

Table 4.5.7 Between-Hospital Variance for THA/TKA

	04/2012-03/2013	04/2013-03/2014	04/2014-03/2015	04/2012-03/2015
Between-hospital variance (SE)	0.014 (0.0005)	0.014 (0.0005)	0.013 (0.0005)	0.013 (0.0005)

Figure 4.5.2 Distribution of Hospital THA/TKA 90-Day Episode-of-Care RSPs between April 2012 and March 2015 (\$2014)



N= 3,481 hospitals

5. GLOSSARY

Case mix: The particular illness severity and age 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 diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system. CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Description of the Condition Categories can be found at http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf.

Confidence Interval (CI): A CI is a range of values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the PR associated with protein-calorie malnutrition noted as “1.09 – 1.15” would indicate that there is 95% confidence that the PR lies between 1.09 and 1.15.

Expected payment: The total payment expected on the basis of an average hospital for a specific hospital’s case mix.

Hierarchical model: A widely accepted statistical method that enables fair evaluation of relative hospital results by accounting for patient risk factors and the number of patients a hospital treats. This statistical model accounts for the structure of the data (patients clustered within hospitals) and calculates: (1) how much variation in hospital payment 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-specific effects.

Hospital-specific effect: A measure of the hospital effect on payment calculated through hierarchical generalized linear regression, taking into consideration how many patients were eligible for the cohort, these patients’ risk factors, and these patients’ total payments. The hospital-specific effect is the calculated random effect intercept for each hospital. The hospital-specific effect will be negative for a lower-than-average-payment hospital, positive for a higher-than-average-payment hospital, and close to zero for an average-payment hospital. The hospital-specific effect is used in the numerator to calculate “predicted” payment.

Index admission: Any admission included in the measure calculation as the initial admission for an episode of care for AMI, HF, pneumonia, or elective THA/TKA and evaluated for the outcome.

Interval estimate: Similar to a CI, the interval estimate is a range of probable values for the measure that characterizes the amount of associated uncertainty. For example, a 95% interval estimate for an RSP indicates that there is 95% statistical confidence that the true value of the RSP lies between the lower limit 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 measure.

National mean payment: Sum of payments among all included episodes divided by the number of episodes included in the measures.

Outcome: The result of a broad set of healthcare activities that affect patients' well-being. For the payment measures, the outcome is the sum of payments accrued during the episode of care.

Payment ratio (PR): A PR greater than one indicates that total payment for a patient with that particular risk factor is expected to be higher, on average, than for a patient without that risk factor, holding all other risk factors constant. A PR less than one indicates that total payment for a patient with that particular risk factor is expected to be lower, on average, than for a patient without that risk factor, holding all other risk factors constant.

Predicted payment: The total payment during the episode of care predicted based on the hospital's results with its observed case mix, also referred to as "adjusted actual" payment.

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

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7. APPENDICES

Appendix A. Statistical Approach to RSPs for AMI, HF, Pneumonia, and THA/TKA Measures

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

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

More specifically, we use a hierarchical generalized linear model to account for the natural clustering of observations within hospitals. The model employs a link and error distribution and a hospital-specific random effect, where the link function and error distribution chosen for each measure is based on the algorithm suggested by Manning & Mullahy and several model diagnostics.¹⁸ The AMI and THA/TKA RSPs were estimated using a log link and an inverse Gaussian distribution. The HF RSP was estimated using a log link and a Gamma distribution. The pneumonia RSP was estimated using an identity link and a Gamma distribution. A generic model is presented here:

$$h(Y_{ij}) = \alpha_i + \beta Z_{ij} \quad (1)$$

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

where i indexes hospitals, j indexes patients within hospitals, α_i represents the hospital-specific intercept, $Z_{ij} = (Z_{1ij}, Z_{2ij}, \dots, Z_{pij})$ 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.²² This model separates within-hospital variation from between-hospital variation. The hierarchical generalized linear models are estimated using the SAS software system (SAS 9.3 GLIMMIX procedure).

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, $\hat{\mu}$, $\{\alpha_i, \alpha_2, \dots, \alpha_{ij}\}$, $\hat{\beta}$, and $\hat{\tau}^2$. We calculate a standardized outcome measure, RSP_i , for each hospital by computing the ratio of the predicted payment to the expected payment, and multiplying by the national observed mean payment, \bar{Y} . Specifically, we calculate:

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

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

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

Again, i indexes hospitals, j indexes patients within hospitals, and n_i is the number of patients within hospital i . If the “predicted” payment is higher (or lower) than the “expected” payment for a given hospital, its \widehat{RSP}_i will be higher (or lower) than the national observed mean payment. For each hospital, we can compute an interval estimate of RSP_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 can be used to characterize and compare hospital results (for example, greater than expected, as expected, or less than expected). See [Figure A.1](#) for our overall analysis steps.

Creating Interval Estimates

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

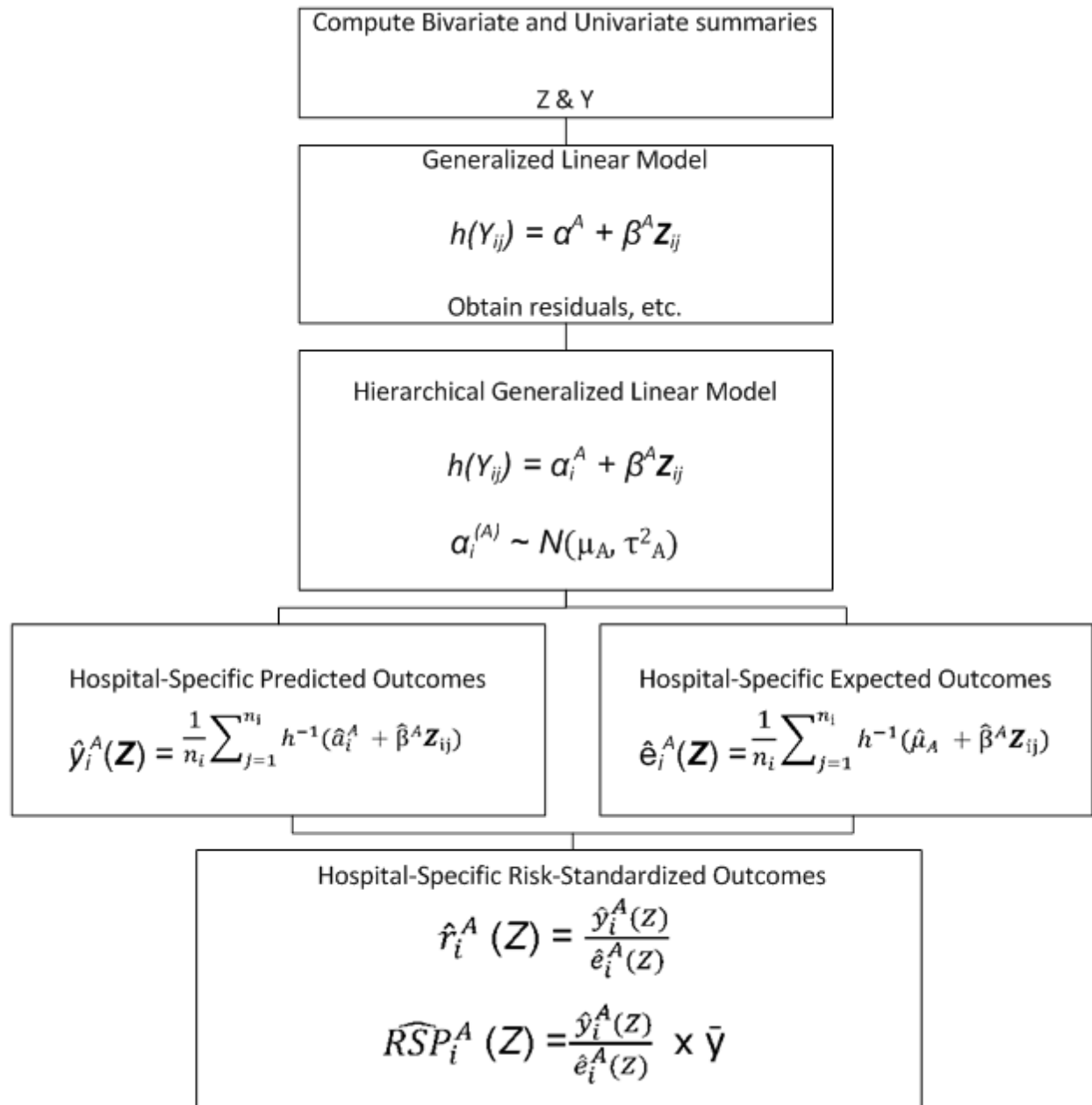
Algorithm:

