

# **2017 Measure Updates and Specifications Report Hospital-Level Risk-Standardized Payment Measures**

**Acute Myocardial Infarction – Version 6.0**

**Heart Failure – Version 4.0**

**Pneumonia – Version 4.0**

**Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty  
(TKA) – Version 3.0**

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## 1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) payment measures used in the Hospital Inpatient Quality Reporting program and publicly reported on [Hospital Compare](#). The measures report hospital-level risk-standardized payments (RSPs) associated with a 30-day episode of care for acute myocardial infarction (AMI), heart failure (HF), and pneumonia, and RSPs associated with a 90-day episode of care for an elective primary total hip arthroplasty (THA) and/or total knee arthroplasty (TKA) procedure. This report serves as a single source of information about these measures for a wide range of readers. Reports describing other [outcome](#) measures can be found on [QualityNet](#).

This report provides an overview of the measures methodology, methodology updates for 2017 public reporting, and the national results for 2017 public reporting. 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](#) – 2017 measure updates**
- **[Section 4](#) – 2017 measure results**
- **[Section 5](#) – Glossary**

The Appendices contain detailed measure information, consisting of:

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

The original measure methodology reports and prior updates and specifications reports are available in the '[Measure Methodology](#)' and '[Archived Resources](#)' sections under the claims-based payment measures page of [QualityNet](#).<sup>1-4</sup>

The AMI payment measure methodology is also described in the peer-reviewed medical literature.<sup>5</sup>

## 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 2017, CMS will begin publicly reporting the hospital 90-day payment measure for elective primary THA/TKA. Note that hospitals received THA/TKA payment results in the hospital-specific reports distributed in 2016.

The HF, pneumonia, and THA/TKA payment measures include non-federal short-term acute care hospitals and critical access hospitals, consistent with the AMI payment measure.

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 (YNHHSC/CORE) to update the AMI, HF, pneumonia, and THA/TKA payment measures for 2017 public reporting through a process of measure reevaluation. Measures are reevaluated annually in order to improve them by responding to stakeholder input and incorporating advances in science or changes in coding.

### 2.2 Overview of Measure Methodology

The 2017 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.<sup>1-4,6-9</sup> 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;
  - The pneumonia measure cohort also includes admissions with a principal discharge diagnosis of sepsis (not including severe sepsis) that have a



secondary discharge diagnosis of pneumonia coded as present on admission (POA) and no secondary diagnosis of severe sepsis coded as POA

- 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:

- Fracture of the pelvis or lower limbs coded in the principal or secondary discharge diagnosis fields of the index admission;
- A concurrent partial hip arthroplasty procedure;
- A concurrent revision, resurfacing, or implanted device/prosthesis removal procedure;
- Mechanical complication coded in the principal discharge diagnosis field; or,
- 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.

The International Classification of Diseases, 10th Revision (ICD-10) codes used to define the cohort inclusions for each measure for discharges on or after October 1, 2015 are listed in Appendix D, in Table D.1.1, Table D.2.1, Table D.3.1, and Table D.4.1, for AMI, HF, pneumonia, and THA/TKA, respectively. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted on QualityNet, with the exception of pneumonia (The complete list of The International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] codes that includes the pneumonia expanded cohort can be found in the 2016 condition-specific mortality measures updates and specifications report posted on QualityNet).

The ICD-10 codes for discharges on or after October 1, 2015 that are used to identify a THA/TKA procedure as non-elective or non-primary and disqualify the admission from cohort inclusion are posted on QualityNet due to volume. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted on QualityNet.

#### Index Admissions Excluded from the Measures

The payment measures exclude index admissions for patients:

- Discharged against medical advice;
- 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 start of 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 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 group. The International Classification of Diseases, 10th Revision, Procedure Coding System (ICD-10-PCS) codes used to identify LVAD and heart transplant procedures for discharges on or after October 1, 2015 are posted on [QualityNet](#) due to volume. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report also posted on [QualityNet](#).

An additional exclusion criterion for the THA/TKA cohort is that patients with more than two THA/TKA procedure codes during the index admission 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.

For the AMI, HF, and pneumonia measures, where index admissions occur during the transition between two years within the measurement period (that is, June/July 2014 or June/July 2015), and both are randomly selected for inclusion in a measure, the measures include only the June admission. July admissions within the 30-day outcome window of the June admission are excluded to avoid assigning payments for the same claims to two admissions.

Similarly, for the THA/TKA measure, where index admissions occur during the transition between two years within the measurement period (that is, March and April-June 2014 or March and April-June 2015), and both are randomly selected for inclusion in the measure, the measure includes only the March admission. April admissions, May admissions, and 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.

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.

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

The measures consider multiple contiguous hospitalizations as a single acute episode of care. Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. To qualify as a transfer, the second inpatient admission must occur on the same day or the next calendar day following discharge from the first inpatient admission at a different short-term acute care hospital. Cases that meet this criterion are considered transfers regardless of whether or not the first institution indicates intent to transfer the patient in the discharge disposition code.

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 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.<sup>10,11</sup>

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.<sup>12</sup> 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.<sup>13</sup> 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 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 the start of the 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.<sup>14</sup>

The THA/TKA measure assess payments within a 90-day period from the start of the index admission. Specifically, the measure includes all payments made for Medicare patients from the start of the index 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 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.

In assessing payments within the 30-day/90-day period, the measures use the claim "FROM" date, which is the date the index admission started (that is, the date the patient first received care at that hospital within three days of the admission). Thus, in the case where a patient began their index admission with an ED visit, observation stay, or care received in another outpatient location within the same facility, the case was converted to inpatient admission by that hospital within three days of that outpatient encounter, and the care is combined into one claim, the date the outpatient care started would be used to begin assessing payments for the 30-day/90-day time frame.

Note that although admissions that occur during the transition between two years within the measurement period are excluded as index admissions in certain cases (as

described in Section [2.2.1](#)), these admissions would be included in the payment outcome.

### 2.2.3 Risk-Adjustment Variables

In order to account for differences in case 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. As part of the NQF's endorsement process for these measures, we completed analyses for the two-year Sociodemographic Trial Period. Although bivariate analyses found that the average total payments is higher for dual-eligible patients (for patients living in lower AHRQ SES Index census block groups) and African-American patients compared with all other patients, analyses in the context of a multivariable model demonstrated that the effect size of these variables was small, and that the quasi-R<sup>2</sup> values for the models are similar with and without the addition of these variables.

Refer to [Table D.1.2](#), [Table D.2.2](#), [Table D.3.2](#), and [Table D.4.2](#) 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 they occur only during the index admission, for AMI, HF, pneumonia, and THA/TKA, respectively. The Condition Categories (CCs) outlined in these tables are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015. The ICD-10 code lists referenced in the tables that are used to identify certain risk variables (for example, history of PTCA) in discharges on or after October 1, 2015 are posted on [QualityNet](#) due to volume. For a list of ICD-9 codes used to identify these variables in discharges prior to October 1, 2015, please refer to the 2016 payment measures updates and specifications report posted on [QualityNet](#).

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

## 2.2.4 Data Sources

The data sources for these analyses include Medicare administrative claims and enrollment information for patients with hospitalizations between July 1, 2013 and June 30, 2016 for AMI, HF, and pneumonia and between April 1, 2013 and March 31, 2016 for THA/TKA. The period for public reporting of the THA/TKA measure differs from the AMI, HF, and pneumonia measures due to the longer period of outcome assessment time frame. This also aligns with the 90-day THA/TKA complication measure. Medicare administrative claims 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.5 report for the Medicare Spending per Beneficiary Measure on [\*QualityNet\*](#).<sup>13</sup> The CMS Standardization Methodology for Allowed Amount for 2006 through 2016 was applied to the claims to calculate the measures.

Refer to the original methodology reports for further descriptions of these data sources and an explanation of the three-year measurement period.<sup>1-4</sup>

## 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.<sup>15</sup> 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 RSPs are estimated as follows:

- AMI and THA/TKA: Use a log link and inverse Gaussian distribution
- HF: Uses a log link and Gamma distribution
- Pneumonia: Uses 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.<sup>16</sup>

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.<sup>15</sup> 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, while 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.2.2](#), [Table D.3.2](#), and [Table D.4.2](#) 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 calculate a predicted value. The "expected" episode-of-care payment (the denominator) is obtained in the same manner except a common effect using all hospitals in our sample is added in place of the hospital-specific effect. The results are summed over all patients attributed to a hospital to calculate 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.

Multiplying the predicted over expected ratio by the national mean payment transforms the ratio into a payment amount that can be compared to the national mean payment. The hierarchical generalized linear regression models are described fully in [Appendix A](#) and in the original methodology reports.<sup>1-4</sup>

## **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 publicly 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 2017 PUBLIC REPORTING

#### 3.1 Rationale for Measure Updates

Annual 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. 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 2017 public reporting, we made the following modifications to the measures:

- Updated the pneumonia measure specifications:
  - Expanded the cohort to include admissions for aspiration pneumonia as well as sepsis admissions (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA.
  - Updated the risk variable list in response to the cohort expansion.
- Revised the measure specifications to accommodate the implementation of ICD-10 coding:
  - Identified the ICD-10 codes used to define each of the measure cohorts for discharges on or after October 1, 2015.
  - Identified the ICD-10 codes used to define wound/joint infections and mechanical complications for discharges on or after October 1, 2015 (used in assessing THA/TKA payments).
  - Re-specified the risk models, updating the CC-based risk variables to the ICD-10-compatible Hierarchical Condition Categories (HCC) system version 22 and applying ICD-10 codes for certain risk variables (for example, history of PTCA) to the models.

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

- Evaluated and validated model performance for the three years combined (For AMI, HF, and pneumonia: July 2013-June 2016; for THA/TKA: April 2013-March 2016);
- Evaluated the stability of the risk-adjustment model over the three-year measurement period by examining the model variable frequencies, model coefficients, and the performance of the risk-adjustment model in each year (For AMI, HF, and pneumonia: July 2013-June 2014, July 2014-June 2015, and July 2015-June 2016; For THA/TKA: April 2013-March 2014, April 2014-March 2015, April 2015-March 2016); and,
- Updated the measures' SAS analytic package (SAS pack) and documentation.

#### 3.2 Detailed Discussion of Measure Updates

##### 3.2.1 Updates to Pneumonia Measure

###### Expansion of Pneumonia Cohort

The pneumonia cohort was expanded to include:

- Admissions with aspiration pneumonia as a principal discharge diagnosis; and,

- Admissions with sepsis (not including severe sepsis) as a principal discharge diagnosis that have a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA.

#### Rationale for Pneumonia Cohort Expansion

This expansion of the cohort allows the measure to capture a broader population of patients admitted for pneumonia and a more consistent clinical cohort across hospitals. Additionally, it aligns the pneumonia payment cohort with the current pneumonia mortality and readmission measure cohorts.

#### Effect of Pneumonia Cohort Expansion on Measure

To determine the impact of expanding the cohort, we conducted analyses of Medicare FFS hospitalizations between July 2011 and June 2014 using the national pneumonia payment measure cohort data. The cohort expansion adds a large number of admissions to the measure. The change in the observed mean national 30-day payments lead to a 12.7% overall increase in RSP, reflecting the inclusion of potentially “sicker” patients with the cohort expansion. Lastly, cohort expansion resulted in an increase in the number of hospitals considered outliers as well as changes in the outlier status classification of hospitals. Risk-adjustment variables were adjusted accordingly.

For more information on the rationale for the cohort expansion or the history behind the change, or for details on the changes to the risk-adjustment variables as a result of the expanded cohort or details on the data and analyses supporting the re-specified cohort, refer to the 2016 Reevaluation and Re-Specification Report of the Hospital-Level 30-Day Risk-Standardized Pneumonia Payment, zip file “AMI, HF, and PN Payment Updates”, posted to the CMS website in March 2016.<sup>13</sup>

### **3.2.2 Updates to ICD-10-Based Measure Specifications**

#### Measure Re-specification

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

- We expanded the cohort definitions to include ICD-10 codes for use with discharges on or after October 1, 2015. (Previously-specified ICD-9 codes continue to be used for discharges before October 1, 2015.)
- We expanded the definitions of the wound/joint infections and mechanical complications used in assessing THA/TKA payments to include ICD-10 codes for use with discharges on or after October 1, 2015. (Previously-specified ICD-9 codes continue to be used for discharges before October 1, 2015.)
- We re-specified the risk models:
  - The CC-based risk variables were updated to the ICD-10-compatible Hierarchical Condition Categories (HCC) system version 22, maintained by RTI International; and,

- Certain risk variables (for example, history of PTCA) previously defined using ICD-9 codes were re-defined using ICD-10 codes, for use with inpatient, outpatient, and/or physician Medicare administrative claims on or after October 1, 2015.

#### Rationale for Measure Re-specification

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

The payment measures use diagnosis and procedure codes on Medicare FFS claims to define the measure cohorts, capture the variables for risk adjustment, and, in the case of the THA/TKA measure, identify THA/TKA-related readmissions due to complications. In public reporting years prior to 2017, the measures exclusively used ICD-9 codes from claims. However, the measurement period for 2017 public reporting requires data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification of the above components was warranted to accommodate ICD-10 coding.

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

#### The ICD-10 Transition Process

In developing the ICD-10 code lists that define the cohorts for the measures, we created cohort crosswalks using the General Equivalence Mappings (GEMs), a tool created by CMS and the Centers for Disease Control and Prevention (CDC) to assist with the conversion of ICD-9 codes to ICD-10 codes. To validate the cohort crosswalks, we compared cohort sizes using ICD-10 codes in a set of claims submitted between October 2015 and March 2016 with cohort sizes using previously-defined ICD-9 codes in a set of claims submitted between October 2014 and March 2015. We conducted clinical review to identify those codes appropriate for cohort definition. Development of the ICD-10 code lists that define the complications used in assessing THA/TKA payments followed this same process.

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

- Experts examined the ICD-9 code-based HCC version 12 and version 22 maps and reviewed shifts that occurred (where an ICD-9 code had moved from one CC to another). Based on these examinations, they recommended new risk variables using version 22 CCs.
- Following re-specification of the risk variables using the HCC version 22 map, we ran risk-adjustment models on several outcome measures, including the AMI payment measure, to ensure testing of all variables where shifts in the ICD-9 codes included in the CCs had occurred.

- For each tested measure, we used the same claims dataset to calculate and compare two separate sets of measure results using two separate risk-adjustment models: One set using the previously-specified version 12 risk variables, and the other using the newly-specified version 22 risk variables. For this analysis we used the ICD-9-coded data from the 2016 measurement period.
  - We compared the frequencies and model coefficients of the two sets of risk-adjustment variables, to ensure that they were similar.
  - We compared the performance of each risk-adjustment model by calculating each model's quasi-R<sup>2</sup> and predictive ability.
  - We examined the correlation in the risk-standardized payments produced by the two risk-adjustment models, to ensure that they produced similar measure results.
  - We examined the degree to which the models produced similar risk-standardized payments at the hospital level by assessing whether individual hospitals' risk-standardized payments fell into the same quintile in the distribution of risk-standardized payments calculated by each of the two models.
  - Based on the results of these analyses, we made minor modifications to the re-specified risk-adjustment variables to ensure that the performance of the risk-adjustment model was as similar as possible to the performance of the previously-specified model, and that the hospital-level results were as similar as possible.

The updated measure specifications can be found in [Appendix D](#).

### 3.3 Changes to SAS Pack

We revised the measure calculation SAS packs to reflect the re-specification done to accommodate the implementation of ICD-10 coding and the changes to the pneumonia cohort definition. The new SAS packs and documentation are available upon request by emailing [cmsepisodepaymentmeasures@yale.edu](mailto: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 packs describe 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 packs available to be completely transparent regarding the measure calculation methodology. However, note that even with the SAS packs, 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 2017 PUBLIC REPORTING

### 4.1 Assessment of Updated Models

The payment measures estimate hospital-specific episode-of-care RSPs using hierarchical generalized linear models. Refer to [Section 2](#) for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and technical reports for further details.<sup>1-4,9 6,7</sup>

We evaluated the performance of the AMI, HF, and pneumonia models and the THA/TKA model using the July 2013 to June 2016 and April 2013 to March 2016 data, respectively, for the 2017 reporting period. We examined the differences in the frequencies of patient risk factors and the model variable coefficients. Before evaluation, all payments were inflation-adjusted to 2015 dollars (designated with “\$2015” in the Section 4 tables and figures below).

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- $R^2$ .