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

1. Sample I hospitals with replacement.
2. Fit the hierarchical generalized linear model using all patients within each sampled hospital. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have I random effects to estimate the variance components. At the conclusion of Step 2, we have:
 - a. $\hat{\beta}^{(b)}$ (the estimated regression coefficients of the risk factors)
 - b. The parameters governing the random effects, hospital adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$
 - c. The set of hospital-specific intercepts and corresponding variances, $\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1, 2, \dots, I\}$
3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \widehat{var}(\hat{\alpha}_i^{(b)}))$ for the unique set of hospitals sampled in Step 1.
4. Within each unique hospital i sampled in Step 1, and for each patient j in that hospital, we calculate $\hat{y}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\widehat{RSP}_i(Z)^{(b)}$ 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).²³

Figure A.1 Analysis Steps



Appendix B. Data QA

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

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

Phase I

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

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

To assure accuracy in SAS pack coding, two analysts independently write SAS codes for any changes made in calculating the payment measures: data preparation, sample selection, hierarchical modeling, and calculation of RSPs. This process highlights any programming errors in syntax or logic. Once the parallel programming process is complete, the analysts cross-check their codes by analyzing datasets in parallel, checking for consistency of output, and reconciling any discrepancies.

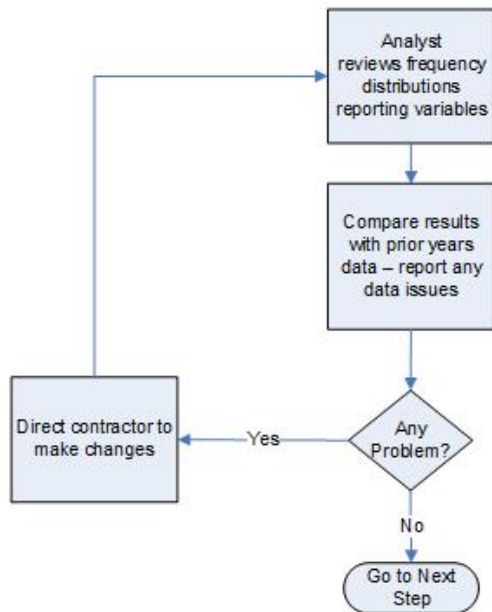
Phase II

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

This phase also compares prior years' risk-adjustment coefficients and variable frequencies, to enable us to check for potential inconsistencies in the data and the impact of any changes to the SAS pack.