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.<sup>17</sup> 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 2017 Model Results**

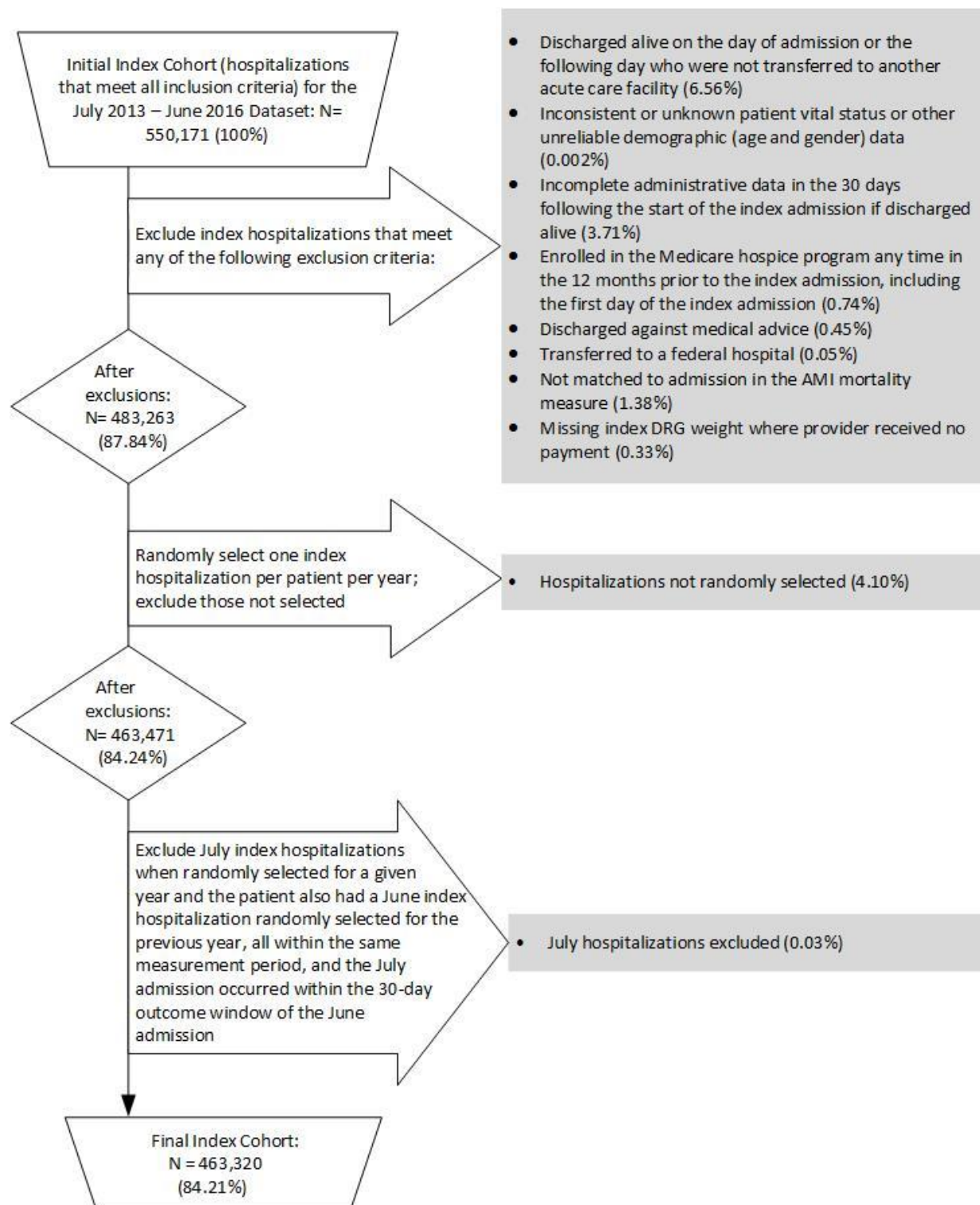
### **4.2.1 Index Cohort Exclusions**

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of AMI admissions that met each exclusion criterion in the July 2013-June 2016 dataset is presented in [Figure 4.2.1](#).

Admissions may have been counted in more than one exclusion category because 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 2013-June 2016 Dataset**





#### 4.2.2 Frequency of AMI Model Variables

We examined the change in the frequencies of clinical and demographic variables. Frequencies of model variables were stable over the measurement period. There were no notable changes (greater than 2% absolute change) in the frequencies.

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

#### 4.2.3 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<sup>2</sup> for the AMI 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<sup>2</sup> is in line with R<sup>2</sup>s from other patient-level risk-adjustment models for healthcare payment.<sup>18</sup>

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<sup>2</sup> and predictive ratios remained similar to the model used for 2016 public reporting ([Table 4.2.4](#)).

#### 4.2.4 Distribution of Hospital Volumes and Payments for AMI

Between July 2013-June 2014 and July 2015-June 2016, the national mean payment increased from \$23,001 to \$23,146 (\$2015).

[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 increased slightly over the three-year period, from \$23,025 (between July 2013 and June 2014) to \$23,165 (between July 2015 and June 2016). The median hospital RSP in the combined three-year dataset was \$23,030 (Interquartile Range [IQR]: \$22,429 - \$23,770). [Table 4.2.7](#) shows the between-hospital variance by individual year, as well as for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.008 (Standard Error [SE]: 0.0003). 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 three-year dataset. The expected 30-day RSP if a patient is 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 SD below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.<sup>15</sup>



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

Of 4,265 hospitals in the study cohort, 209 had a payment “Greater than the National Payment,” 1,923 had a payment “No Different than the National Payment,” and 196 had a payment “Less than the National Payment.” 1,937 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	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Total N	153,368	154,474	155,478	463,320
Age (>=85)	26.4	26.4	25.1	26.0
Age (65 – 74)	36.8	37.5	38.7	37.7
Age (75 – 84)	36.7	36.1	36.2	36.4
History of coronary artery bypass graft (CABG) surgery	11.5	11.8	13.5	12.3
History of percutaneous transluminal coronary angioplasty (PTCA)	16.3	17.5	17.9	17.2
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	4.0	4.0	4.1	4.1
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	47.3	47.4	47.6	47.4
Protein-calorie malnutrition (CC 21)	6.1	6.2	6.1	6.1
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	87.0	87.5	88.2	87.6
Other significant endocrine and metabolic disorders (CC 23)	7.7	7.8	8.0	7.8
Other gastrointestinal disorders (CC 38)	54.5	55.1	55.6	55.1
Osteoporosis and other bone/cartilage disorders (CC 43)	16.2	16.1	15.9	16.1
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	46.8	46.7	45.9	46.5
Delirium and encephalopathy (CC 50)	4.6	4.7	5.1	4.8
Dementia (CC 51-52)	17.2	16.8	16.1	16.7
Drug/alcohol psychosis (CC 54)	1.0	1.1	0.6	0.9
Drug/alcohol abuse/dependence (CC 55-56)	16.5	17.0	17.1	16.8
Severe mental illness (CC 57-58)	4.9	4.9	5.2	5.0
Reactive and unspecified psychosis (CC 59)	3.5	3.6	2.3	3.1
Depression/anxiety (CC 61-62)	16.7	17.2	17.6	17.2
Congestive heart failure (CC 85)	28.7	28.4	28.3	28.5
Coronary atherosclerosis or angina (CC 88-89)	85.2	85.2	83.3	84.6
Heart infection/inflammation, except rheumatic (CC 90)	1.9	2.0	2.1	2.0
Valvular and rheumatic heart disease (CC 91)	31.3	31.9	31.9	31.7
Congenital cardiac/circulatory defects (CC 92-93)	1.0	1.0	1.1	1.0
Hypertension and hypertensive disease (CC 94-95)	84.5	84.8	85.4	84.9
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	15.3	14.9	14.7	15.0
Vascular disease and complications (CC 106-108)	27.2	27.0	27.0	27.0
Other respiratory disorders (CC 118)	31.5	31.7	32.6	31.9

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Legally blind (CC 119)	1.1	1.1	1.0	1.1
Dialysis status (CC 134)	3.4	3.5	3.6	3.5
Internal injuries (CC 172)	1.0	0.9	0.8	0.9

**Table 4.2.2 – Hierarchical Generalized Linear Regression Model Variable Coefficients for AMI over Different Time Periods**

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Intercept	9.711	9.713	9.714	9.714
Age (>=85) (reference group)	--	--	--	--
Age (65 – 74)	0.174	0.175	0.171	0.175
Age (75 – 84)	0.168	0.157	0.165	0.164
History of coronary artery bypass graft (CABG) surgery	-0.222	-0.219	-0.207	-0.215
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.086	-0.093	-0.087	-0.088
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	-0.074	-0.068	-0.066	-0.070
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	0.084	0.068	0.079	0.076
Protein-calorie malnutrition (CC 21)	0.198	0.183	0.169	0.184
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	-0.037	-0.020	-0.015	-0.023
Other significant endocrine and metabolic disorders (CC 23)	0.032	0.024	0.014	0.024
Other gastrointestinal disorders (CC 38)	-0.031	-0.024	-0.028	-0.027
Osteoporosis and other bone/cartilage disorders (CC 43)	-0.032	-0.047	-0.053	-0.044
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.198	0.200	0.212	0.201
Delirium and encephalopathy (CC 50)	-0.026	-0.050	-0.056	-0.045
Dementia (CC 51-52)	-0.072	-0.070	-0.071	-0.072
Drug/alcohol psychosis (CC 54)	0.119	0.126	0.104	0.115
Drug/alcohol abuse/dependence (CC 55-56)	0.023	0.011	0.016	0.017
Severe mental illness (CC 57-58)	0.015	0.008	0.005	0.007
Reactive and unspecified psychosis (CC 59)	0.005	0.007	-0.026	-0.003
Depression/anxiety (CC 61-62)	-0.027	-0.027	-0.030	-0.027
Congestive heart failure (CC 85)	-0.060	-0.057	-0.061	-0.060
Coronary atherosclerosis or angina (CC 88-89)	0.159	0.164	0.149	0.155
Heart infection/inflammation, except rheumatic (CC 90)	0.180	0.196	0.189	0.188
Valvular and rheumatic heart disease (CC 91)	0.075	0.068	0.072	0.071
Congenital cardiac/circulatory defects (CC 92-93)	0.095	0.092	0.090	0.093
Hypertension and hypertensive disease (CC 94-95)	-0.033	-0.033	-0.025	-0.031
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	0.003	0.011	0.015	0.009
Vascular disease and complications (CC 106-108)	-0.006	-0.007	-0.005	-0.007
Other respiratory disorders (CC 118)	0.052	0.051	0.051	0.052
Legally blind (CC 119)	-0.035	-0.034	-0.003	-0.025
Dialysis status (CC 134)	0.135	0.119	0.120	0.121
Internal injuries (CC 172)	0.156	0.115	0.100	0.123

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

Variable	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2015-06/2016 PR (95% CI)	07/2013-06/2016 PR (95% CI)
Age (>=85) (reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
Age (65 – 74)	1.19 (1.18, 1.20)	1.19 (1.18, 1.20)	1.19 (1.18, 1.20)	1.19 (1.18, 1.20)
Age (75 – 84)	1.18 (1.17, 1.19)	1.17 (1.16, 1.18)	1.18 (1.17, 1.19)	1.18 (1.17, 1.18)
History of coronary artery bypass graft (CABG) surgery	0.80 (0.79, 0.81)	0.80 (0.79, 0.81)	0.81 (0.80, 0.82)	0.81 (0.80, 0.81)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.92 (0.91, 0.93)	0.91 (0.90, 0.92)	0.92 (0.91, 0.93)	0.92 (0.91, 0.92)
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	0.93 (0.91, 0.95)	0.93 (0.92, 0.95)	0.94 (0.92, 0.95)	0.93 (0.92, 0.94)
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	1.09 (1.08, 1.10)	1.07 (1.06, 1.08)	1.08 (1.07, 1.09)	1.08 (1.07, 1.08)
Protein-calorie malnutrition (CC 21)	1.22 (1.20, 1.24)	1.20 (1.18, 1.22)	1.18 (1.16, 1.20)	1.20 (1.19, 1.21)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	0.96 (0.95, 0.97)	0.98 (0.97, 0.99)	0.99 (0.97, 1.00)	0.98 (0.97, 0.98)
Other significant endocrine and metabolic disorders (CC 23)	1.03 (1.02, 1.05)	1.02 (1.01, 1.04)	1.01 (1.00, 1.03)	1.02 (1.01, 1.03)
Other gastrointestinal disorders (CC 38)	0.97 (0.96, 0.98)	0.98 (0.97, 0.98)	0.97 (0.97, 0.98)	0.97 (0.97, 0.98)
Osteoporosis and other bone/cartilage disorders (CC 43)	0.97 (0.96, 0.98)	0.95 (0.94, 0.96)	0.95 (0.94, 0.96)	0.96 (0.95, 0.96)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.22 (1.21, 1.23)	1.22 (1.21, 1.23)	1.24 (1.23, 1.25)	1.22 (1.22, 1.23)
Delirium and encephalopathy (CC 50)	0.97 (0.96, 0.99)	0.95 (0.93, 0.97)	0.95 (0.93, 0.96)	0.96 (0.95, 0.97)
Dementia (CC 51-52)	0.93 (0.92, 0.94)	0.93 (0.92, 0.94)	0.93 (0.92, 0.94)	0.93 (0.92, 0.94)
Drug/alcohol psychosis (CC 54)	1.13 (1.08, 1.17)	1.13 (1.09, 1.18)	1.11 (1.06, 1.17)	1.12 (1.10, 1.15)
Drug/alcohol abuse/dependence (CC 55-56)	1.02 (1.01, 1.03)	1.01 (1.00, 1.02)	1.02 (1.01, 1.03)	1.02 (1.01, 1.02)
Severe mental illness (CC 57-58)	1.02 (1.00, 1.03)	1.01 (0.99, 1.03)	1.00 (0.99, 1.02)	1.01 (1.00, 1.02)
Reactive and unspecified psychosis (CC 59)	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	0.97 (0.95, 1.00)	1.00 (0.99, 1.01)
Depression/anxiety (CC 61-62)	0.97 (0.96, 0.98)	0.97 (0.96, 0.98)	0.97 (0.96, 0.98)	0.97 (0.97, 0.98)
Congestive heart failure (CC 85)	0.94 (0.93, 0.95)	0.95 (0.94, 0.95)	0.94 (0.93, 0.95)	0.94 (0.94, 0.95)
Coronary atherosclerosis or angina (CC 88-89)	1.17 (1.16, 1.18)	1.18 (1.17, 1.19)	1.16(1.15, 1.17)	1.17 (1.16, 1.17)
Heart infection/inflammation, except rheumatic (CC 90)	1.20 (1.16, 1.23)	1.22 (1.18, 1.25)	1.21 (1.18, 1.24)	1.21 (1.19, 1.23)
Valvular and rheumatic heart disease (CC 91)	1.08 (1.07, 1.09)	1.07 (1.06, 1.08)	1.07 (1.07, 1.08)	1.07 (1.07, 1.08)
Congenital cardiac/circulatory defects (CC 92-93)	1.10 (1.06, 1.14)	1.10 (1.06, 1.14)	1.09 (1.05, 1.14)	1.10 (1.07, 1.12)
Hypertension and hypertensive disease (CC 94-95)	0.97 (0.96, 0.98)	0.97 (0.96, 0.98)	0.97 (0.96, 0.99)	0.97 (0.96, 0.98)
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	1.00 (0.99, 1.01)	1.01 (1.00, 1.02)	1.02 (1.00, 1.03)	1.01 (1.00, 1.02)

Variable	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2015-06/2016 PR (95% CI)	07/2013-06/2016 PR (95% CI)
Vascular disease and complications (CC 106-108)	0.99 (0.99, 1.00)	0.99 (0.98, 1.00)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)
Other respiratory disorders (CC 118)	1.05 (1.05, 1.06)	1.05 (1.04, 1.06)	1.05 (1.04, 1.06)	1.05 (1.05, 1.06)
Legally blind (CC 119)	0.97 (0.93, 1.00)	0.97 (0.93, 1.00)	1.00 (0.96, 1.03)	0.98 (0.96, 1.00)
Dialysis status (CC 134)	1.14 (1.11, 1.18)	1.13 (1.10, 1.16)	1.13 (1.10, 1.16)	1.13 (1.11, 1.15)
Internal injuries (CC 172)	1.17 (1.12, 1.22)	1.12 (1.08, 1.17)	1.10 (1.06, 1.15)	1.13 (1.10, 1.16)

**Table 4.2.4 – AMI Generalized Linear Model Performance over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Predictive ratios (lowest decile – highest decile)	0.96-0.92	0.96-0.91	0.95-0.92	0.96-0.92
Quasi-R <sup>2</sup>	0.08	0.08	0.08	0.08

**Table 4.2.5 – Distribution of Hospital AMI Admission Volumes over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	3,898	3,816	3,723	4,265
Mean number of admissions (SD)	39 (53)	40 (54)	42 (56)	109 (157)
Range (min. – max.)	1 - 463	1 - 485	1 - 551	1 - 1,499
25 <sup>th</sup> percentile	4	4	4	7
50 <sup>th</sup> percentile	16	17	18	36
75 <sup>th</sup> percentile	57	59	62	157

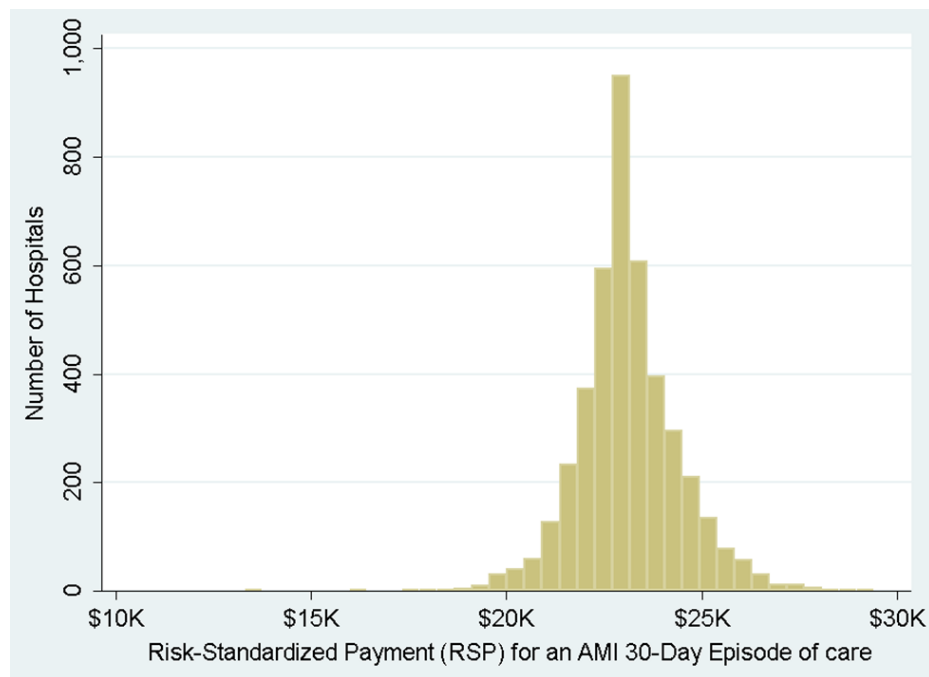
**Table 4.2.6 – Distribution of Hospital AMI RSPs over Different Time Periods (\$2015)**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	3,898	3,816	3,723	4,265
Mean (SD)	23,025 (1,069)	23,140 (1,022)	23,165 (944)	23,123 (1,271)
Range (min. – max.)	17,028 - 28,935	15,567 - 29,209	18,256 - 27,856	13,294 - 29,443
25 <sup>th</sup> percentile	22,482	22,637	22,719	22,429
50 <sup>th</sup> percentile	22,914	23,049	23,079	23,030
75 <sup>th</sup> percentile	23,522	23,618	23,622	23,770

**Table 4.2.7 – Between-Hospital Variance for AMI**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Between-hospital variance (SE)	0.008 (0.0005)	0.007 (0.0005)	0.006 (0.0005)	0.008 (0.0003)

**Figure 4.2.2 – Distribution of Hospital AMI 30-Day Episode-of-Care RSPs between July 2013 and June 2016 (\$2015)**



N= 4,265 hospitals

## **4.3 HF Payment 2017 Model Results**

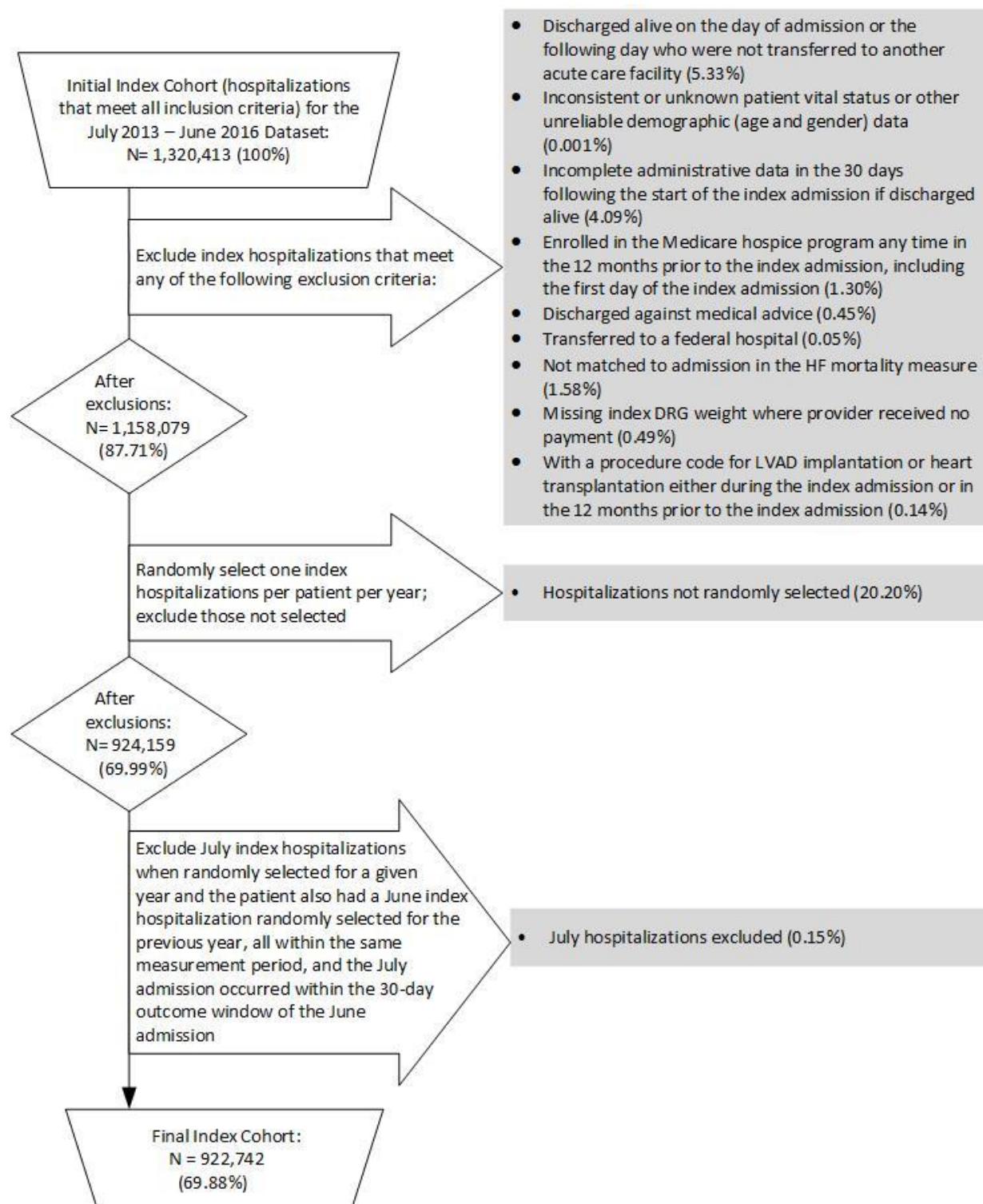
### **4.3.1 Index Cohort Exclusions**

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of HF admissions that met each exclusion criterion in the July 2013-June 2016 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 2013-June 2016 Dataset**



### 4.3.2 Frequency of HF Model Variables

We examined the change in the frequencies of clinical and demographic variables. Frequencies of model variables were stable over the measurement period. The largest changes in the frequencies (those greater than 2% absolute change) include increases in Other psychiatric disorders (20.3% to 22.7%), Respiratory arrest/cardiorespiratory failure/respirator dependence (27.8% to 31.2%), and Renal failure (61.1% to 63.3%).

Refer to [Table 4.3.1](#) for more detail. Note that the increases and decreases in some model variables may reflect not only changes in rates of comorbidities in the Medicare FFS population, but also changes due to ICD-10 code implementation effective with October 1, 2015+ discharges.

### 4.3.3 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.<sup>18</sup>

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 remained similar to the model used for 2016 public reporting ([Table 4.3.4](#)).

### 4.3.4 Distribution of Hospital Volumes and Payments for HF

Between July 2013-June 2014 and July 2015-June 2016, the national mean payment decreased from \$16,193 to \$16,136 (\$2015).

[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 \$16,221 (between July 2013 and June 2014) to \$16,164 (between July 2015 and June 2016). The median hospital RSP in the combined three-year dataset was \$16,124 (IQR: \$15,374 - \$17,022). [Table 4.3.7](#) shows the between-hospital variance by individual year, as well as for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.011 (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 three-year dataset. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was 1.23 times higher than the expected 30-day RSP if treated at a hospital one SD below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.<sup>15</sup>



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

Of 4,594 hospitals in the study cohort, 553 had a payment “Greater than the National Payment,” 2,660 had a payment “No Different than the National Payment,” and 410 had a payment “Less than the National Payment.” 971 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	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Total N	302,841	311,970	307,931	922,742
Age (>=85)	37.3	37.5	37.1	37.3
Age (65 – 74)	25.7	25.9	26.6	26.0
Age (75 – 84)	37.0	36.6	36.3	36.7
Severe infection (CC 1, 3-6)	1.7	1.6	1.6	1.6
Other infectious diseases (CC 7)	37.2	37.2	37.2	37.2
Protein-calorie malnutrition (CC 21)	9.9	9.9	10.3	10.0
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	88.5	89.3	89.9	89.2
Other significant endocrine and metabolic disorders (CC 23)	11.6	11.6	11.9	11.7
Other gastrointestinal disorders (CC 38)	63.4	64.2	65.0	64.2
Bone/joint/muscle infections/necrosis (CC 39)	2.6	2.6	2.7	2.6
Other musculoskeletal and connective tissue disorders (CC 45)	75.5	76.0	75.8	75.8
Delirium and encephalopathy (CC 50)	8.8	9.3	10.2	9.4
Dementia or other specified brain disorders (CC 51-53)	24.2	23.9	23.8	24.0
Severe mental illness (CC 57-58)	6.4	6.4	6.8	6.5
Other psychiatric disorders (CC 63)	20.3	21.5	22.7	21.5
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82-84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 82-84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	27.8	29.1	31.2	29.4
Coronary atherosclerosis or angina (CC 88-89)	72.0	70.9	70.3	71.1
Heart infection/inflammation, except rheumatic (CC 90)	3.7	3.8	4.0	3.8
Major congenital cardiac/circulatory defect (CC 92)	0.1	0.1	0.1	0.1
Hypertension (CC 95)	87.3	87.4	88.1	87.6
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	67.1	67.5	67.8	67.5
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	22.2	21.4	20.6	21.4
Vascular or circulatory disease (CC 106-109)	52.1	52.0	52.2	52.1
Pneumonia (CC 114-116)	44.7	44.8	43.7	44.4
Other ear, nose, throat, and mouth disorders (CC 131)	32.0	32.0	32.3	32.1
Dialysis status (CC 134)	4.3	4.3	4.3	4.3
Renal failure (CC 135-140)	61.1	61.9	63.3	62.1

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Decubitus ulcer of skin (CC 157-160)	5.7	5.5	5.8	5.6
Chronic ulcer of skin, except pressure (CC 161)	11.4	11.3	11.1	11.2
Cellulitis, local skin infection (CC 164)	17.7	17.3	17.2	17.4
Hip fracture/dislocation (CC 170)	3.7	3.6	3.5	3.6
Internal injuries (CC 172)	1.7	1.6	1.4	1.6

**Table 4.3.2 – Hierarchical Generalized Linear Regression Model Variable Coefficients for HF over Different Time Periods**

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Intercept	9.516	9.529	9.538	9.525
Age (>=85) (reference group)	--	--	--	--
Age (65 – 74)	0.075	0.066	0.064	0.071
Age (75 – 84)	0.056	0.053	0.051	0.055
Severe infection (CC 1, 3-6)	0.076	0.041	0.056	0.057
Other infectious diseases (CC 7)	0.020	0.018	0.024	0.019
Protein-calorie malnutrition (CC 21)	0.139	0.134	0.119	0.130
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	-0.001	-0.006	-0.008	-0.006
Other significant endocrine and metabolic disorders (CC 23)	0.055	0.057	0.051	0.054
Other gastrointestinal disorders (CC 38)	0.001	0.006	0.008	0.006
Bone/joint/muscle infections/necrosis (CC 39)	0.036	0.047	0.043	0.043
Other musculoskeletal and connective tissue disorders (CC 45)	0.000	0.006	0.000	0.002
Delirium and encephalopathy (CC 50)	0.012	0.014	0.014	0.012
Dementia or other specified brain disorders (CC 51-53)	0.047	0.040	0.038	0.042
Severe mental illness (CC 57-58)	0.041	0.040	0.043	0.038
Other psychiatric disorders (CC 63)	0.008	0.010	0.010	0.009
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82-84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 82-84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	0.016	0.022	0.021	0.020
Coronary atherosclerosis or angina (CC 88-89)	0.019	0.021	0.021	0.018
Heart infection/inflammation, except rheumatic (CC 90)	0.080	0.064	0.071	0.070
Major congenital cardiac/circulatory defect (CC 92)	0.073	-0.015	-0.018	0.009
Hypertension (CC 95)	-0.044	-0.045	-0.053	-0.047
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	-0.031	-0.037	-0.039	-0.036
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	0.017	0.009	0.018	0.014
Vascular or circulatory disease (CC 106-109)	0.014	0.010	0.011	0.011
Pneumonia (CC 114-116)	0.104	0.098	0.088	0.096
Other ear, nose, throat, and mouth disorders (CC 131)	-0.018	-0.016	-0.018	-0.018
Dialysis status (CC 134)	0.134	0.128	0.122	0.125
Renal failure (CC 135-140)	0.052	0.056	0.055	0.054
Decubitus ulcer of skin (CC 157-160)	0.031	0.036	0.046	0.037

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Chronic ulcer of skin, except pressure (CC 161)	0.065	0.064	0.062	0.063
Cellulitis, local skin infection (CC 164)	0.007	0.011	0.013	0.010
Hip fracture/dislocation (CC 170)	0.044	0.037	0.035	0.038
Internal injuries (CC 172)	0.070	0.067	0.050	0.062

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

Variable	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2015-06/2016 PR (95% CI)	07/2013-06/2016 PR (95% CI)
Age (>=85) (reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
Age (65 – 74)	1.08 (1.07, 1.09)	1.07 (1.06, 1.08)	1.07 (1.06, 1.07)	1.07 (1.07, 1.08)
Age (75 – 84)	1.06 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)	1.06 (1.05, 1.06)
Severe infection (CC 1, 3-6)	1.08 (1.06, 1.10)	1.04 (1.02, 1.06)	1.06 (1.04, 1.08)	1.06 (1.05, 1.07)
Other infectious diseases (CC 7)	1.02 (1.01, 1.03)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.02)
Protein-calorie malnutrition (CC 21)	1.15 (1.14, 1.16)	1.14 (1.13, 1.15)	1.13 (1.12, 1.14)	1.14 (1.13, 1.14)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	1.00 (0.99, 1.01)	0.99 (0.99, 1.00)	0.99 (0.98, 1.00)	0.99 (0.99, 1.00)
Other significant endocrine and metabolic disorders (CC 23)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)	1.05 (1.04, 1.06)	1.06 (1.05, 1.06)
Other gastrointestinal disorders (CC 38)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)
Bone/joint/muscle infections/necrosis (CC 39)	1.04 (1.02, 1.05)	1.05 (1.03, 1.07)	1.04 (1.03, 1.06)	1.04 (1.03, 1.05)
Other musculoskeletal and connective tissue disorders (CC 45)	1.00 (0.99, 1.01)	1.01 (1.00, 1.01)	1.00 (0.99, 1.01)	1.00 (1.00, 1.01)
Delirium and encephalopathy (CC 50)	1.01 (1.00, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)
Dementia or other specified brain disorders (CC 51-53)	1.05 (1.04, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.04, 1.05)
Severe mental illness (CC 57-58)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)
Other psychiatric disorders (CC 63)	1.01 (1.00, 1.01)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.01 (1.01, 1.01)
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82-84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 82-84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.01, 1.03)	1.02 (1.02, 1.02)
Coronary atherosclerosis or angina (CC 88-89)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.03)	1.02 (1.01, 1.02)
Heart infection/inflammation, except rheumatic (CC 90)	1.08 (1.07, 1.10)	1.07(1.05, 1.08)	1.07 (1.06, 1.09)	1.07 (1.06, 1.08)
Major congenital cardiac/circulatory defect (CC 92)	1.08 (0.98, 1.18)	0.99 (0.91, 1.07)	0.98 (0.90, 1.07)	1.01 (0.96, 1.06)
Hypertension (CC 95)	0.96 (0.95, 0.96)	0.96 (0.95, 0.96)	0.95 (0.94, 0.96)	0.95 (0.95, 0.96)
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	0.97 (0.96, 0.97)	0.96 (0.96, 0.97)	0.96 (0.96, 0.97)	0.96 (0.96, 0.97)

Variable	07/2013-06/2014 PR (95% CI)	07/2014-06/2015 PR (95% CI)	07/2015-06/2016 PR (95% CI)	07/2013-06/2016 PR (95% CI)
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	1.02 (1.01, 1.02)	1.01 (1.00, 1.02)	1.02 (1.01, 1.02)	1.01 (1.01, 1.02)
Vascular or circulatory disease (CC 106-109)	1.01 (1.01, 1.02)	1.01 (1.00, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.01)
Pneumonia (CC 114-116)	1.11 (1.10, 1.12)	1.10 (1.10, 1.11)	1.09 (1.09, 1.10)	1.10 (1.10, 1.10)
Other ear, nose, throat, and mouth disorders (CC 131)	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 134)	1.14 (1.13, 1.16)	1.14 (1.12, 1.15)	1.13 (1.11, 1.15)	1.13 (1.12, 1.14)
Renal failure (CC 135-140)	1.05 (1.05, 1.06)	1.06 (1.05, 1.06)	1.06 (1.05, 1.06)	1.06 (1.05, 1.06)
Decubitus ulcer of skin (CC 157-160)	1.03 (1.02, 1.04)	1.04 (1.03, 1.05)	1.05 (1.04, 1.06)	1.04 (1.03, 1.04)
Chronic ulcer of skin, except pressure (CC 161)	1.07 (1.06, 1.08)	1.07 (1.06, 1.08)	1.06 (1.05, 1.07)	1.07 (1.06, 1.07)
Cellulitis, local skin infection (CC 164)	1.01 (1.00, 1.01)	1.01 (1.00, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.01)
Hip fracture/dislocation (CC 170)	1.04 (1.03, 1.06)	1.04 (1.02, 1.05)	1.04 (1.02, 1.05)	1.04 (1.03, 1.05)
Internal injuries (CC 172)	1.07 (1.05, 1.09)	1.07 (1.05, 1.09)	1.05 (1.03, 1.07)	1.06 (1.05, 1.08)