Figure B.1 - CORE QA Phase I

Pre SAS Package Processing QA



SAS Package QA

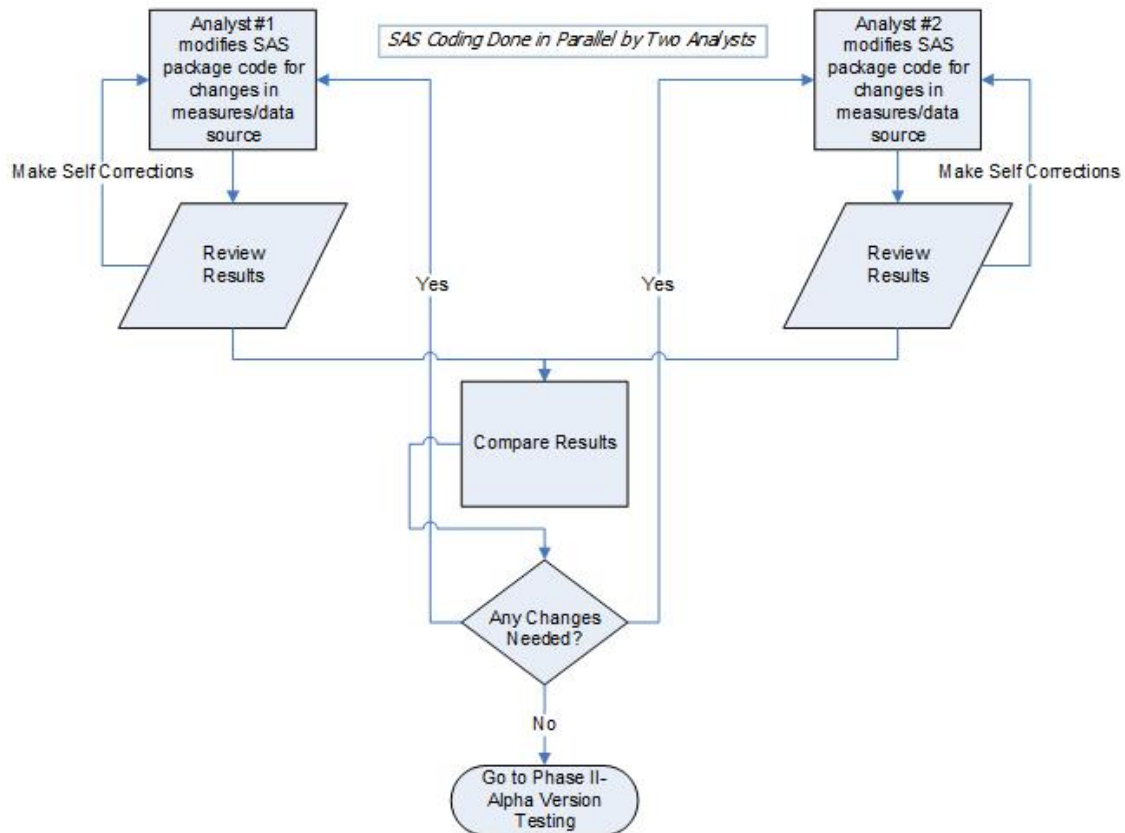
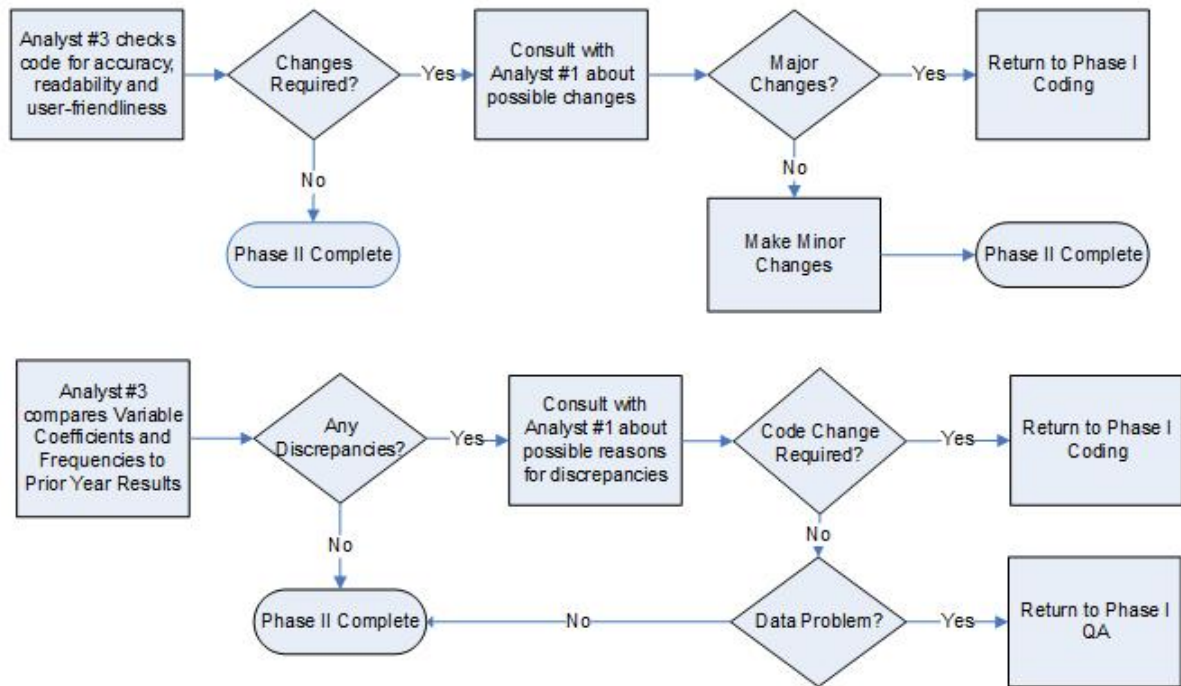


Figure B.2 - CORE QA Phase II

Results Testing – Alpha Version



Appendix C. Annual Updates

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

2016

2016 Measure Updates and Specifications Report Payment (AMI Version 5.0, HF Version 3.0, Pneumonia Version 3.0, THA/TKA Version 2.0)

1. Updated HF cohort to exclude patients with an LVAD implantation or heart transplantation during the index admission or in the 12 months prior to the index admission.
 - Rationale: The use of LVADs, in particular, has increased dramatically since the time of measure development. These patients represent a clinically distinct, highly-selected group for whom resource use in the post-discharge period is likely to be higher compared with patients who do not have these procedures. Additionally, this change was made to ensure that the HF mortality, readmission, and HF payment measure cohorts remain aligned.
2. Updated the calculation of THA/TKA payments in days 31-90 to include payments for hip/knee joint manipulations under anesthesia that occur in ambulatory surgical centers (ASCs) and outpatient hospital settings.
 - Rationale: The update to the THA/TKA measure to include joint manipulations in days 31 through 90 was recommended through stakeholder input and is clinically relevant as the TEP suggested that joint manipulation under anesthesia often takes place within 90 days of an elective primary THA/TKA and should be considered for inclusion in the measure.

2015

2015 Measure Updates and Specifications Report Payment (AMI Version 4.0, HF Version 2.0, Pneumonia Version 2.0)

1. Updated the price-standardized payment data source for the analytic input files to Medicare administrative claims data processed by the CMS Standardization Methodology for Allowed Amount.
 - Rationale: The use of the CMS Standardization Methodology for Allowed Amount harmonizes the payment calculation methodology across the broader suite of CMS cost and resource use measures and creates time efficiencies for the completion of the episode-of-care payment measures.
2. Updated the pneumonia payment model for calculating hospital RSPs to use an identity link function and Gamma distribution.
 - Rationale: This choice of link function and distribution was based on several model diagnostics and better prediction of the payment outcome at the extremes of the distribution.

2014

2014 Measure Updates and Specifications Report AMI Payment (Version 3.0)

1. Updated payment calculation to include a new technology add-on payment.
 - Rationale: New technology payments are meant to ensure that Medicare beneficiaries have access to new technologies that have not been accounted for by the DRG reimbursement rate.

2. Updated payment calculation to include a blood clotting add-on payment.
 - Rationale: Blood clotting add-on payments ensure that inpatient hospitals, inpatient rehabilitation facilities, and long-term care hospitals receive additional reimbursement for blood clotting factor for patients with hemophilia.
3. Updated the payment calculation to include Winsorization of outlier payments.
 - Rationale: Winsorization eliminates extreme values at the upper end of the total payment distribution to improve model prediction and mitigate the impact of possibly erroneous claims without attempting to make corrections or excluding patients.
4. Excluded patients with a missing DRG weight during the index admission if there was also no payment on the claim for the provider.
 - Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

2013

2013 Measure Updates and Specifications Report AMI Payment (Version 2.0)

1. Updated the inclusion and exclusion criteria to include Maryland and US territories hospitals.
 - Rationale: The original measure did not include AMI admissions from hospitals in Maryland or US Territories because CMS reimburses hospitals in Maryland and US Territories using a different mechanism than hospitals in the other 49 states and the District of Columbia. These hospitals are now included in the measure and treated as if they were paid under CMS's IPPS.
2. Updated the inclusion and exclusion criteria to exclude hospice patients.
 - Rationale: The original AMI payment measure did not exclude patients with any hospice assignment due to a desire to include the full breadth of AMI index admissions that met our criteria. This decision was not aligned with CMS's publicly reported 30-day AMI mortality measure. After discussion with our Technical Expert Panel, we decided to exclude patients with hospice enrollment within one year prior to or on the date of an index admission in order for the AMI payment and mortality measure cohorts to be aligned as closely as possible. Consistent with CMS's 30-day AMI mortality measure, we chose to retain patients with hospice assignments after the date of index admission because the hospice assignment may have been related to care received during the index AMI admission.