**Table 4.3.4 – HF Generalized Linear Model Performance over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Predictive ratios (lowest decile – highest decile)	1.02-1.02	1.03-1.01	1.03-1.02	1.03-1.02
Quasi-R <sup>2</sup>	0.03	0.03	0.03	0.03

**Table 4.3.5 – Distribution of Hospital HF Admission Volumes over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	4,485	4,455	4,419	4,594
Mean number of admissions (SD)	68 (83)	70 (87)	70 (88)	201 (255)
Range (min. – max.)	1 - 947	1 - 1038	1 - 947	1 – 2,932
25 <sup>th</sup> percentile	12	11	11	30
50 <sup>th</sup> percentile	34	35	34	95
75 <sup>th</sup> percentile	96	100	100	286

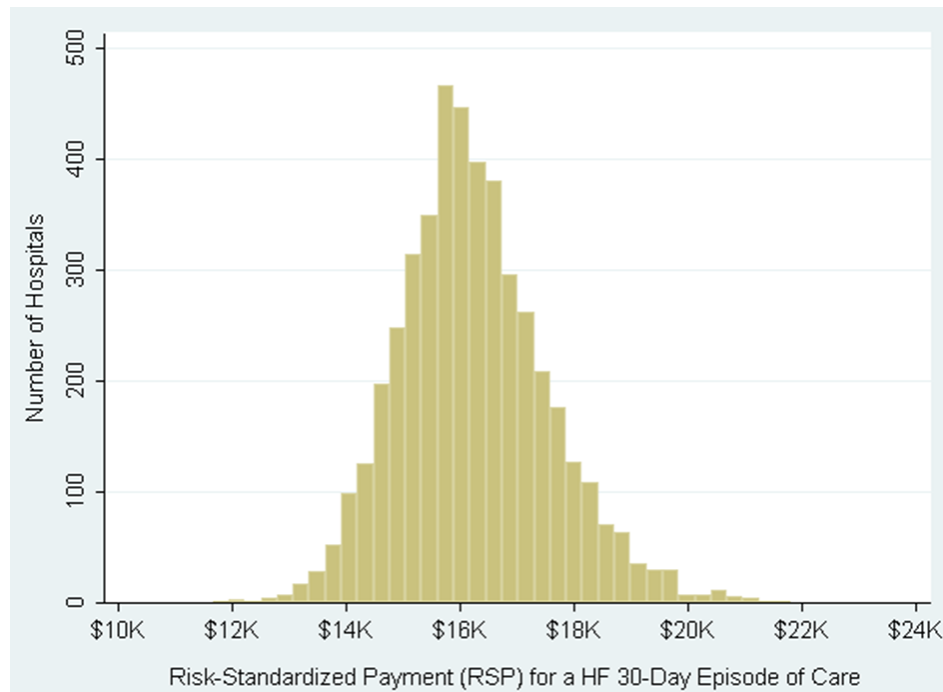
**Table 4.3.6 – Distribution of Hospital HF RSPs over Different Time Periods (\$2015)**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	4,485	4,455	4,419	4,594
Mean (SD)	16,221 (967)	16,269 (959)	16,164 (962)	16,243 (1321)
Range (min. – max.)	12,638 – 21,431	12,960 – 21,155	12,019 – 20,617	11,652 – 21,819
25 <sup>th</sup> percentile	15,609	15,675	15,560	15,374
50 <sup>th</sup> percentile	16,129	16,162	16,047	16,124
75 <sup>th</sup> percentile	16,729	16,795	16,671	17,022

**Table 4.3.7 – Between-Hospital Variance for HF**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Between-hospital variance (SE)	.009 (.0004)	.008 (.0004)	.009 (.0004)	.011 (.0004)

**Figure 4.3.2 – Distribution of Hospital HF 30-Day Episode-of-Care RSPs between July 2013 and June 2016 (\$2015)**



N= 4,594 hospitals

## 4.4 Pneumonia Payment 2017 Model Results

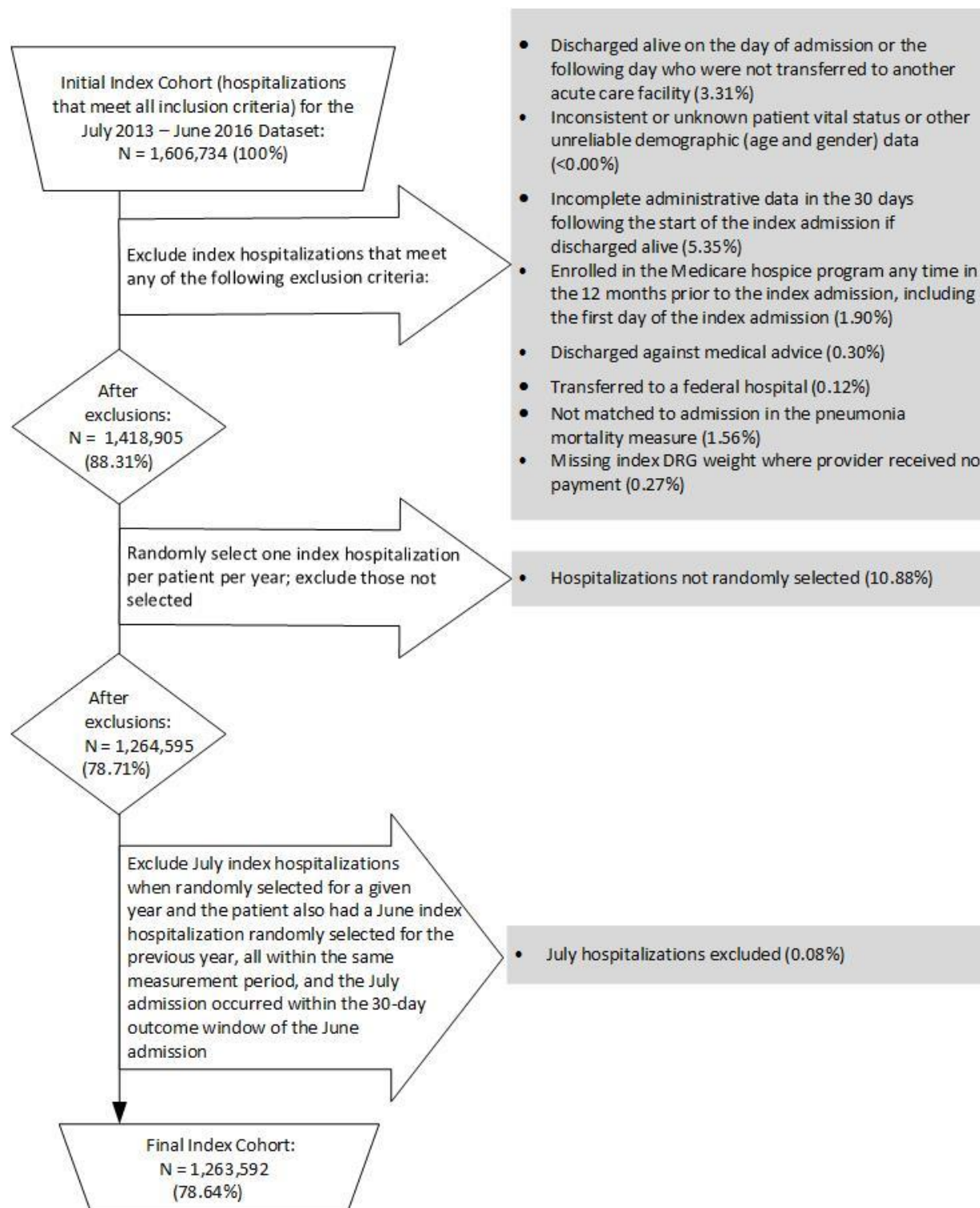
### 4.4.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of pneumonia admissions that met each exclusion criterion in the July 2013-June 2016 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 either a principal discharge diagnosis of pneumonia (including aspiration pneumonia) or a principal discharge diagnosis of sepsis (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA;
- 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 2013-June 2016 Dataset**



#### 4.4.2 Frequency of Pneumonia Model Variables

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

- Increases in Septicemia, sepsis, systemic inflammatory response syndrome/shock (12.6% to 14.9%), Respiratory arrest/cardiorespiratory failure/respirator dependence (24.1% to 26.3%), Asthma (11.1% to 14.2%), and Viral and unspecified pneumonia, pleurisy (50.2% to 52.3%)
- A decrease in Iron deficiency or other/unspecified anemias and blood disease (60.1% to 57.9%)

Refer to [Table 4.4.1](#) for more detail. Note that the increases and decreases in some model variables may reflect not only changes in rates of comorbidities in the Medicare FFS population, but also changes due to ICD-10 code implementation effective with October 1, 2015+ discharges.

#### 4.4.3 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.<sup>18</sup>

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 remained similar to the model used for 2016 public reporting ([Table 4.4.3](#)).

#### 4.4.4 Distribution of Hospital Volumes and Payments for Pneumonia

Between July 2013-June 2014 and July 2015-June 2016, the national mean payment decreased from \$17,123 to \$17,066 (\$2015).

[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 \$17,087 (between July 2013 and June 2014) to \$17,036 (between July 2015 and June 2016). The median hospital RSP in the combined three-year dataset was \$16,908 (IQR: \$15,825 - \$18,001). [Table 4.4.6](#) shows the between-hospital variance by individual year, as well as for the combined three-year dataset. Between-hospital variance in the combined dataset was \$4,153,254 (SE: \$119,902). 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 three-year dataset. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was \$4,076 higher than the expected 30-day RSP if treated at a



hospital one SD below the national average payment. If there were no systematic differences between hospitals, this difference would be \$0.<sup>15</sup>

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

Of 4,655 hospitals in the study cohort, 798 had a payment “Greater than the National Payment,” 2,496 had a payment “No Different than the National Payment,” and 907 had a payment “Less than the National Payment.” 454 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	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Total N	410,665	441,145	411,782	1,263,592
Age (>=85)	34.8	36.0	34.3	35.1
Age (65 – 74)	28.5	27.6	29.7	28.6
Age (75 – 84)	36.7	36.4	36.0	36.4
Severe infection (CC 1, 3-6)	2.9	2.8	2.9	2.9
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	12.6	13.2	14.9	13.6
Other infectious diseases (CC 7)	39.4	39.1	39.0	39.2
Metastatic cancer or acute leukemia (CC 8)	5.0	4.8	5.4	5.0
Lung and other severe cancers (CC 9)	7.8	7.4	8.0	7.7
Lymphatic, head and neck, brain, and other major cancers (CC 10-11)	9.3	9.1	9.5	9.3
Benign neoplasms of skin, breast, eye (CC 16)	12.0	12.3	12.7	12.3
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	42.8	42.2	42.6	42.5
Protein-calorie malnutrition (CC 21)	16.5	16.2	16.9	16.5
Other significant endocrine and metabolic disorders (CC 23)	9.5	9.6	9.9	9.7
Liver disease (CC 27-30)	2.7	2.7	3.0	2.8
Gallbladder and biliary tract disorders (CC 32)	3.4	3.3	3.4	3.4
Appendicitis (CC 37)	0.2	0.2	0.2	0.2
Bone/joint/muscle infections/necrosis (CC 39)	2.4	2.4	2.5	2.4
Osteoporosis and other bone/cartilage disorders (CC 43)	24.1	23.9	23.1	23.7
Severe hematological disorders (CC 46)	2.2	2.1	2.1	2.1
Disorders of immunity (CC 47)	5.6	5.7	6.1	5.8
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	60.1	58.3	57.9	58.8
Delirium and encephalopathy (CC 50)	10.9	11.4	12.5	11.6
Dementia or other specified brain disorders (CC 51-53)	35.4	35.1	34.2	34.9
Drug/alcohol psychosis or dependence (CC 54-55)	3.7	3.7	4.1	3.8
Major psychiatric disorders (CC 57-59)	15.4	15.4	14.1	15.0

Variable	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	8.5	8.3	9.0	8.6
Neuropathy; muscular dystrophy (CC 75-76)	1.4	1.4	1.5	1.4
Multiple sclerosis and Parkinson's (CC 77-78)	5.7	5.5	5.6	5.6
Seizure disorders and convulsions (CC 79)	7.3	7.1	7.1	7.1
Coma, brain compression/anoxic damage (CC 80)	0.9	0.9	1.2	1.0
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	21.2	21.7	22.7	21.9
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82-84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 82-84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	24.1	24.4	26.3	24.9
Congestive heart failure (CC 85)	38.1	37.4	37.5	37.7
Coronary atherosclerosis or angina (CC 88-89)	48.5	47.5	47.3	47.8
Heart infection/inflammation, except rheumatic (CC 90)	2.2	2.2	2.4	2.3
Valvular and rheumatic heart disease (CC 91)	26.0	26.1	26.5	26.2
Hypertensive heart disease (CC 94)	4.3	3.8	4.1	4.1
Stroke (CC 99-100)	10.6	10.3	10.0	10.3
Late effects of cerebrovascular disease, except paralysis (CC 105)	9.4	9.0	8.3	8.9
Chronic obstructive pulmonary disease (COPD) (CC 111)	52.1	50.7	51.1	51.3
Asthma (CC 113)	11.1	11.1	14.2	12.1
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	2.6	2.2	2.9	2.5
Viral and unspecified pneumonia, pleurisy (CC 116)	50.2	50.8	52.3	51.1
Pleural effusion/pneumothorax (CC 117)	17.3	16.8	17.7	17.3
Other respiratory disorders (CC 118)	48.7	48.4	50.1	49.1
Other eye disorders (CC 128)	22.4	22.6	23.0	22.7
Significant ear, nose, and throat disorders (CC 129)	2.1	2.1	2.2	2.2
Other ear, nose, throat, and mouth disorders (CC 131)	36.4	36.4	36.6	36.5
Dialysis status (CC 134)	3.4	3.4	3.6	3.5
Urinary incontinence (CC 143)	10.5	10.9	10.8	10.7
Other female genital disorders (CC 148)	4.1	4.0	3.8	4.0
Decubitus ulcer or chronic skin ulcer (CC 157-161)	13.5	13.0	13.0	13.2
Vertebral fractures without spinal cord injury (CC 169)	5.4	5.4	5.3	5.4
Major fracture, except of skull, vertebrae, or hip (CC 171)	2.8	2.8	2.8	2.8
Internal injuries (CC 172)	1.4	1.3	1.2	1.3
Traumatic amputations, other injuries (CC 173-174)	41.2	41.5	42.6	41.8
Poisonings and allergic and inflammatory reactions (CC 175)	13.1	12.4	12.2	12.6
Major symptoms, abnormalities (CC 178)	86.9	86.6	86.3	86.6
Minor symptoms, signs, findings (CC 179)	90.1	90.3	91.6	90.7

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

Variable	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2015-06/2016 \$ (95% CI)	07/2013-06/2016 \$ (95% CI)
Intercept	11,437 (11,299, 11,574)	11,266 (11,136, 11,395)	11,452 (11,313, 11,591)	11,509 (11,416, 11,603)
Age (>=85) (reference group)	--	--	--	--
Age (65 – 74)	-667 (-757, -578)	-732 (-816, -647)	-596 (-683, -508)	-621 (-672, -571)
Age (75 – 84)	-373 (-453, -293)	-462 (-537, -387)	-306 (-385, -227)	-356 (-401, -311)
Severe infection (CC 1, 3-6)	2,168 (1,927, 2,408)	2,427 (2,193, 2,661)	2,019 (1,786, 2,253)	2,192 (2,055, 2,329)
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	123 (-6, 252)	-114 (-233, 4)	-138 (-254, -21)	-59 (-129, 12)
Other infectious diseases (CC 7)	313 (239, 387)	375 (305, 445)	423 (350, 496)	355 (313, 397)
Metastatic cancer or acute leukemia (CC 8)	1,107 (915, 1,299)	1,246 (1,062, 1,431)	1,189 (1,004, 1,374)	1,164 (1,056, 1,272)
Lung and other severe cancers (CC 9)	412 (266, 557)	224 (85, 362)	516 (374, 659)	361 (278, 443)
Lymphatic, head and neck, brain, and other major cancers (CC 10-11)	380 (255, 505)	439 (320, 557)	356 (234, 478)	379 (309, 450)
Benign neoplasms of skin, breast, eye (CC 16)	-475 (-572, -379)	-505 (-596, -415)	-429 (-522, -335)	-485 (-539, -431)
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	616 (547, 684)	679 (614, 744)	650 (582, 717)	636 (597, 675)
Protein-calorie malnutrition (CC 21)	3,843 (3,724, 3,961)	3,412 (3,302, 3,523)	3,196 (3,085, 3,308)	3,420 (3,354, 3,486)
Other significant endocrine and metabolic disorders (CC 23)	1,161 (1,015, 1,307)	966 (830, 1,102)	1,143 (1,003, 1,282)	1,078 (997, 1,159)
Liver disease (CC 27-30)	804 (565, 1,043)	638 (416, 860)	692 (470, 914)	703 (571, 835)
Gallbladder and biliary tract disorders (CC 32)	737 (532, 941)	839 (639, 1,038)	1,191 (985, 1,397)	907 (789, 1,025)
Appendicitis (CC 37)	1,647 (724, 2,571)	1,806 (915, 2,696)	1,063 (177, 1,948)	1,514 (992, 2,036)
Bone/joint/muscle infections/necrosis (CC 39)	1,876 (1,593, 2,160)	1,754 (1,488, 2,021)	1,852 (1,579, 2,126)	1,816 (1,657, 1,976)
Osteoporosis and other bone/cartilage disorders (CC 43)	-364 (-443, -284)	-220 (-296, -145)	-454 (-533, -376)	-348 (-394, -303)
Severe hematological disorders (CC 46)	699 (440, 958)	766 (511, 1,020)	585 (324, 847)	683 (533, 833)
Disorders of immunity (CC 47)	1,069 (895, 1,242)	769 (610, 929)	913 (751, 1,075)	889 (793, 985)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1,364 (1,295, 1,434)	1,386 (1,320, 1,452)	1,358 (1,289, 1,427)	1,340 (1,300, 1,379)
Delirium and encephalopathy (CC 50)	324 (185, 462)	246 (117, 374)	245 (117, 373)	246 (170, 322)
Dementia or other specified brain disorders (CC 51-53)	1,157 (1,076, 1,238)	1,129 (1,053, 1,205)	1,125 (1,045, 1,205)	1,098 (1,052, 1,143)
Drug/alcohol psychosis or dependence (CC 54-55)	1,082 (883, 1,281)	1,108 (920, 1,296)	868 (685, 1,052)	1,032 (922, 1,142)
Major psychiatric disorders (CC 57-59)	806 (701, 912)	802 (702, 902)	740 (633, 847)	750 (690, 811)

Variable	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2015-06/2016 \$ (95% CI)	07/2013-06/2016 \$ (95% CI)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1,338 (1,184, 1,492)	1,140 (994, 1,286)	1,267 (1,121, 1,414)	1,231 (1,145, 1,317)
Neuropathy; muscular dystrophy (CC 75-76)	1,461 (1,135, 1,786)	1,938 (1,622, 2,255)	1,487 (1,180, 1,793)	1,631 (1,448, 1,814)
Multiple sclerosis and Parkinson's (CC 77-78)	1,339 (1,176, 1,501)	1,590 (1,433, 1,746)	1,418 (1,258, 1,578)	1,417 (1,324, 1,509)
Seizure disorders and convulsions (CC 79)	777 (628, 926)	727 (585, 869)	820 (672, 968)	755 (670, 840)
Coma, brain compression/anoxic damage (CC 80)	1,797 (1,322, 2,272)	1,370 (929, 1,811)	1,888 (1,478, 2,298)	1,652 (1,398, 1,907)
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	65 (-19, 150)	68 (-11, 147)	102 (21, 183)	82 (35, 129)
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82-84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 82-84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	573 (475, 670)	613 (521, 705)	503 (410, 597)	556 (501, 610)
Congestive heart failure (CC 85)	595 (514, 675)	467 (390, 544)	401 (321, 481)	496 (451, 542)
Coronary atherosclerosis or angina (CC 88-89)	-45 (-114, 24)	-8 (-74, 57)	36 (-33, 104)	-19 (-58, 21)
Heart infection/inflammation, except rheumatic (CC 90)	1,712 (1,440, 1,983)	1,639 (1,381, 1,898)	1,560 (1,304, 1,815)	1,631 (1,479, 1,783)
Valvular and rheumatic heart disease (CC 91)	573 (490, 656)	597 (518, 676)	547 (466, 628)	563 (516, 610)
Hypertensive heart disease (CC 94)	-85 (-254, 83)	-177 (-347, -8)	220 (47, 393)	-84 (-183, 15)
Stroke (CC 99-100)	383 (248, 518)	266 (138, 394)	160 (25, 294)	259 (182, 336)
Late effects of cerebrovascular disease, except paralysis (CC 105)	838 (694, 982)	872 (734, 1,011)	915 (764, 1,066)	856 (772, 939)
Chronic obstructive pulmonary disease (COPD) (CC 111)	376 (307, 445)	414 (349, 479)	360 (292, 429)	365 (326, 405)
Asthma (CC 113)	-1,025 (-1,123, -926)	-907 (-1,001, -814)	-845 (-935, -755)	-915 (-970, -861)
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	-600 (-833, -367)	-515 (-755, -274)	-416 (-630, -202)	-486 (-619, -354)
Viral and unspecified pneumonia, pleurisy (CC 116)	1,522 (1,450, 1,594)	1,705 (1,638, 1,773)	1,720 (1,650, 1,789)	1,640 (1,600, 1,680)
Pleural effusion/pneumothorax (CC 117)	253 (144, 363)	239 (134, 343)	353 (246, 459)	271 (209, 333)
Other respiratory disorders (CC 118)	-145 (-214, -75)	-209 (-274, -143)	-145 (-213, -77)	-175 (-214, -136)
Other eye disorders (CC 128)	-310 (-388, -232)	-222 (-296, -149)	-238 (-314, -162)	-254 (-298, -210)
Significant ear, nose, and throat disorders (CC 129)	874 (626, 1,122)	906 (672, 1,140)	883 (645, 1,120)	886 (747, 1,025)

Variable	07/2013-06/2014 \$ (95% CI)	07/2014-06/2015 \$ (95% CI)	07/2015-06/2016 \$ (95% CI)	07/2013-06/2016 \$ (95% CI)
Other ear, nose, throat, and mouth disorders (CC 131)	-495 (-563, -427)	-587 (-651, -522)	-591 (-658, -525)	-558 (-597, -520)
Dialysis status (CC 134)	2,566 (2,290, 2,842)	2,783 (2,523, 3,043)	2,272 (2,011, 2,534)	2,482 (2,328, 2,636)
Urinary incontinence (CC 143)	330 (218, 443)	393 (288, 499)	331 (222, 441)	356 (293, 419)
Other female genital disorders (CC 148)	-370 (-528, -211)	-614 (-766, -462)	-388 (-551, -225)	-461 (-553, -370)
Decubitus ulcer or chronic skin ulcer (CC 157-161)	1,222 (1,102, 1,343)	1,115 (1,000, 1,230)	1,179 (1,058, 1,299)	1,152 (1,083, 1,220)
Vertebral fractures without spinal cord injury (CC 169)	1,120 (952, 1,288)	891 (734, 1,048)	894 (729, 1,059)	952 (858, 1,047)
Major fracture, except of skull, vertebrae, or hip (CC 171)	583 (357, 808)	357 (147, 567)	437 (218, 656)	458 (332, 584)
Internal injuries (CC 172)	1,883 (1,524, 2,241)	1,580 (1,239, 1,921)	1,192 (826, 1,558)	1,544 (1,339, 1,750)
Traumatic amputations, other injuries (CC 173-174)	600 (528, 672)	672 (604, 740)	734 (663, 804)	672 (631, 713)
Poisonings and allergic and inflammatory reactions (CC 175)	-228 (-341, -116)	-390 (-498, -282)	-423 (-536, -310)	-326 (-390, -262)
Major symptoms, abnormalities (CC 178)	631 (542, 721)	731 (647, 815)	432 (344, 520)	583 (532, 633)
Minor symptoms, signs, findings (CC 179)	198 (98, 298)	262 (167, 357)	417 (313, 521)	291 (233, 349)

**Table 4.4.3 – Pneumonia Generalized Linear Model Performance over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Predictive ratios (lowest decile – highest decile)	1.06-1.06	1.06-1.06	1.06-1.06	1.06-1.06
Quasi-R <sup>2</sup>	0.09	0.08	0.08	0.08

**Table 4.4.4 – Distribution of Hospital Pneumonia Admission Volumes over Different Time Periods**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	4,575	4,544	4,521	4,655
Mean number of admissions (SD)	90 (97)	97 (106)	91 (102)	271 (301)
Range (min. – max.)	1 – 1,009	1 – 1,105	1 – 1,121	1 – 3,154
25 <sup>th</sup> percentile	22	23	20	61
50 <sup>th</sup> percentile	56	59	55	164
75 <sup>th</sup> percentile	127	137	130	386

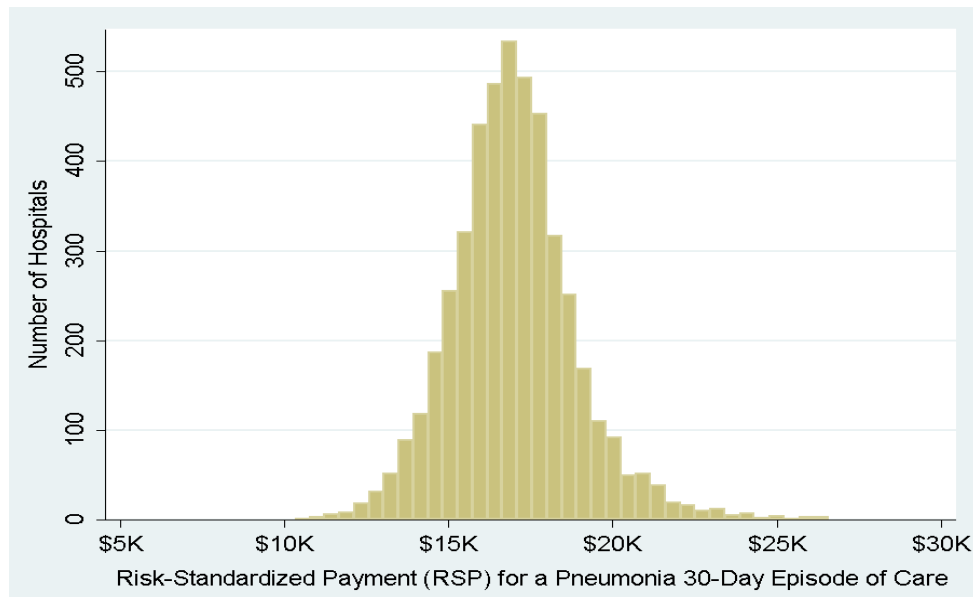
**Table 4.4.5 – Distribution of Hospital Pneumonia RSPs over Different Time Periods (\$2015)**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Number of hospitals	4,575	4,544	4,521	4,655
Mean (SD)	17,087 (1,656)	16,869 (1,553)	17,036 (1,580)	16,986 (1,892)
Range (min. – max.)	10,904 - 25,012	11,170 - 24,054	11,619 - 25,025	10,310 - 26,601
25 <sup>th</sup> percentile	16,042	15,910	16,059	15,825
50 <sup>th</sup> percentile	17,063	16,812	16,975	16,908
75 <sup>th</sup> percentile	18,084	17,797	18,019	18,001

**Table 4.4.6 – Between-Hospital Variance for Pneumonia**

Characteristic	07/2013-06/2014	07/2014-06/2015	07/2015-06/2016	07/2013-06/2016
Between hospital-variance (SE) (\$)	3,976,941 (144,964)	3,545,770 (133,027)	3,733,163 (141,191)	4,153,254 (119,902)

**Figure 4.4.2 – Distribution of Hospital Pneumonia 30-Day Episode-of-Care RSPs between July 2013 and June 2016 (\$2015)**



N= 4,655 hospitals

## **4.5 THA/TKA Payment 2017 Model Results**

### **4.5.1 Index Cohort Exclusions**

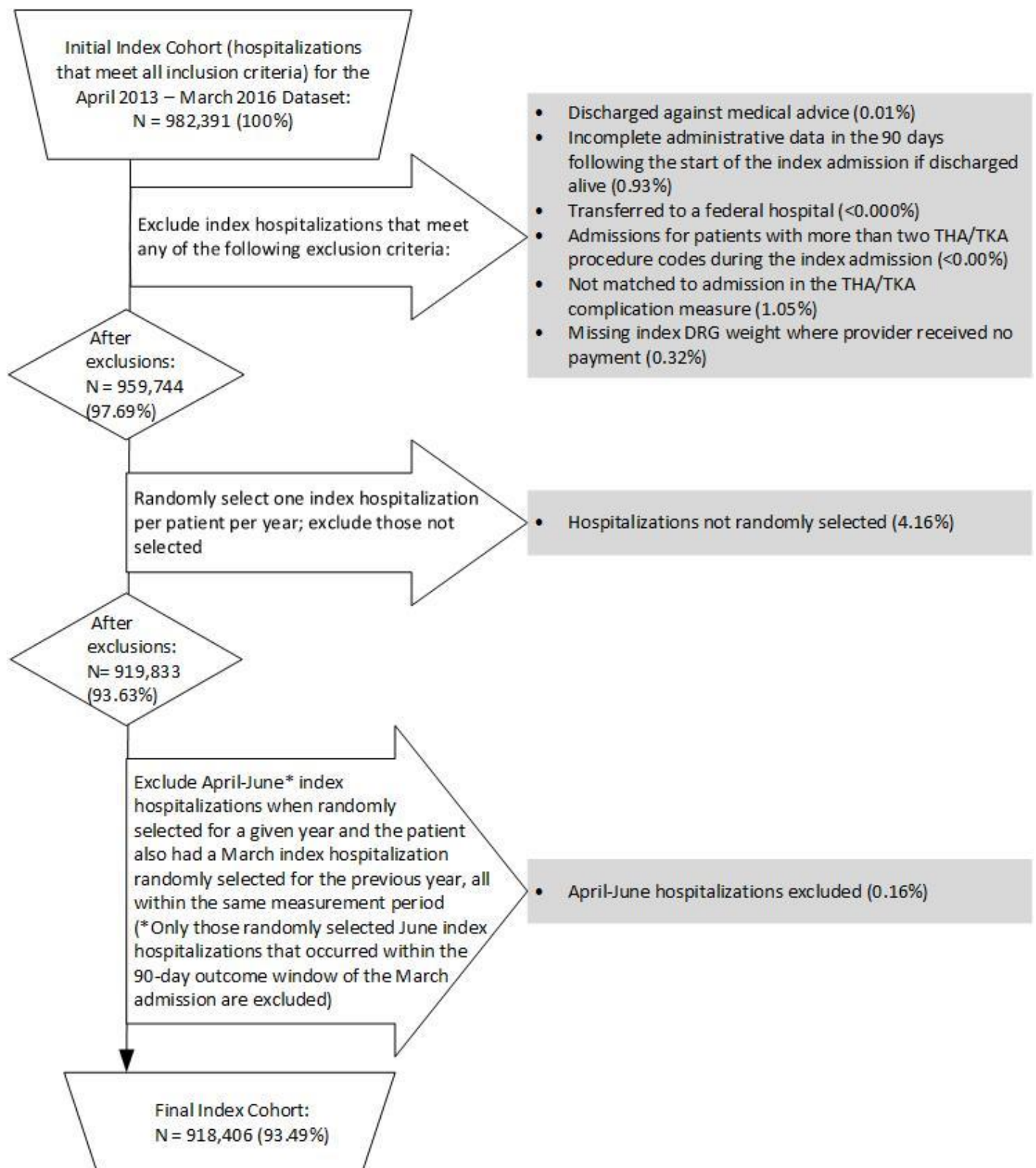
The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of THA/TKA admissions that met each exclusion criterion in the April 2013-March 2016 dataset is presented in [Figure 4.5.1](#).

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 2013-March 2016 Dataset**





#### 4.5.2 Frequency of THA/TKA Model Variables

We examined the change in the frequencies of clinical and demographic variables. Frequencies of model variables were stable over the measurement period. There were no notable changes (greater than 2% absolute change) in the frequencies.

Refer to [Table 4.5.1](#) for more detail. Note that the increases and decreases in some model variables may reflect not only changes in rates of comorbidities in the Medicare FFS population, but also changes due to ICD-10 code implementation effective with October 1, 2015+ discharges.

#### 4.5.3 THA/TKA Model Parameters and Performance

[Table 4.5.2](#) shows the hierarchical generalized linear regression 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.<sup>18</sup>

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 remained similar to the model used during development ([Table 4.5.4](#)).

#### 4.5.4 Distribution of Hospital Volumes and Payments for THA/TKA

Between April 2013-March 2014 and April 2015-March 2016, the national mean payment decreased from \$23,333 to \$21,613 (\$2015).