Appendix D. Measure Specifications

Appendix D.1 Hospital-Level RSP Associated with a 30-Day Episode of Care for AMI (NQF #2431)

Cohort

Inclusion Criteria for AMI Measure

1. Principal discharge diagnosis of AMI

Rationale: AMI is the condition targeted for measurement ([Table D.1.1](#)).

2. Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A and Part B 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. Additionally, Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure. Medicare Part B is required to ensure coverage across all care settings.

3. 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 they are considered to be too clinically distinct from Medicare patients 65 and over.

4. Not transferred from another acute care facility

Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for AMI Measure

1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility

Rationale: It is unlikely that these patients had clinically significant AMI.

2. Inconsistent or unknown patient vital status or other unreliable demographic (age and gender) 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.

3. Incomplete administrative data in the 30 days following the index admission if discharged alive

Rationale: This is necessary in order to identify the outcome (payments) in the sample over our analytic period.

4. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission

Rationale: This exclusion is made in order to harmonize with the AMI mortality measure. These patients are likely continuing to seek comfort measures only, so payment may reflect patient preferences rather than hospital practice patterns.

5. Discharged against medical advice (AMA)

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

6. Transferred to a federal hospital

Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

7. Not matched to admission in the AMI mortality measure

Rationale: As part of the current data processing, we match our index AMI admissions to the AMI mortality cohort to obtain the risk-adjustment variables. Patients are excluded if they cannot be matched between the AMI payment and AMI mortality cohorts.

8. Missing index DRG weight where provider received no payment

Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

After exclusions #1-8 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that year are excluded. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning payments for the same claims to two admissions.

Table D.1.1 ICD-9-CM Codes for Inclusion in AMI Cohort

ICD-9-CM Diagnosis Codes	Description
410.00	Acute myocardial infarction of anterolateral wall, episode of care unspecified
410.01	Acute myocardial infarction of anterolateral wall, initial episode of care
410.10	Acute myocardial infarction of other anterior wall, episode of care unspecified
410.11	Acute myocardial infarction of other anterior wall, initial episode of care
410.20	Acute myocardial infarction of inferolateral wall, episode of care unspecified
410.21	Acute myocardial infarction of inferolateral wall, initial episode of care
410.30	Acute myocardial infarction of inferoposterior wall, episode of care unspecified
410.31	Acute myocardial infarction of inferoposterior wall, initial episode of care
410.40	Acute myocardial infarction of other inferior wall, episode of care unspecified
410.41	Acute myocardial infarction of other inferior wall, initial episode of care
410.50	Acute myocardial infarction of other lateral wall, episode of care unspecified
410.51	Acute myocardial infarction of other lateral wall, initial episode of care
410.60	True posterior wall infarction, episode of care unspecified
410.61	True posterior wall infarction, initial episode of care
410.70	Subendocardial infarction, episode of care unspecified
410.71	Subendocardial infarction, initial episode of care
410.80	Acute myocardial infarction of other specified sites, episode of care unspecified
410.81	Acute myocardial infarction of other specified sites, initial episode of care
410.90	Acute myocardial infarction of unspecified site, episode of care unspecified

ICD-9-CM Diagnosis Codes	Description
410.91	Acute myocardial infarction of unspecified site, initial episode of care

Risk Adjustment

Table D.1.2 Risk Variables for AMI Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by “X”)
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
Age (>=85)	n/a	
History of Percutaneous Transluminal Coronary Angioplasty (PTCA)	ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07	
History of Coronary Artery Bypass Graft (CABG) surgery	ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10–36.16	
Metastatic cancer, acute leukemia and other severe cancers	CC 7 Metastatic cancer or acute leukemia	
	CC 8 Lung, upper digestive tract, and other severe cancers	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Other significant endocrine and metabolic disorders	CC 22 Other significant endocrine and metabolic disorders	
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Osteoporosis and other bone/cartilage disorders	CC 41 Osteoporosis and other bone/cartilage disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Delirium and encephalopathy	CC 48 Delirium and encephalopathy	X
Dementia	CC 49 Dementia	
Drug/alcohol psychosis	CC 51 Drug/alcohol psychosis	
Drug/alcohol abuse/dependence	CC 52 Drug/alcohol dependence	
	CC 53 Drug/alcohol abuse, without dependence	
Severe mental illness	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
Reactive and unspecified psychosis	CC 56 Reactive and unspecified psychosis	
Depression/anxiety	CC 58 Depression	
	CC 59 Anxiety disorders	
Congestive heart failure	CC 80 Congestive heart failure	X
Angina pectoris/old myocardial infarction	CC 83 Angina pectoris/old myocardial infarction	
Heart infection/inflammation, except rheumatic	CC 85 Heart infection/ inflammation, except rheumatic	
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	
Congenital cardiac/circulatory defects	CC 87 Major congenital cardiac/circulatory defect	
	CC 88 Other congenital heart/circulatory disease	
Hypertension and hypertension complications	CC 89 Hypertensive heart and renal disease or encephalopathy	
	CC 90 Hypertensive heart disease	
	CC 91 Hypertension	
Precerebral arterial occlusion and transient cerebral ischemia	CC 97 Precerebral arterial occlusion and transient cerebral ischemia	X
Vascular disease and complications	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
Other lung disorders	CC 115 Other lung disorders	
Legally blind	CC 116 Legally blind	
Dialysis status	CC 130 Dialysis status	X
Internal injuries	CC 160 Internal injuries	

Outcome

Outcome Criteria for AMI Measure

Total payments associated with an episode of care for AMI

Rationale: The goal is to sum all payments made for Medicare patients, including index admission and post-discharge payments for readmission or other post-discharge inpatient care, SNFs, outpatient providers, home health agencies, hospice care, physician/clinical laboratory/ambulance

services, supplier Part B items, and durable medical equipment, prosthetics/orthotics, and supplies. The 30-day time frame is a meaningful period for decisions made at the admitting hospital to affect hospitalization payments and payments for care in the immediate post-discharge period. The 30-day timeframe also aligns with CMS's risk-standardized AMI mortality measure.

Appendix D.2 Hospital-Level RSP Associated with a 30-Day Episode of Care for HF (NQF #2436)

Cohort

Inclusion Criteria for HF Measure

1. Principal discharge diagnosis of HF

Rationale: HF is the condition targeted for measurement ([Table D.2.1](#)).

2. Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A and Part B 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. Additionally, Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure. Medicare Part B is required to ensure coverage across all care settings.

3. 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 they are considered to be too clinically distinct from Medicare patients 65 and over.

4. Not transferred from another acute care facility

Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for HF Measure

1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility

Rationale: It is unlikely that these patients had clinically significant HF.

2. Inconsistent or unknown patient vital status, or other unreliable demographic (age and gender) 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.

3. Incomplete administrative data in the 30 days following the index admission if discharged alive

Rationale: This is necessary in order to identify the outcome (payments) in the sample over our analytic period.

4. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission

Rationale: This exclusion is made in order to harmonize with the HF mortality measure. These patients are likely continuing to seek comfort measures only, so payment may reflect patient preferences rather than hospital practice patterns.

5. Discharged against medical advice (AMA)

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

6. Transferred to a federal hospital

Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

7. Not matched to admission in the HF mortality measure

Rationale: As part of the current data processing, we match our index HF admissions to the HF mortality cohort to obtain the risk-adjustment variables. Patients are excluded if they cannot be matched between the HF payment and HF mortality cohorts.

8. Missing index DRG weight where provider received no payment

Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive

9. With a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission

Rationale: These patients represent a clinically distinct, highly-selected group ([Table D.2.2](#)).

After exclusions #1-9 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that year are excluded. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning payments for the same claims to two admissions.

Table D.2.1 ICD-9-CM Codes for Inclusion in HF Cohort

ICD-9-CM Diagnosis Codes	Description
402.01	Malignant hypertensive heart disease with heart failure
402.11	Benign hypertensive heart disease with heart failure
402.91	Unspecified hypertensive heart disease with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure

ICD-9-CM Diagnosis Codes	Description
428.22	Chronic systolic heart failure
428.23	Acute or chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.32	Chronic diastolic heart failure
428.33	Acute or chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.42	Chronic combined systolic and diastolic heart failure
428.43	Acute or chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified

Table D.2.2 ICD-9-CM LVAD and Heart Transplant Codes Which Exclude an Admission from HF Cohort

ICD-9-CM Procedure Codes	Description
33.6	Combined heart-lung transplantation
37.51	Heart transplantation
37.60	Implantation or insertion of biventricular external heart assist system
37.62	Insertion of temporary non-implantable extracorporeal circulatory assist device
37.65	Implant of single ventricular (extracorporeal) external heart assist system
37.66	Insertion of implantable heart assist system
37.68	Insertion of percutaneous external heart assist device

Risk Adjustment

Table D.2.3 Risk Variables for HF Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
Age (>=85)	n/a	
Severe infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
Other infectious diseases	CC 6 Other infectious diseases	X
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Other significant endocrine and metabolic disorders	CC 22 Other significant endocrine and metabolic disorders	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Bone/joint/muscle infections/necrosis	CC 37 Bone/joint/muscle infections/necrosis	
Other musculoskeletal and connective tissue disorders	CC 43 Other musculoskeletal and connective tissue disorders	
Delirium and encephalopathy	CC 48 Delirium and encephalopathy	X
Dementia or other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Severe mental illness	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
Other psychiatric disorders	CC 60 Other psychiatric disorders	
Respiratory arrest/cardiorespiratory failure/respirator dependence	CC 77 Respirator dependence/tracheostomy status	X
	CC 78 Respiratory arrest	X
	CC 79 Cardio-respiratory failure and shock	X
Angina pectoris/old myocardial infarction	CC 83 Angina pectoris/old myocardial infarction	
Heart infection/inflammation, except rheumatic	CC 85 Heart infection/inflammation, except rheumatic	
Major congenital cardiac/circulatory defect	CC 87 Major congenital cardiac/circulatory defect	
Hypertension	CC 91 Hypertension	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified	CC 97 Precerebral arterial occlusion and transient cerebral ischemia	X
	CC 98 Cerebral atherosclerosis and aneurysm	
	CC 99 Cerebrovascular disease, unspecified	
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Other ear, nose, throat, and mouth disorders	CC 127 Other ear, nose, throat, and mouth disorders	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Decubitus ulcer of skin	CC 148 Decubitus ulcer of skin	X
Chronic ulcer of skin, except decubitus	CC 149 Chronic ulcer of skin, except decubitus	
Cellulitis, local skin infection	CC 152 Cellulitis, local skin infection	X
Hip fracture/dislocation	CC 158 Hip fracture/dislocation	X
Internal injuries	CC 160 Internal injuries	

Outcome

Outcome Criteria for HF Measure

Total payments associated with an episode of care for HF

Rationale: The goal is to sum all payments made for Medicare patients, including index admission and post-discharge payments for readmission or other post-discharge inpatient care, SNFs, outpatient providers, home health agencies, hospice care, physician/clinical laboratory/ambulance services, supplier Part B items, and durable medical equipment, prosthetics/orthotics, and supplies. The 30-day time frame is a meaningful period for decisions made at the admitting hospital to affect hospitalization payments and payments for care in the immediate post-discharge period. The 30-day timeframe also aligns with CMS's risk-standardized HF mortality measure.

Appendix D.3 Hospital-Level RSP Associated with a 30-Day Episode of Care for Pneumonia (NQF #2579)

Cohort

Inclusion Criteria for Pneumonia Measure

1. Principal discharge diagnosis of pneumonia

Rationale: Pneumonia is the condition targeted for measurement (Table D.3.1).

2. Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A and Part B 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. Additionally, Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure. Medicare Part B is required to ensure coverage across all care settings.

3. 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 they are considered to be too clinically distinct from Medicare patients 65 and over.

4. Not transferred from another acute care facility

Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for Pneumonia Measure

1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility

Rationale: It is unlikely that these patients had clinically significant pneumonia.

2. Inconsistent or unknown patient vital status, or other unreliable demographic (age and gender) 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.

3. Incomplete administrative data in the 30 days following the index admission if discharged alive

Rationale: This is necessary in order to identify the outcome (payments) in the sample over our analytic period.

4. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission

Rationale: This exclusion is made in order to harmonize with the pneumonia mortality measure. These patients are likely continuing to seek comfort measures only, so payment may reflect patient preferences rather than hospital practice patterns.

5. Discharged against medical advice (AMA)

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

6. Transferred to a federal hospital

Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

7. Not matched to admission in the pneumonia mortality measure

Rationale: As part of the current data processing, we match our index pneumonia admissions to the pneumonia mortality cohort to obtain the risk-adjustment variables. Patients are excluded if they cannot be matched between the pneumonia payment and pneumonia mortality cohorts.

8. Missing index DRG weight where provider received no payment

Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

After exclusions #1-8 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that year are excluded. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning payments for the same claims to two admissions.