[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 \$23,454 (between April 2013 and March 2014) to \$21,733 (between April 2015 and March 2016). The median hospital RSP in the combined three-year dataset was \$22,408 (IQR: \$20,847 - \$24,174). [Table 4.5.7](#) shows the between-hospital variance by individual year, as well as for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.015 (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 three-year dataset. The expected 90-day RSP if a patient is treated at a hospital one SD above the national average was 1.28 times higher than the expected 90-day RSP if treated at a hospital one SD below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.<sup>15</sup>

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

Of 3,452 hospitals in the study cohort, 680 had a payment “Greater than the National Payment,” 1,078 had a payment “No Different than the National Payment,” and 1,038

had a payment “Less than the National Payment.” 656 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	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Total N	301,444	298,825	318,137	918,406
Age minus 65 (years above 65, continuous)	9.1 (6.0)	9.0 (6.0)	8.9 (6.0)	9.0 (6.0)
Male (%)	37.0	37.2	37.2	37.1
Index admissions with an elective THA procedure	30.9	32.2	32.8	32.0
Procedure type (bilateral joint replacement)	2.4	2.2	2.1	2.2
Procedure type (single joint replacement)	96.8	96.9	97.1	96.9
Procedure type (staged joint replacements)	0.8	0.8	0.8	0.8
Severe infection; other infectious diseases (CC 1, 3-7)	17.7	17.6	17.7	17.6
Metastatic cancer or acute leukemia (CC 8)	0.5	0.5	0.5	0.5
Cancer (CC 9-14)	18.5	18.4	18.3	18.4
Benign neoplasms of skin, breast, eye (CC 16)	18.8	19.3	19.8	19.3
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	28.3	28.2	27.8	28.1
Protein-calorie malnutrition (CC 21)	0.7	0.7	0.7	0.7
Morbid obesity (CC 22)	7.7	8.1	8.5	8.1
Other significant endocrine and metabolic disorders (CC 23)	3.0	3.0	3.1	3.1
Disorders of thyroid, cholesterol, lipids (CC 25-26)	69.2	69.3	68.8	69.1
Appendicitis (CC 37)	0.1	0.1	0.1	0.1
Bone/joint/muscle infections/necrosis (CC 39)	2.7	2.7	2.9	2.8
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	9.4	9.6	9.5	9.5
Disorders of the vertebrae and spinal discs (CC 41)	29.2	29.4	29.5	29.4
Osteoarthritis of hip or knee (CC 42)	96.3	96.2	96.3	96.3
Other musculoskeletal and connective tissue disorders (CC 45)	89.6	89.9	89.9	89.8
Severe hematological disorders (CC 46)	0.4	0.4	0.4	0.4
Coagulation defects and other specified hematological disorders (CC 48)	4.4	4.4	4.8	4.5
Delirium and encephalopathy (CC 50)	1.0	1.0	1.1	1.1
Dementia or other specified brain disorders (CC 51-53)	4.2	4.1	4.1	4.1
Major psychiatric disorders (CC 57-59)	4.6	4.8	4.8	4.7
Depression/anxiety (CC 61-62)	16.5	17.5	17.5	17.2
Other psychiatric disorders (CC 63)	12.9	14.0	14.8	13.9
Mental retardation or developmental disability (CC 64-68)	0.1	0.1	0.1	0.1
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1.0	1.0	1.1	1.1
Polyneuropathy; other neuropathies (CC 75, 81)	13.5	13.7	14.0	13.7
Multiple sclerosis (CC 77)	0.2	0.2	0.3	0.3
Parkinson’s and Huntington’s diseases (CC 78)	1.0	1.0	1.0	1.0
Seizure disorders and convulsions (CC 79)	1.5	1.5	1.5	1.5

Variable	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Congestive heart failure (CC 85)	8.4	8.3	8.2	8.3
Acute coronary syndrome (CC 86-87)	1.9	1.9	1.9	1.9
Valvular and rheumatic heart disease (CC 91)	14.6	14.3	14.3	14.4
Hypertension and hypertensive disease (CC 94-95)	81.7	80.9	80.2	80.9
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	24.0	24.3	24.4	24.2
Stroke (CC 99-100)	2.1	2.1	2.1	2.1
Vascular or circulatory disease (CC 106-109)	21.8	21.7	21.5	21.7
Chronic obstructive pulmonary disease (COPD) (CC 111)	13.0	12.7	12.3	12.7
Pleural effusion/pneumothorax (CC 117)	1.4	1.4	1.5	1.4
Other respiratory disorders (CC 118)	28.2	27.8	28.9	28.3
Legally blind (CC 119)	0.2	0.2	0.2	0.2
Dialysis status (CC 134)	0.2	0.2	0.2	0.2
Renal failure (CC 135-140)	12.3	12.8	13.4	12.8
Urinary incontinence (CC 143)	8.4	8.6	8.3	8.4
Urinary tract infection (CC 144)	15.3	15.0	14.6	14.9
Other urinary tract disorders (CC 145)	11.4	11.1	10.8	11.1
Decubitus ulcer or chronic skin ulcer (CC 157-161)	2.4	2.4	2.3	2.4
Cellulitis, local skin infection (CC 164)	7.3	7.2	7.0	7.2
Other dermatological disorders (CC 165)	40.0	40.8	41.4	40.7
Trauma (CC 166-168, 170-173)	4.8	4.9	5.0	4.9
Vertebral fractures without spinal cord injury (CC 169)	1.2	1.2	1.1	1.2
Other injuries (CC 174)	27.8	28.0	27.9	27.9
Major symptoms, abnormalities (CC 178)	61.9	62.1	62.6	62.2
Minor symptoms, signs, findings (CC 179)	77.3	77.0	77.7	77.4

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

Variable	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Intercept	9.689	9.667	9.630	9.671
Age minus 65 (years above 65, continuous)	0.015	0.015	0.015	0.015
Male	-0.068	-0.066	-0.063	-0.065
Index admissions with an elective THA procedure	0.003	0.004	-0.003	0.001
Procedure type (bilateral joint replacement)	0.565	0.587	0.568	0.574
Procedure type (single joint replacement; reference group)	--	--	--	--
Procedure type (staged joint replacements)	0.561	0.561	0.551	0.558
Severe infection; other infectious diseases (CC 1, 3-7)	0.045	0.044	0.042	0.043
Metastatic cancer or acute leukemia (CC 8)	0.037	0.032	0.051	0.040
Cancer (CC 9-14)	-0.008	-0.004	-0.004	-0.005
Benign neoplasms of skin, breast, eye (CC 16)	-0.020	-0.022	-0.020	-0.021
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	0.052	0.053	0.052	0.052
Protein-calorie malnutrition (CC 21)	0.136	0.155	0.160	0.150

Variable	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Morbid obesity (CC 22)	0.105	0.108	0.108	0.106
Other significant endocrine and metabolic disorders (CC 23)	0.030	0.032	0.028	0.030
Disorders of thyroid, cholesterol, lipids (CC 25-26)	-0.010	-0.010	-0.011	-0.010
Appendicitis (CC 37)	-0.041	-0.004	-0.050	-0.032
Bone/joint/muscle infections/necrosis (CC 39)	0.045	0.041	0.053	0.046
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	0.022	0.029	0.024	0.025
Disorders of the vertebrae and spinal discs (CC 41)	0.008	0.007	0.011	0.009
Osteoarthritis of hip or knee (CC 42)	0.067	0.063	0.063	0.064
Other musculoskeletal and connective tissue disorders (CC 45)	0.030	0.028	0.032	0.029
Severe hematological disorders (CC 46)	0.085	0.081	0.130	0.101
Coagulation defects and other specified hematological disorders (CC 48)	0.016	0.022	0.016	0.016
Delirium and encephalopathy (CC 50)	0.052	0.039	0.054	0.047
Dementia or other specified brain disorders (CC 51-53)	0.111	0.111	0.112	0.111
Major psychiatric disorders (CC 57-59)	0.085	0.087	0.082	0.085
Depression/anxiety (CC 61-62)	0.039	0.033	0.033	0.035
Other psychiatric disorders (CC 63)	0.022	0.020	0.022	0.019
Mental retardation or developmental disability (CC 64-68)	0.211	0.244	0.190	0.214
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	0.085	0.112	0.114	0.103
Polyneuropathy; other neuropathies (CC 75, 81)	0.013	0.015	0.013	0.013
Multiple sclerosis (CC 77)	0.104	0.130	0.114	0.116
Parkinson's and Huntington's diseases (CC 78)	0.159	0.173	0.173	0.169
Seizure disorders and convulsions (CC 79)	0.067	0.075	0.056	0.067
Congestive heart failure (CC 85)	0.060	0.055	0.060	0.059
Acute coronary syndrome (CC 86-87)	0.002	0.002	0.004	0.003
Valvular and rheumatic heart disease (CC 91)	0.010	0.010	0.007	0.009
Hypertension and hypertensive disease (CC 94-95)	0.023	0.026	0.021	0.024
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	0.015	0.017	0.017	0.016
Stroke (CC 99-100)	0.037	0.040	0.036	0.038
Vascular or circulatory disease (CC 106-109)	0.030	0.028	0.030	0.029
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.047	0.054	0.047	0.050
Pleural effusion/pneumothorax (CC 117)	-0.017	-0.008	0.003	-0.007
Other respiratory disorders (CC 118)	0.021	0.019	0.017	0.018
Legally blind (CC 119)	0.115	0.120	0.117	0.118
Dialysis status (CC 134)	0.332	0.324	0.360	0.339
Renal failure (CC 135-140)	0.057	0.055	0.051	0.053
Urinary incontinence (CC 143)	0.040	0.038	0.038	0.040
Urinary tract infection (CC 144)	0.013	0.017	0.018	0.016
Other urinary tract disorders (CC 145)	0.003	0.003	0.007	0.005
Decubitus ulcer or chronic skin ulcer (CC 157-161)	0.083	0.082	0.085	0.084
Cellulitis, local skin infection (CC 164)	0.022	0.025	0.024	0.025
Other dermatological disorders (CC 165)	-0.012	-0.011	-0.013	-0.013
Trauma (CC 166-168, 170-173)	0.059	0.053	0.048	0.053
Vertebral fractures without spinal cord injury (CC 169)	0.042	0.043	0.053	0.047
Other injuries (CC 174)	0.012	0.012	0.015	0.013
Major symptoms, abnormalities (CC 178)	0.036	0.034	0.034	0.034

Variable	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Minor symptoms, signs, findings (CC 179)	0.013	0.015	0.013	0.014

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

Variable	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2015-03/2016 PR (95% CI)	04/2013-03/2016 PR (95% CI)
Age minus 65 (years above 65, continuous)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.01)	1.01 (1.01, 1.02)
Male	0.93 (0.93, 0.94)	0.94 (0.93, 0.94)	0.94 (0.94, 0.94)	0.94 (0.94, 0.94)
Index admissions with an elective THA procedure	1.00 (1.00, 1.01)	1.00 (1.00, 1.01)	1.00 (0.99, 1.00)	1.00 (1.00, 1.00)
Procedure type (bilateral joint replacement)	1.76 (1.74, 1.78)	1.80 (1.78, 1.82)	1.76 (1.75, 1.78)	1.78 (1.76, 1.79)
Procedure type (single joint replacement; reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
Procedure type (staged joint replacements)	1.75 (1.72, 1.78)	1.75 (1.72, 1.78)	1.74 (1.71, 1.77)	1.75 (1.73, 1.77)
Severe infection; other infectious diseases (CC 1, 3-7)	1.05 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)
Metastatic cancer or acute leukemia (CC 8)	1.04 (1.02, 1.06)	1.03 (1.01, 1.05)	1.05 (1.03, 1.07)	1.04 (1.03, 1.05)
Cancer (CC 9-14)	0.99 (0.99, 1.00)	1.00 (0.99, 1.00)	1.00 (0.99, 1.00)	0.99 (0.99, 1.00)
Benign neoplasms of skin, breast, eye (CC 16)	0.98 (0.98, 0.98)	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 17-19, 122-123)	1.05 (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)	1.15 (1.13, 1.17)	1.17 (1.15, 1.19)	1.17 (1.15, 1.20)	1.16 (1.15, 1.17)
Morbid obesity (CC 22)	1.11 (1.11, 1.12)	1.11 (1.11, 1.12)	1.11 (1.11, 1.12)	1.11 (1.11, 1.11)
Other significant endocrine and metabolic disorders (CC 23)	1.03 (1.02, 1.04)	1.03 (1.02, 1.04)	1.03 (1.02, 1.04)	1.03 (1.03, 1.04)
Disorders of thyroid, cholesterol, lipids (CC 25-26)	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 37)	0.96 (0.92, 1.00)	1.00 (0.96, 1.04)	0.95 (0.92, 0.99)	0.97 (0.95, 0.99)
Bone/joint/muscle infections/necrosis (CC 39)	1.05 (1.04, 1.06)	1.04 (1.03, 1.05)	1.05 (1.05, 1.06)	1.05 (1.04, 1.05)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)
Disorders of the vertebrae and spinal discs (CC 41)	1.01 (1.01, 1.01)	1.01 (1.00, 1.01)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)
Osteoarthritis of hip or knee (CC 42)	1.07 (1.06, 1.08)	1.07 (1.06, 1.07)	1.07 (1.06, 1.07)	1.07 (1.06, 1.07)
Other musculoskeletal and connective tissue disorders (CC 45)	1.03 (1.03, 1.03)	1.03 (1.02, 1.03)	1.03 (1.03, 1.04)	1.03 (1.03, 1.03)

Variable	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2015-03/2016 PR (95% CI)	04/2013-03/2016 PR (95% CI)
Severe hematological disorders (CC 46)	1.09 (1.07, 1.11)	1.08 (1.06, 1.11)	1.14 (1.11, 1.17)	1.11 (1.09, 1.12)
Coagulation defects and other specified hematological disorders (CC 48)	1.02 (1.01, 1.02)	1.02 (1.02, 1.03)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)
Delirium and encephalopathy (CC 50)	1.05 (1.04, 1.07)	1.04 (1.02, 1.05)	1.05 (1.04, 1.07)	1.05 (1.04, 1.06)
Dementia or other specified brain disorders (CC 51-53)	1.12 (1.11, 1.13)	1.12 (1.11, 1.13)	1.12 (1.11, 1.13)	1.12 (1.11, 1.12)
Major psychiatric disorders (CC 57-59)	1.09 (1.08, 1.10)	1.09 (1.08, 1.10)	1.09 (1.08, 1.09)	1.09 (1.08, 1.09)
Depression/anxiety (CC 61-62)	1.04 (1.04, 1.04)	1.03 (1.03, 1.04)	1.03 (1.03, 1.04)	1.04 (1.03, 1.04)
Other psychiatric disorders (CC 63)	1.02 (1.02, 1.03)	1.02 (1.02, 1.02)	1.02 (1.02, 1.03)	1.02 (1.02, 1.02)
Mental retardation or developmental disability (CC 64-68)	1.23 (1.18, 1.29)	1.28 (1.22, 1.33)	1.21 (1.16, 1.26)	1.24 (1.21, 1.27)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1.09 (1.07, 1.10)	1.12 (1.10, 1.13)	1.12 (1.11, 1.14)	1.11 (1.10, 1.12)
Polyneuropathy; other neuropathies (CC 75, 81)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)
Multiple sclerosis (CC 77)	1.11 (1.08, 1.14)	1.14 (1.11, 1.17)	1.12 (1.09, 1.15)	1.12 (1.11, 1.14)
Parkinson's and Huntington's diseases (CC 78)	1.17 (1.16, 1.19)	1.19 (1.17, 1.21)	1.19 (1.17, 1.21)	1.18 (1.17, 1.19)
Seizure disorders and convulsions (CC 79)	1.07 (1.06, 1.08)	1.08 (1.07, 1.09)	1.06 (1.05, 1.07)	1.07 (1.06, 1.08)
Congestive heart failure (CC 85)	1.06 (1.06, 1.07)	1.06 (1.05, 1.06)	1.06 (1.06, 1.07)	1.06 (1.06, 1.06)
Acute coronary syndrome (CC 86-87)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (1.00, 1.01)
Valvular and rheumatic heart disease (CC 91)	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.00, 1.01)	1.01 (1.01, 1.01)
Hypertension and hypertensive disease (CC 94-95)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.02)	1.02 (1.02, 1.03)
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)
Stroke (CC 99-100)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.04 (1.03, 1.04)
Vascular or circulatory disease (CC 106-109)	1.03 (1.03, 1.03)	1.03 (1.02, 1.03)	1.03 (1.03, 1.03)	1.03 (1.03, 1.03)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.05 (1.04, 1.05)	1.06 (1.05, 1.06)	1.05 (1.04, 1.05)	1.05 (1.05, 1.05)
Pleural effusion/pneumothorax (CC 117)	0.98 (0.97, 0.99)	0.99 (0.98, 1.00)	1.00 (0.99, 1.01)	0.99 (0.99, 1.00)
Other respiratory disorders (CC 118)	1.02 (1.02, 1.02)	1.02 (1.02, 1.02)	1.02 (1.01, 1.02)	1.02 (1.02, 1.02)
Legally blind (CC 119)	1.12 (1.09, 1.16)	1.13 (1.09, 1.16)	1.12 (1.09, 1.16)	1.13 (1.11, 1.15)
Dialysis status (CC 134)	1.39 (1.34, 1.45)	1.38 (1.33, 1.44)	1.43 (1.38, 1.49)	1.40 (1.37, 1.44)
Renal failure (CC 135-140)	1.06 (1.05, 1.06)	1.06 (1.05, 1.06)	1.05 (1.05, 1.06)	1.05 (1.05, 1.06)
Urinary incontinence (CC 143)	1.04 (1.04, 1.05)	1.04 (1.03, 1.04)	1.04 (1.03, 1.04)	1.04 (1.04, 1.04)

Variable	04/2013-03/2014 PR (95% CI)	04/2014-03/2015 PR (95% CI)	04/2015-03/2016 PR (95% CI)	04/2013-03/2016 PR (95% CI)
Urinary tract infection (CC 144)	1.01 (1.01, 1.01)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)	1.02 (1.01, 1.02)
Other urinary tract disorders (CC 145)	1.00 (1.00, 1.01)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)
Decubitus ulcer or chronic skin ulcer (CC 157-161)	1.09 (1.08, 1.10)	1.08 (1.07, 1.10)	1.09 (1.08, 1.10)	1.09 (1.08, 1.09)
Cellulitis, local skin infection (CC 164)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)	1.03 (1.02, 1.03)
Other dermatological disorders (CC 165)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)	0.99 (0.98, 0.99)	0.99 (0.99, 0.99)
Trauma (CC 166-168, 170-173)	1.06 (1.05, 1.07)	1.05 (1.05, 1.06)	1.05 (1.04, 1.06)	1.05 (1.05, 1.06)
Vertebral fractures without spinal cord injury (CC 169)	1.04 (1.03, 1.06)	1.04 (1.03, 1.06)	1.05 (1.04, 1.07)	1.05 (1.04, 1.06)
Other injuries (CC 174)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.02 (1.01, 1.02)	1.01 (1.01, 1.01)
Major symptoms, abnormalities (CC 178)	1.04 (1.03, 1.04)	1.03 (1.03, 1.04)	1.03 (1.03, 1.04)	1.03 (1.03, 1.04)
Minor symptoms, signs, findings (CC 179)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)

**Table 4.5.4 – THA/TKA Generalized Linear Model Performance over Different Time Periods**

Characteristic	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Predictive ratios (lowest decile – highest decile)	0.98-1.01	0.98-1.01	0.98-1.00	0.98-1.01
Quasi-R <sup>2</sup>	0.22	0.21	0.20	0.21