Table D.3.1 ICD-9-CM Codes for Inclusion in Pneumonia Cohort

ICD-9-CM Diagnosis Codes	Description
480.0	Pneumonia due to adenovirus
480.1	Pneumonia due to respiratory syncytial virus
480.2	Pneumonia due to parainfluenza virus
480.3	Pneumonia due to SARS-associated coronavirus
480.8	Pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia, unspecified
481	Pneumococcal pneumonia (Streptococcus pneumoniae pneumonia)
482.0	Pneumonia due to Klebsiella pneumoniae
482.1	Pneumonia due to Pseudomonas
482.2	Pneumonia due to Hemophilus influenzae (H. influenzae)
482.30	Pneumonia due to Streptococcus, unspecified
482.31	Pneumonia due to Streptococcus, group A
482.32	Pneumonia due to Streptococcus, group B
482.39	Pneumonia due to other Streptococcus
482.40	Pneumonia due to Staphylococcus, unspecified
482.41	Methicillin susceptible pneumonia due to Staphylococcus aureus
482.42	Methicillin resistant pneumonia due to Staphylococcus aureus
482.49	Other Staphylococcus pneumonia
482.81	Pneumonia due to anaerobes
482.82	Pneumonia due to escherichia coli (E. coli)

ICD-9-CM Diagnosis Codes	Description
482.83	Pneumonia due to other gram-negative bacteria
482.84	Pneumonia due to Legionnaires' disease
482.89	Pneumonia due to other specified bacteria
482.9	Bacterial pneumonia, unspecified
483.0	Pneumonia due to mycoplasma pneumoniae
483.1	Pneumonia due to chlamydia
483.8	Pneumonia due to other specified organism
485	Bronchopneumonia, organism unspecified
486	Pneumonia, organism unspecified
487.0	Influenza with pneumonia
488.11	Influenza due to identified 2009 H1N1 influenza virus with pneumonia

Risk Adjustment

Table D.3.2 Risk Variables for Pneumonia Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
Age (>=85)	n/a	
Severe infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
Other infectious diseases	CC 6 Other infectious diseases	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Lung, upper digestive tract, and other severe cancers	CC 8 Lung, upper digestive tract, and other severe cancers	
Lymphatic, head and neck, brain, and other major cancers	CC 9 Lymphatic, head and neck, brain, and other major cancers	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Other significant endocrine and metabolic disorders	CC 22 Other significant endocrine and metabolic disorders	
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Bone/joint/muscle infections/necrosis	CC 37 Bone/joint/muscle infections/necrosis	
Osteoporosis and other bone/cartilage disorders	CC 41 Osteoporosis and other bone/cartilage disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Delirium and encephalopathy	CC 48 Delirium and encephalopathy	X
Dementia or other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Drug/alcohol psychosis or dependence	CC 51 Drug/alcohol psychosis	
	CC 52 Drug/alcohol dependence	
Drug/alcohol abuse, without dependence	CC 53 Drug/alcohol abuse, without dependence	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Hemiplegia, paraplegia, paralysis, spinal cord disorder and amputation	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	
	CC 177 Amputation status, lower limb/amputation complications	
	CC 178 Amputation status, upper limb	
Muscular dystrophy and/or polyneuropathy	CC 70 Muscular dystrophy	
	CC 71 Polyneuropathy	
Multiple sclerosis and Parkinson's	CC 72 Multiple sclerosis	
	CC 73 Parkinson's or Huntington's disease	
Coma, brain compression/anoxic damage	CC 75 Coma, brain compression/anoxic damage	X

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Respiratory arrest/cardiorespiratory failure/respirator dependence	CC 77 Respirator dependence/tracheostomy status	X
	CC 78 Respiratory arrest	X
	CC 79 Cardio-respiratory failure and shock	X
Congestive heart failure	CC 80 Congestive heart failure	X
Angina pectoris/old myocardial infarction	CC 83 Angina pectoris/old myocardial infarction	
Heart infection/inflammation, except rheumatic	CC 85 Heart infection/inflammation, except rheumatic	
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	
Hypertension	CC 91 Hypertension	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Fibrosis of lung or other chronic lung disorders	CC 109 Fibrosis of lung or other chronic lung disorders	
Asthma	CC 110 Asthma	
Aspiration and specified bacterial pneumonias	CC 111 Aspiration and specified bacterial pneumonias	X
Pleural effusion/pneumothorax	CC 114 Pleural effusion/pneumothorax	X
Other ear, nose, throat, and mouth disorders	CC 127 Other ear, nose, throat, and mouth disorders	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	
Head injury	CC 154 Severe head injury	X
	CC 155 Major head injury	X
	CC 156 Concussion or unspecified head injury	X
Vertebral fractures	CC 157 Vertebral fractures	
Hip fracture/dislocation	CC 158 Hip fracture/dislocation	X
Major fracture, except of skull, vertebrae, or hip	CC 159 Major fracture, except of skull, vertebrae, or hip	X
Internal injuries	CC 160 Internal injuries	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Major symptoms, abnormalities	CC 166 Major symptoms, abnormalities	

Outcome

Total payments associated with an episode of care for pneumonia

Rationale: The goal is to sum all payments made for Medicare patients, including index admission and post-discharge payments for readmission or other post-discharge inpatient care, SNFs, outpatient providers, home health agencies, hospice care, physician/clinical laboratory/ambulance services, supplier Part B items, and durable medical equipment, prosthetics/orthotics, and supplies. The 30-day time frame is a meaningful period for decisions made at the admitting hospital to affect hospitalization payments and payments for care in the immediate post-discharge period. The 30-day timeframe also aligns with CMS's risk-standardized pneumonia mortality measure.

Appendix D.4 Hospital-Level RSP Associated with a 90-Day Episode of Care for Elective Primary THA and/or TKA

Cohort

Inclusion Criteria for THA/TKA Measure

1. Having a qualifying elective primary THA/TKA procedure during the index admission:

Rationale: Elective primary THA or TKA is the procedure targeted for measurement ([Table D.4.1](#)).

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

- **Femur, hip, or pelvic fractures coded in the principal or secondary discharge diagnosis fields of the index admission**
Rationale: Patients with fractures have higher mortality, complication, and readmission rates and the procedures are not elective ([Table D.4.2](#)).
- **A concurrent partial hip arthroplasty procedure**
Rationale: Partial arthroplasty procedures are primarily done for hip fractures and are typically performed on patients who are older, frailer, and have more comorbid conditions ([Table D.4.3](#)). Partial knee arthroplasty procedures are not distinguished by ICD-9-CM codes and are therefore currently captured by the THA/TKA payment measure.
- **A concurrent revision procedure**
Rationale: Revision procedures may be performed at a disproportionately small number of hospitals and are associated with higher mortality, complication, and readmission rates ([Table D.4.4](#)).
- **A concurrent resurfacing procedure**
Rationale: Resurfacing procedures are a different type of procedure involving only the joint's articular surface. Resurfacing procedures are typically performed on younger, healthier patients ([Table D.4.5](#)).
- **Mechanical complication coded in the principal discharge diagnosis field of the index admission**
Rationale: A complication coded as the principal discharge diagnosis suggests the procedure was more likely the result of a previous procedure. These patients may require more technically complex arthroplasty procedures and may be at increased risk for complications, particularly mechanical complications, and readmission ([Table D.4.6](#)).
- **Malignant neoplasm of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or a disseminated malignant neoplasm coded in the principal discharge diagnosis field**
Rationale: Patients with these malignant neoplasms are at increased risk for complications and readmission, and the procedure may not be elective ([Table D.4.7](#)).
- **Removal of implanted devices/prostheses**
Rationale: Elective procedures performed in these patients may be more complicated ([Table D.4.8](#)).
- **Transfer from another acute care facility for the THA/TKA**
Rationale: The THA/TKA complication measure does not include admissions for patients transferred in to the index hospital, as they likely do not represent elective THA/TKA procedures.

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

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. Additionally, Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure. Medicare Part B is required to ensure coverage across all care settings.

3. 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 they are considered to be too clinically distinct from Medicare patients 65 and over.

4. Not transferred from another acute care facility

Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for THA/TKA Measure

1. Discharged against medical advice (AMA)

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

2. Incomplete administrative data in the 90 days following the index admission if discharged alive.

Rationale: This is necessary in order to identify the outcome (payments) in the sample over our analytic period.

3. Transferred to a federal hospital

Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

4. With more than two THA/TKA procedure codes during the index admission

Rationale: Although clinically possible, it is highly unlikely that patients would receive more than two elective THA/TKA procedures in one hospitalization, which may reflect a coding error.

5. Not matched to admission in the THA/TKA complication measure

Rationale: As part of the current data processing, we match our index THA/TKA admissions to the THA/TKA complication cohort to obtain the risk-adjustment variables. Patients are excluded if they cannot be matched between the THA/TKA payment and THA/TKA complication cohorts.

6. Missing index DRG weight where provider received no payment

Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

After exclusions #1-6 are applied, the measure randomly selects one hospitalization per patient per year for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that year are excluded. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (March and April-June of each year) and both are randomly selected for inclusion in the measure, the measure includes only the March admission. April-June admissions within the 90-day outcome

window of the March admission are excluded to avoid assigning payments for the same claims to two admissions.

Table D.4.1 ICD-9-CM Codes for Inclusion in THA/TKA Cohort

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

Table D.4.2 ICD-9-CM Codes for Fractures that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

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

ICD-9-CM Diagnosis Codes	Description
820.10	Open fracture of intracapsular section of neck of femur, unspecified
820.11	Open fracture of epiphysis (separation) (upper) of neck of femur
820.12	Open fracture of midcervical section of neck of femur
820.13	Open fracture of base of neck of femur
820.19	Other open transcervical fracture of neck of femur
820.20	Closed fracture of trochanteric section of neck of femur
820.21	Closed fracture of intertrochanteric section of neck of femur
820.22	Closed fracture of subtrochanteric section of neck of femur
820.30	Open fracture of trochanteric section of neck of femur, unspecified
820.31	Open fracture of intertrochanteric section of neck of femur
820.32	Open fracture of subtrochanteric section of neck of femur
820.8	Closed fracture of unspecified part of neck of femur
820.9	Open fracture of unspecified part of neck of femur
821.00	Closed fracture of unspecified part of femur
821.01	Closed fracture of shaft of femur
821.10	Open fracture of unspecified part of femur
821.11	Open fracture of shaft of femur
821.20	Closed fracture of lower end of femur, unspecified part
821.21	Closed fracture of condyle, femoral
821.22	Closed fracture of epiphysis, lower (separation) of femur
821.23	Closed supracondylar fracture of femur
821.29	Other closed fracture of lower end of femur
821.30	Open fracture of lower end of femur, unspecified part
821.31	Open fracture of condyle, femoral
821.32	Open fracture of epiphysis, lower (separation) of femur
821.33	Open supracondylar fracture of femur
821.39	Other open fracture of lower end of femur

Table D.4.3 ICD-9-CM Codes for Partial Hip Replacement that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

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

Table D.4.4 ICD-9-CM Codes for THA and TKA Revisions that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Procedure Codes	Description
81.53	Revision of hip replacement, not otherwise specified
81.55	Revision of knee replacement, not otherwise specified
81.59	Revision of joint replacement of lower extremity, not elsewhere classified
00.70	Revision of hip replacement, both acetabular and femoral components

ICD-9-CM Procedure Codes	Description
00.71	Revision of hip replacement, acetabular component
00.72	Revision of hip replacement, femoral component
00.73	Revision of hip replacement, acetabular liner and/or femoral head only
00.80	Replacement of knee replacement, total (all components)
00.81	Replacement of knee replacement, tibial component
00.82	Revision of knee replacement, femoral component
00.83	Revision of knee replacement, patellar component
00.84	Revision of total knee replacement, tibial insert (liner)

Table D.4.5 ICD-9-CM Codes for Resurfacing Procedures that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

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

Table D.4.6 ICD-9-CM Codes for Mechanical Complications that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

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

Table D.4.7 ICD-9-CM Codes for Malignant Neoplasms that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

ICD-9-CM Diagnosis Codes	Description
170.6	Malignant neoplasm of pelvic bones, sacrum, and coccyx
170.7	Malignant neoplasm of long bones of lower limb
170.9	Malignant neoplasm of bone and articular cartilage, site unspecified
195.3	Malignant neoplasm of pelvis

ICD-9-CM Diagnosis Codes	Description
195.5	Malignant neoplasm of lower limb
198.5	Secondary malignant neoplasm of bone and bone marrow
199.0	Disseminated malignant neoplasm without specification of site

Table D.4.8 ICD-9-CM Codes for Removal of Devices/Prosthesis that Disqualify an Admission From Inclusion in the THA/TKA Final Cohort