**Table 4.5.5 – Distribution of Hospital THA/TKA Admission Volumes over Different Time Periods**

Characteristic	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Number of hospitals	3,312	3,298	3,285	3,452
Mean number of admissions (SD)	91 (129)	91 (129)	96 (139)	266 (389)
Range (min. – max.)	1 – 2,882	1 – 2,853	1 – 3,127	1 – 8,862
25 <sup>th</sup> percentile	15	14	15	37
50 <sup>th</sup> percentile	48	46	49	132
75 <sup>th</sup> percentile	121	119	128	349

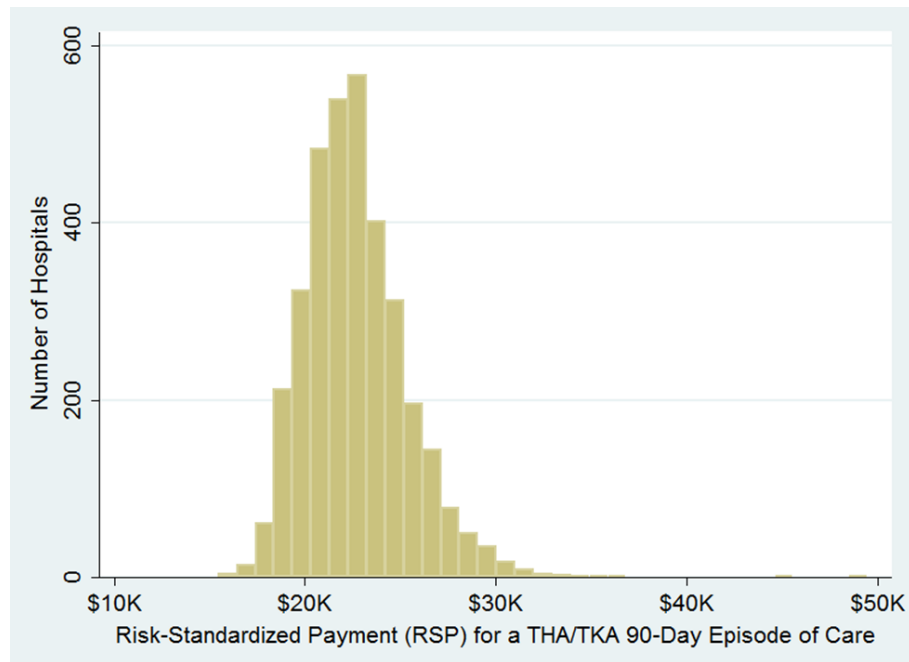
**Table 4.5.6 – Distribution of Hospital THA/TKA RSPs over Different Time Periods (\$2015)**

Characteristic	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Number of hospitals	3,312	3,298	3,285	3,452
Mean (SD)	23,454 (2,431)	22,840 (2,356)	21,733 (2,330)	22,686 (2,655)
Range (min. – max.)	16,965 – 46,407	14,660 – 49,154	15,545 – 40,604	15,481 – 49,496
25 <sup>th</sup> percentile	21,821	21,240	20,134	20,847
50 <sup>th</sup> percentile	23,248	22,660	21,529	22,408
75 <sup>th</sup> percentile	24,880	24,185	23,106	24,174

**Table 4.5.7 – Between-Hospital Variance for THA/TKA**

Characteristic	04/2013-03/2014	04/2014-03/2015	04/2015-03/2016	04/2013-03/2016
Between-hospital variance (SE)	0.014 (0.0005)	0.014 (0.0005)	0.015 (0.0005)	0.015 (0.0005)

**Figure 4.5.2 – Distribution of Hospital THA/TKA 90-Day Episode-of-Care RSPs between April 2013 and March 2016 (\$2015)**



N= 3,452 hospitals



## 5. GLOSSARY

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

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

**Comorbidities:** Medical conditions the patient had in addition to his/her primary reason for admission to the hospital.

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

**Condition Categories (CCs):** Groupings of ICD-9-CM/ICD-10-CM diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system.<sup>18,19</sup> CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Mappings which show the assignment of ICD-9 and ICD-10 codes to the CCs are available on the [QualityNet](#) website.

**Confidence Interval (CI):** A CI is a range of values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the 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 evaluation of relative hospital results by accounting for patient risk factors. This statistical model accounts for the hierarchical structure of the data (patients clustered within hospitals are assumed to be correlated) and accommodates modeling of the association between outcomes and patient characteristics. Based on the hierarchical model, we can evaluate: (1) how much variation in hospital 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 primary 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 there is 95% confidence that the true value of the RSP lies between the lower and the upper limit of the interval.

**Medicare fee-for-service (FFS):** Original Medicare plan in which providers receive a fee or payment for each individual service provided directly from Medicare. Only beneficiaries in Medicare FFS, not in managed care (Medicare Advantage), are included in the measures.

**National 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.

**Predictive ratio:** An estimator's ratio of predicted outcome to observed outcome.<sup>17</sup> 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.

**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 case mix and the average hospital effect (that is, the average effect among all hospitals in the national sample). The predicted payment for each hospital is estimated using the same case mix but an estimated hospital-specific effect for that hospital. 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 obtained by summing the predicted payments for all patients in the hospital. The predicted payment for each patient is calculated via the hierarchical model, which applies the estimated regression coefficients to the observed patient characteristics and adds the hospital-specific effect.

More specifically, we use a hierarchical 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.<sup>16</sup> 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:

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

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

where  $i$  indexes hospitals,  $j$  indexes patients within hospitals,  $\alpha_i$  represents the hospital-specific intercept,  $Z_{ij} = (Z_{1ij}, Z_{2ij}, \dots, Z_{pij})$  the patient-specific covariates,  $\mu$  is the adjusted average hospital intercept across all hospitals in the sample, and  $\tau^2$  is the between-hospital variance component.<sup>20</sup> 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,  $\hat{\mu}$ ,  $\{\alpha_1, \alpha_2, \dots, \alpha_{ij}\}$ ,  $\hat{\beta}$ , 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  $\widehat{RSP}_i$  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.

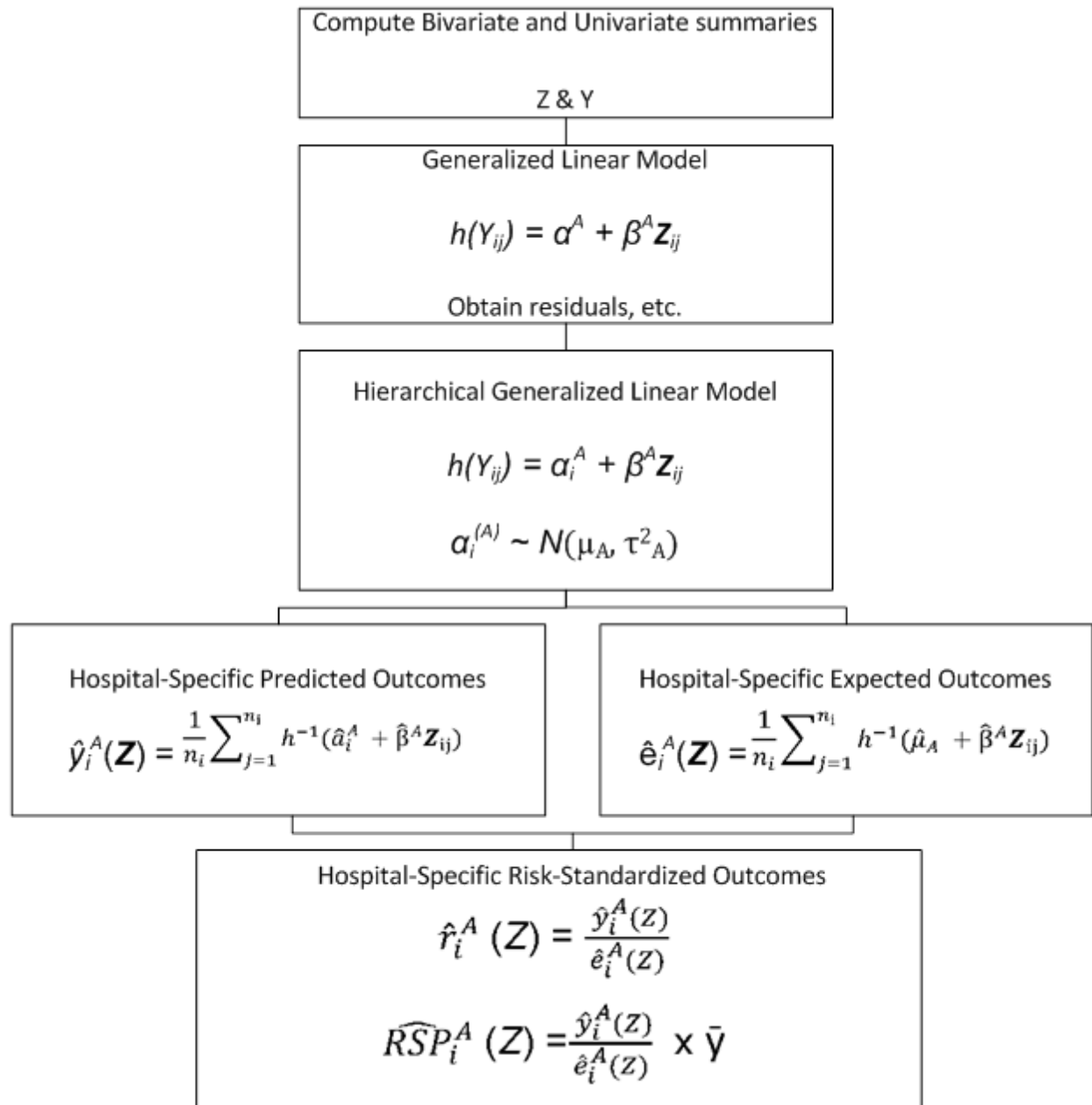
Algorithm:

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. The estimated regression coefficients of the risk factors,  $\hat{\beta}^{(b)}$
  - b. The parameters governing the random effects, hospital adjusted outcomes, distribution,  $\hat{\mu}^{(b)}$  and  $\hat{\tau}^{2(b)}$
  - c. The set of hospital-specific intercepts and corresponding variances,  $\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1, 2, \dots, I\}$
3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw  $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \widehat{var}(\hat{\alpha}_i^{(b)}))$  for the unique set of hospitals sampled in Step 1.
4. Within each unique hospital  $i$  sampled in Step 1, and for each 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 2.5<sup>th</sup> and 97.5<sup>th</sup> percentiles of the B estimates (or the percentiles corresponding to the alternative desired intervals).<sup>21</sup>

**Figure A.1 – Analysis Steps**



## **Appendix B. Data QA**

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

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 public reporting because another contractor conducts that work.

### **Phase I**

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

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

### **Phase II**

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

### **Phase III**

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



## Appendix C. Annual Updates

Prior annual updates for the 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 public reporting.

### 2017

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#### **2017 Measure Updates and Specifications Report Payment (AMI Version 6.0, HF Version 4.0, Pneumonia Version 4.0, THA/TKA Version 3.0)**

1. Updated the pneumonia measure specifications:
  - ICD-9 cohort codes include aspiration pneumonia admissions as well as sepsis admissions (not including severe sepsis) that have a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA.
    - Rationale: This expansion of the cohort allows the measure to capture a broader population of patients admitted for pneumonia and a more consistent clinical cohort across hospitals. Additionally, it aligns the pneumonia payment cohort with the current pneumonia mortality and readmission measure cohorts.
  - Updated the risk variable list in concordance with the expanded cohort.
    - Rationale: Risk variables were adjusted according to their associations with payment in the expanded pneumonia cohort.
2. Revised the measure specifications to accommodate the implementation of ICD-10 coding:
  - Identified the ICD-10 codes used to define each of the measure cohorts for discharges on or after October 1, 2015.
  - Identified the ICD-10 codes used to define wound/joint infections and mechanical complications for discharges on or after October 1, 2015 (used in assessing THA/TKA payments).
  - Re-specified the risk models, updating the CC-based risk variables to the ICD-10-compatible Hierarchical Condition Categories (HCC) system version 22 and applying ICD-10 codes for certain risk variables (for example, history of PTCA) to the models.
    - Rationale: The ICD-9 code sets used to report medical diagnoses and inpatient procedures were replaced by ICD-10 code sets on October 1, 2015. HHS mandated that ICD-10 codes be used for medical coding, effective October 1, 2015 discharges. The measurement period for 2017 public reporting required data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification was warranted to accommodate ICD-10 coding.
3. Changes from the 2016 payment measures updates and specifications report.
  - Rationale: The ‘Risk Variables for THA/TKA Measure’ table was corrected from the 2016 report. Table D.4.9 of the 2016 report incorrectly identified the following Version 12 CCs as not being potential complications of care:
    - CC 24 (Other endocrine/metabolic/nutritional disorders)
    - CC 37 (Bone/joint/muscle infections/necrosis)
    - CC 43 (Other musculoskeletal and connective tissue disorders)
    - CC 160 (Internal injuries)
    - CC 161 (Traumatic amputation)

- CC 162 (Other injuries)
- CC 177 (Amputation status, lower limb/amputation complications)
- CC 178 (Amputation status, upper limb)

Measure specifications in the 2016 SAS code correctly classified these conditions as potential complications of care (not used in risk adjustment if they occurred only during the index admission). These conditions, now updated to version 22, are correctly classified in Table D.4.2 of this report.

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## 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.<sup>22</sup> These patients represent a clinically distinct 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 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.

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## 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.

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## 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

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### 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 start of 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**

Rationale: Providers had limited opportunity to implement high quality care.

**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. Admissions 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. 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 within the 30-day outcome window of the June admission are excluded to avoid assigning payments for the same claims to two admissions.

**Table D.1.1 – ICD-10-CM Codes for AMI Cohort**

Table D.1.1 below outlines the ICD-10-CM codes used to define the AMI cohort for discharges on or after October 1, 2015. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted on *QualityNet*.

ICD-10-CM Codes	Description
I21.01	ST elevation (STEMI) myocardial infarction involving left main coronary artery
I21.02	ST elevation (STEMI) myocardial infarction involving left anterior descending coronary artery
I21.09	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
I21.11	ST elevation (STEMI) myocardial infarction involving right coronary artery
I21.19	ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall
I21.21	ST elevation (STEMI) myocardial infarction involving left circumflex coronary artery
I21.29	ST elevation (STEMI) myocardial infarction involving other sites
I21.3	ST elevation (STEMI) myocardial infarction of unspecified site
I21.4	Non-ST elevation (NSTEMI) myocardial infarction

## **Risk Adjustment**

**Table D.1.2 – Risk Variables for AMI Measure**

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

The ICD-10 codes used to identify History of CABG surgery and History of PTCA in discharges on or after October 1, 2015 are posted on [QualityNet](#) due to volume; hyperlinks to these lists are provided in the table. For a list of ICD-9 codes used to identify these variables in discharges prior to October 1, 2015, please refer to the 2016 payment measures updates and specifications report posted on [QualityNet](#).

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by “X”)
Age (>=85)	n/a	
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
History of coronary artery bypass graft (CABG) surgery	ICD-10-CM code list and ICD-10-PCS code list	
History of percutaneous transluminal coronary angioplasty (PTCA)	ICD-10-CM code list and ICD-10-PCS code list	
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	Metastatic cancer and acute leukemia (CC 8)	
	Lung and other severe cancers (CC 9)	
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	Diabetes with acute complications (CC 17)	X
	Diabetes with chronic complications (CC 18)	
	Diabetes without complications (CC 19)	
	Proliferative diabetic retinopathy and vitreous hemorrhage (CC 122)	
	Diabetic and other vascular retinopathies (CC 123)	
Protein-calorie malnutrition (CC 21)	Protein-calorie malnutrition (CC 21)	
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	Morbid obesity (CC 22)	
	Disorders of lipid metabolism (CC 25)	
	Other endocrine/metabolic/nutritional disorders (CC 26)	
Other significant endocrine and metabolic disorders (CC 23)	Other significant endocrine and metabolic disorders (CC 23)	
Other gastrointestinal disorders (CC 38)	Other gastrointestinal disorders (CC 38)	
Osteoporosis and other bone/cartilage disorders (CC 43)	Osteoporosis and other bone/cartilage disorders (CC 43)	
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	Iron deficiency or other/unspecified anemias and blood disease (CC 49)	

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Delirium and encephalopathy (CC 50)	Delirium and encephalopathy (CC 50)	X
Dementia (CC 51-52)	Dementia with complications (CC 51)	
	Dementia without complications (CC 52)	
Drug/alcohol psychosis (CC 54)	Drug/alcohol psychosis (CC 54)	
Drug/alcohol abuse/dependence (CC 55-56)	Drug/alcohol dependence (CC 55)	
	Drug/alcohol abuse, without dependence (CC 56)	
Severe mental illness (CC 57-58)	Schizophrenia (CC 57)	
	Major depressive, bipolar, and paranoid disorders (CC 58)	
Reactive and unspecified psychosis (CC 59)	Reactive and unspecified psychosis (CC 59)	
Depression/anxiety (CC 61-62)	Depression (CC 61)	
	Anxiety disorders (CC 62)	
Congestive heart failure (CC 85)	Congestive heart failure (CC 85)	X
Coronary atherosclerosis or angina (CC 88-89)	Angina pectoris (CC 88)	
	Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	
Heart infection/inflammation, except rheumatic (CC 90)	Heart infection/inflammation, except rheumatic (CC 90)	
Valvular and rheumatic heart disease (CC 91)	Valvular and rheumatic heart disease (CC 91)	
Congenital cardiac/circulatory defects (CC 92-93)	Major congenital cardiac/circulatory defect (CC 92)	
	Other congenital heart/circulatory disease (CC 93)	
Hypertension and hypertensive disease (CC 94-95)	Hypertensive heart disease (CC 94)	
	Hypertension (CC 95)	
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	X
Vascular disease and complications (CC 106-108)	Atherosclerosis of the extremities with ulceration or gangrene (CC 106)	X
	Vascular disease with complications (CC 107)	X
	Vascular disease (CC 108)	X
Other respiratory disorders (CC 118)	Other respiratory disorders (CC 118)	
Legally blind (CC 119)	Legally blind (CC 119)	
Dialysis status (CC 134)	Dialysis status (CC 134)	X
Internal injuries (CC 172)	Internal injuries (CC 172)	

## **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 time frame 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 start of 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**

Rationale: Providers had limited opportunity to implement high quality care.