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

Risk Adjustment

Table D.4.9 Risk Variables for THA/TKA Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	N/A	
Male	N/A	
Index admissions with an elective THA procedure	ICD-9 procedure code 81.51	
Procedure type (bilateral joint replacement)	N/A	
Procedure type (staged joint replacements)	N/A	
Procedure type (single joint replacement)	N/A	
Morbid obesity	ICD-9 diagnosis code 278.01	
History of infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
	CC 6 Other infectious diseases	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Cancer	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Benign neoplasms of skin, breast, eye	CC 14 Benign neoplasms of skin, breast, eye	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Other significant endocrine and metabolic disorders	CC 22 Other significant endocrine and metabolic disorders	
Obesity/disorders of thyroid, cholesterol, lipids	CC 24 (Other endocrine/metabolic/nutritional disorders), excluding ICD-9 diagnosis code 278.01	
Appendicitis	CC 35 Appendicitis	
Bone/joint/muscle infections/necrosis	CC 37 Bone/joint/muscle infections/necrosis	
Rheumatoid arthritis and inflammatory connective tissue disease	CC 38 Rheumatoid arthritis and inflammatory connective tissue disease	
Disorders of the vertebrae and spinal discs	CC 39 Disorders of the vertebrae and spinal discs	
Osteoarthritis of hip or knee	CC 40 Osteoarthritis of hip or knee	
Other musculoskeletal and connective tissue disorders	CC 43 Other musculoskeletal and connective tissue disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Coagulation defects and other specified hematological disorders	CC 46 Coagulation defects and other specified hematological disorders	X
Delirium and encephalopathy	CC 48 Delirium and encephalopathy	X
	CC 49 Dementia	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Dementia or other specified brain disorders	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Major psychiatric disorders; personality disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
	CC 57 Personality disorders	
Depression/anxiety	CC 58 Depression	
	CC 59 Anxiety disorders	
Other psychiatric disorders	CC 60 Other psychiatric disorders	
Mental retardation or developmental disability	CC 61 Profound mental retardation/developmental disability	
	CC 62 Severe mental retardation/developmental disability	
	CC 63 Moderate mental retardation/developmental disability	
	CC 64 Mild/unspecified mental retardation/developmental disability	
	CC 65 Other developmental disability	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	
	CC 178 Amputation status, upper limb	
Polyneuropathy	CC 71 Polyneuropathy	
Multiple sclerosis	CC 72 Multiple sclerosis	
Parkinson's and Huntington's disease	CC 73 Parkinson's and Huntington's disease	
Seizure disorders and convulsions	CC 74 Seizure disorders and convulsions	
Congestive heart failure	CC 80 Congestive heart failure	X
Acute coronary syndrome	CC 81 Acute myocardial infarction	X
	CC 82 Other acute/subacute forms of ischemic heart disease	X
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Hypertension and hypertension complications	CC 89 Hypertensive heart and renal disease or encephalopathy	
	CC 90 Hypertensive heart disease	
	CC 91 Hypertension	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Pleural effusion/pneumothorax	CC 114 Pleural effusion/pneumothorax	X
Other lung disorders	CC 115 Other lung disorders	
Legally blind	CC 116 Legally blind	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Incontinence	CC 134 Incontinence	
Urinary tract infection	CC 135 Urinary tract infection	X
Other urinary tract disorders	CC 136 Other urinary tract disorders	
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	
Cellulitis, local skin infection	CC 152 Cellulitis, local skin infection	X
Other dermatological disorders	CC 153 Other dermatological disorders	
Trauma	CC 154 Severe head injury	X
	CC 155 Major head injury	X
	CC 156 Concussion or unspecified head injury	X
	CC 158 Hip fracture/dislocation	X
	CC 159 Major fracture, except of skull, vertebrae, or hip	X
	CC 160 Internal injuries	
	CC 161 Traumatic amputation	
Vertebral fractures	CC 157 Vertebral fractures	
Other injuries	CC 162 Other injuries	
Major symptoms, abnormalities	CC 166 Major symptoms, abnormalities	
Minor symptoms, signs, findings	CC 167 Minor symptoms, signs, findings	

Outcome

Outcome Criteria for THA/TKA Measure

Total payments associated with an episode of care for THA/TKA

Rationale: The goal is to sum all payments made for Medicare patients, including index admission and post-discharge payments for readmission or other post-discharge inpatient care, SNFs, outpatient providers, home health agencies, hospice care, physician/clinical laboratory/ambulance services, supplier Part B items, and durable medical equipment, prosthetics/orthotics, and supplies. The 90-day time frame is a meaningful period for decisions made at the admitting hospital to affect not only hospitalization payments, but also payments for the ongoing post-discharge care the THA/TKA procedures require. The 90-day time frame also aligns with CMS's risk-standardized THA/TKA complication measure.

The measurement includes all payments for the first 30 days after admission and only THA/TKA-related claims for days 31-90. We have defined THA/TKA-related payments as any claims, including physician claims, for the following care settings or services:

- Durable Medical Equipment
- Inpatient rehabilitation
- Outpatient rehabilitation
- Skilled Nursing Facilities (SNFs)
- Home health
- Outpatient hospital (joint manipulation procedures under anesthesia) ([Table D.4.10](#))
- Ambulatory Surgery Centers (joint manipulation procedures under anesthesia) ([Table D.4.10](#))
- Staged or repeat admission for single-site surgeries within 90 days of index admission
- Readmissions for complications as defined in the CMS THA/TKA Complication measure (wound/joint infection or mechanical complication) ([Table D.4.11](#))

Table D.4.10 Common Procedural Terminology (CPT) Codes Defining Joint Manipulation Under Anesthesia Procedures

CPT Code	Description
27275	Manipulation, hip joint, requiring general anesthesia
27570	Manipulation of knee joint under general anesthesia (includes application of traction or other fixation devices)

Table D.4.11 ICD-9-CM Codes Defining Complications in CMS's THA/TKA Complication Measure

Complication	ICD-9 Codes Defining Complication
Mechanical Complications	<p>996.4 Mechanical complication of internal orthopedic device implant and graft</p> <p>996.40 Unspecified mechanical complication of internal orthopedic device, implant, and graft</p> <p>996.41 Mechanical loosening of prosthetic joint</p> <p>996.42 Dislocation of prosthetic joint</p> <p>996.44 Peri-prosthetic fracture around prosthetic joint</p> <p>996.47 Other mechanical complication of prosthetic joint implant</p> <p>996.49 Other mechanical complication of other internal orthopedic device, implant, and graft</p>
Peri-prosthetic Joint Infection/Wound Infection	<p>998.6 Persistent postoperative fistula not elsewhere classified</p> <p>998.83 Non-healing surgical wound</p> <p>998.3 Disruption of wound</p> <p>998.30 Disruption of wound, unspecified</p> <p>998.31 Disruption of internal operation (surgical) wound</p> <p>998.32 Disruption of external operation (surgical) wound</p> <p>998.33 Disruption of traumatic wound repair</p> <p>998.5 Postoperative infection not elsewhere classified</p> <p>998.51 Infected postoperative seroma</p> <p>998.59 Other postoperative infection</p> <p>996.67 Infection and inflammatory reaction due to other internal orthopedic device implant and graft</p> <p>996.66 Infection and inflammatory reaction due to internal joint prosthesis</p> <p>One of the above codes AND at least one of the following procedure codes:</p> <p>86.22 Excisional debridement of wound, infection, or burn</p> <p>86.28 Non-excisional debridement of wound, infection, or burn</p> <p>86.04 Other incision with drainage of skin and subcutaneous tissue</p> <p>81.53 Revise Hip Replacement, NOS</p> <p>81.55 Revision of Knee replacement, NOS</p> <p>81.59 Revision of joint replacement of lower extremity, not elsewhere classified</p> <p>00.70 REV Hip Repl-acetab/fem</p> <p>00.71 REV Hip Repl-acetab comp</p> <p>00.72 REV Hip Repl-fem comp</p> <p>00.73 REV Hip Repl-liner/head</p> <p>00.80 Replacement of femoral, tibial, and patellar components (all components)</p> <p>00.81 Replacement of tibial baseplate and tibial insert (liner)</p> <p>00.82 Revision of knee replacement, femoral component</p> <p>00.83 Revision of knee replacement, patellar component</p> <p>00.84 Revision of total knee replacement, tibial insert (liner)</p>

Complication	ICD-9 Codes Defining Complication
	80.05 Arthrotomy for removal of prosthesis, hip 80.06 Arthrotomy for removal of prosthesis, knee 80.09 Arthrotomy for removal of prosthesis, other unspecified sites 78.65 Removal of implanted devices for femur 78.66 Removal of implanted devices from bone; patella 78.67 Removal of implanted devices from bone; tibia and fibula