**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. Admissions 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 group (ICD-10-PCS code list).

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. 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 within the 30-day outcome window of the June admission are excluded to avoid assigning payments for the same claims to two admissions.

**Table D.2.1 – ICD-10-CM Codes for HF Cohort**

Table D.2.1 below outlines the ICD-10-CM codes used to define the HF cohort for discharges on or after October 1, 2015. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted on *QualityNet*.

ICD-10-CM Codes	Description
I11.0	Hypertensive heart disease with heart failure
I13.0	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease
I13.2	Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease
I50.1	Left ventricular failure
I50.20	Unspecified systolic (congestive) heart failure
I50.21	Acute systolic (congestive) heart failure
I50.22	Chronic systolic (congestive) heart failure
I50.23	Acute on chronic systolic (congestive) heart failure
I50.30	Unspecified diastolic (congestive) heart failure
I50.31	Acute diastolic (congestive) heart failure
I50.32	Chronic diastolic (congestive) heart failure
I50.33	Acute on chronic diastolic (congestive) heart failure
I50.40	Unspecified combined systolic (congestive) and diastolic (congestive) heart failure

ICD-10-CM Codes	Description
I50.41	Acute combined systolic (congestive) and diastolic (congestive) heart failure
I50.42	Chronic combined systolic (congestive) and diastolic (congestive) heart failure
I50.43	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
I50.9	Heart failure, unspecified

### **Risk Adjustment**

The CCs outlined in Table D.2.2 below are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015.

**Table D.2.2 – Risk Variables for HF Measures**

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by “X”)
Age ( $\geq 85$ )	n/a	
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
Severe infection (CC 1, 3-6)	HIV/AIDS (CC 1)	
	Bacterial, fungal, and parasitic central nervous system infections (CC 3)	
	Viral and late effects central nervous system infections (CC 4)	
	Tuberculosis (CC 5)	
	Opportunistic infections (CC 6)	
Other infectious diseases (CC 7)	Other infectious diseases (CC 7)	X
Protein-calorie malnutrition (CC 21)	Protein-calorie malnutrition (CC 21)	
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	Morbid obesity (CC 22)	
	Disorders of lipid metabolism (CC 25)	
	Other endocrine/metabolic/nutritional disorders (CC 26)	
Other significant endocrine and metabolic disorders (CC 23)	Other significant endocrine and metabolic disorders (CC 23)	
Other gastrointestinal disorders (CC 38)	Other gastrointestinal disorders (CC 38)	
Bone/joint/muscle infections/necrosis (CC 39)	Bone/joint/muscle infections/necrosis (CC 39)	
Other musculoskeletal and connective tissue disorders (CC 45)	Other musculoskeletal and connective tissue disorders (CC 45)	
Delirium and encephalopathy (CC 50)	Delirium and encephalopathy (CC 50)	X
Dementia or other specified brain disorders (CC 51-53)	Dementia with complications (CC 51)	
	Dementia without complications (CC 52)	

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
	Nonpsychotic organic brain syndromes/conditions (CC 53)	
Severe mental illness (CC 57-58)	Schizophrenia (CC 57)	
	Major depressive, bipolar, and paranoid disorders (CC 58)	
Other psychiatric disorders (CC 63)	Other psychiatric disorders (CC 63)	
Respiratory arrest/cardiorespiratory failure/respirator dependence	Respirator dependence/tracheostomy status (CC 82)	X
	Respiratory arrest (CC 83)	X
	Cardio-respiratory failure and shock (CC 84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	X
Coronary atherosclerosis or angina (CC 88-89)	Angina pectoris (CC 88)	
	Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	
Heart infection/inflammation, except rheumatic (CC 90)	Heart infection/inflammation, except rheumatic (CC 90)	
Major congenital cardiac/circulatory defect (CC 92)	Major congenital cardiac/circulatory defect (CC 92)	
Hypertension (CC 95)	Hypertension (CC 95)	
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	Specified heart arrhythmias (CC 96)	X
	Other heart rhythm and conduction disorders (CC 97)	X
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	X
	Cerebrovascular atherosclerosis, aneurysm, and other disease (CC 102)	
Vascular or circulatory disease (CC 106-109)	Atherosclerosis of the extremities with ulceration or gangrene (CC 106)	X
	Vascular disease with complications (CC 107)	X
	Vascular disease (CC 108)	X
	Other circulatory disease (CC 109)	X
Pneumonia (CC 114-116)	Aspiration and specified bacterial pneumonias (CC 114)	X
	Pneumococcal pneumonia, empyema, lung abscess (CC 115)	X
	Viral and unspecified pneumonia, pleurisy (CC 116)	
Other ear, nose, throat, and mouth disorders (CC 131)	Other ear, nose, throat, and mouth disorders (CC 131)	

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Dialysis status (CC 134)	Dialysis status (CC 134)	X
Renal failure (CC 135-140)	Acute renal failure (CC 135)	X
	Chronic kidney disease, stage 5 (CC 136)	
	Chronic kidney disease, severe (stage 4) (CC 137)	
	Chronic kidney disease, moderate (stage 3) (CC 138)	
	Chronic kidney disease, mild or unspecified (stages 1-2 or unspecified) (CC 139)	
	Unspecified renal failure (CC 140)	X
Decubitus ulcer of skin (CC 157-160)	Pressure ulcer of skin with necrosis through to muscle, tendon, or bone (CC 157)	X
	Pressure ulcer of skin with full thickness skin loss (CC 158)	X
	Pressure ulcer of skin with partial thickness skin loss (CC 159)	X
	Pressure pre-ulcer skin changes or unspecified stage (CC 160)	X
Chronic ulcer of skin, except pressure (CC 161)	Chronic ulcer of skin, except pressure (CC 161)	
Cellulitis, local skin infection (CC 164)	Cellulitis, local skin infection (CC 164)	X
Hip fracture/dislocation (CC 170)	Hip fracture/dislocation (CC 170)	X
Internal injuries (CC 172)	Internal injuries (CC 172)	

## 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 time frame 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 (including aspiration pneumonia); or,**
- **Sepsis (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA**

Rationale: Pneumonia is the condition targeted for measurement. Sepsis admissions with a secondary diagnosis of pneumonia, as described above, are also included in order for the measure to more fully reflect the population of Medicare FFS beneficiaries being treated for pneumonia ([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 start of 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**

Rationale: Providers had limited opportunity to implement high quality care.

**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. Admissions 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. 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 within the 30-day outcome window of the June admission are excluded to avoid assigning payments for the same claims to two admissions.

**Table D.3.1 – ICD-10-CM Codes Pneumonia Cohort**

Table D.3.1 below outlines the ICD-10-CM codes used to define the pneumonia cohort for discharges on or after October 1, 2015. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 condition-specific mortality measures updates and specifications report posted on *QualityNet*.

ICD-10-CM Codes	Description
A48.1	Legionnaires' disease
J10.00	Influenza due to other identified influenza virus with unspecified type of pneumonia
J10.01	Influenza due to other identified influenza virus with the same other identified influenza virus pneumonia
J10.08	Influenza due to other identified influenza virus with other specified pneumonia
J11.00	Influenza due to unidentified influenza virus with unspecified type of pneumonia
J11.08	Influenza due to unidentified influenza virus with specified pneumonia
J12.0	Adenoviral pneumonia
J12.1	Respiratory syncytial virus pneumonia
J12.2	Parainfluenza virus pneumonia
J12.3	Human metapneumovirus pneumonia
J12.81	Pneumonia due to SARS-associated coronavirus
J12.89	Other viral pneumonia
J12.9	Viral pneumonia, unspecified

ICD-10-CM Codes	Description
J13	Pneumonia due to Streptococcus pneumoniae
J14	Pneumonia due to Hemophilus influenzae
J15.0	Pneumonia due to Klebsiella pneumoniae
J15.1	Pneumonia due to Pseudomonas
J15.20	Pneumonia due to staphylococcus, unspecified
J15.211	Pneumonia due to Methicillin susceptible Staphylococcus aureus
J15.212	Pneumonia due to Methicillin resistant Staphylococcus aureus
J15.29	Pneumonia due to other staphylococcus
J15.3	Pneumonia due to streptococcus, group B
J15.4	Pneumonia due to other streptococci
J15.5	Pneumonia due to Escherichia coli
J15.6	Pneumonia due to other aerobic Gram-negative bacteria
J15.7	Pneumonia due to Mycoplasma pneumoniae
J15.8	Pneumonia due to other specified bacteria
J15.9	Unspecified bacterial pneumonia
J16.0	Chlamydial pneumonia
J16.8	Pneumonia due to other specified infectious organisms
J18.0	Bronchopneumonia, unspecified organism
J18.1	Lobar pneumonia, unspecified organism
J18.8	Other pneumonia, unspecified organism
J18.9	Pneumonia, unspecified organism
J69.0	Pneumonitis due to inhalation of food and vomit
Principal discharge diagnosis codes included in cohort if combined with a secondary diagnosis of pneumonia coded as POA AND no secondary diagnosis of severe sepsis (R65.20 Severe sepsis without septic shock or R65.21 Severe sepsis with septic shock) coded as POA is present	
A02.1	Salmonella sepsis
A22.7	Anthrax sepsis
A26.7	Erysipelothrix sepsis
A32.7	Listerial sepsis
A40.0	Sepsis due to streptococcus, group A
A40.1	Sepsis due to streptococcus, group B
A40.3	Sepsis due to Streptococcus pneumoniae
A40.8	Other streptococcal sepsis
A40.9	Streptococcal sepsis, unspecified
A41.01	Sepsis due to Methicillin susceptible Staphylococcus aureus
A41.02	Sepsis due to Methicillin resistant Staphylococcus aureus
A41.1	Sepsis due to other specified staphylococcus
A41.2	Sepsis due to unspecified staphylococcus
A41.3	Sepsis due to Hemophilus influenzae
A41.4	Sepsis due to anaerobes
A41.50	Gram-negative sepsis, unspecified
A41.51	Sepsis due to Escherichia coli [E. coli]
A41.52	Sepsis due to Pseudomonas
A41.53	Sepsis due to Serratia
A41.59	Other Gram-negative sepsis
A41.81	Sepsis due to Enterococcus
A41.89	Other specified sepsis
A41.9	Sepsis, unspecified organism
A42.7	Actinomycotic sepsis



ICD-10-CM Codes	Description
A54.86	Gonococcal sepsis
B37.7	Candidal sepsis

### **Risk Adjustment**

**Table D.3.2 – Risk Variables for Pneumonia Measure**

The CCs outlined in Table D.3.2 below are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015.

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by “X”)
Age (>=85)	n/a	
Age (65 – 74)	n/a	
Age (75 – 84)	n/a	
Severe infection (CC 1, 3-6)	HIV/AIDS (CC 1)	
	Bacterial, fungal, and parasitic central nervous system infections (CC 3)	
	Viral and late effects central nervous system infections (CC 4)	
	Tuberculosis (CC 5)	
	Opportunistic infections (CC 6)	
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	X
Other infectious diseases (CC 7)	Other infectious diseases (CC 7)	X
Metastatic cancer or acute leukemia (CC 8)	Metastatic cancer or acute leukemia (CC 8)	
Lung and other severe cancers (CC 9)	Lung and other severe cancers (CC 9)	
Lymphatic, head and neck, brain, and other major cancers (CC 10-11)	Lymphoma and other cancers (CC 10)	
	Colorectal, bladder, and other cancers (CC 11)	
Benign neoplasms of skin, breast, eye (CC 16)	Benign neoplasms of skin, breast, eye (CC 16)	
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	Diabetes with acute complications (CC 17)	X
	Diabetes with chronic complications (CC 18)	
	Diabetes without complications (CC 19)	
	Proliferative diabetic retinopathy and vitreous hemorrhage (CC 122)	
	Diabetic and other vascular retinopathies (CC 123)	
Protein-calorie malnutrition (CC 21)	Protein-calorie malnutrition (CC 21)	
Other significant endocrine and metabolic disorders (CC 23)	Other significant endocrine and metabolic disorders (CC 23)	
Liver disease (CC 27-30)	End-stage liver disease (CC 27)	
	Cirrhosis of liver (CC 28)	
	Chronic hepatitis (CC 29)	
	Acute liver failure/disease (CC 30)	X

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Gallbladder and biliary tract disorders (CC 32)	Gallbladder and biliary tract disorders (CC 32)	
Appendicitis (CC 37)	Appendicitis (CC 37)	
Bone/joint/muscle infections/necrosis (CC 39)	Bone/joint/muscle infections/necrosis (CC 39)	
Osteoporosis and other bone/cartilage disorders (CC 43)	Osteoporosis and other bone/cartilage disorders (CC 43)	
Severe hematological disorders (CC 46)	Severe hematological disorders (CC 46)	
Disorders of immunity (CC 47)	Disorders of immunity (CC 47)	
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	Iron deficiency or other/unspecified anemias and blood disease (CC 49)	
Delirium and encephalopathy (CC 50)	Delirium and encephalopathy (CC 50)	X
Dementia or other specified brain disorders (CC 51-53)	Dementia with complications (CC 51)	
	Dementia without complications (CC 52)	
	Nonpsychotic organic brain syndromes/conditions (CC 53)	
Drug/alcohol psychosis or dependence (CC 54-55)	Drug/alcohol psychosis (CC 54)	
	Drug/alcohol dependence (CC 55)	
Major psychiatric disorders (CC 57-59)	Schizophrenia (CC 57)	
	Major depressive, bipolar, and paranoid disorders (CC 58)	
	Reactive and unspecified psychosis (CC 59)	
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	Quadriplegia (CC 70)	
	Paraplegia (CC 71)	
	Spinal cord disorders/injuries (CC 72)	
	Amyotrophic lateral sclerosis and other motor neuron disease (CC 73)	
	Cerebral palsy (CC 74)	
	Hemiplegia/hemiparesis (CC 103)	
	Monoplegia, other paralytic syndromes (CC 104)	
	Amputation status, lower limb/amputation complications (CC 189)	
	Amputation status, upper limb (CC 190)	
Neuropathy; muscular dystrophy (CC 75-76)	Myasthenia gravis/myoneural disorders and Guillain-Barre syndrome/inflammatory and toxic neuropathy (CC 75)	
	Muscular dystrophy (CC 76)	
Multiple sclerosis and Parkinson's (CC 77-78)	Multiple sclerosis (CC 77)	
	Parkinson's and Huntington's diseases (CC 78)	
Seizure disorders and convulsions (CC 79)	Seizure disorders and convulsions (CC 79)	
Coma, brain compression/anoxic damage (CC 80)	Coma, brain compression/anoxic damage (CC 80)	X

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	
Respiratory arrest/cardiorespiratory failure/respirator dependence	Respirator dependence/tracheostomy status (CC 82)	X
	Respiratory arrest (CC 83)	X
	Cardio-respiratory failure and shock (CC 84 plus ICD-10-CM codes R09.01 and R09.02, for discharges on or after October 1, 2015; CC 84 plus ICD-9-CM codes 799.01 and 799.02, for discharges prior to October 1, 2015)	X
Congestive heart failure (CC 85)	Congestive heart failure (CC 85)	X
Coronary atherosclerosis or angina (CC 88-89)	Angina pectoris (CC 88)	
	Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	
Heart infection/inflammation, except rheumatic (CC 90)	Heart infection/inflammation, except rheumatic (CC 90)	
Valvular and rheumatic heart disease (CC 91)	Valvular and rheumatic heart disease (CC 91)	
Hypertensive heart disease (CC 94)	Hypertensive heart disease (CC 94)	
Stroke (CC 99-100)	Cerebral hemorrhage (CC 99)	X
	Ischemic or unspecified stroke (CC 100)	X
Late effects of cerebrovascular disease, except paralysis (CC 105)	Late effects of cerebrovascular disease, except paralysis (CC 105)	
Chronic obstructive pulmonary disease (COPD) (CC 111)	Chronic obstructive pulmonary disease (COPD) (CC 111)	
Asthma (CC 113)	Asthma (CC 113)	
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	Pneumococcal pneumonia, empyema, lung abscess (CC 115)	X
Viral and unspecified pneumonia, pleurisy (CC 116)	Viral and unspecified pneumonia, pleurisy (CC 116)	
Pleural effusion/pneumothorax (CC 117)	Pleural effusion/pneumothorax (CC 117)	X
Other respiratory disorders (CC 118)	Other respiratory disorders (CC 118)	
Other eye disorders (CC 128)	Other eye disorders (CC 128)	
Significant ear, nose, and throat disorders (CC 129)	Significant ear, nose, and throat disorders (CC 129)	
Other ear, nose, throat, and mouth disorders (CC 131)	Other ear, nose, throat, and mouth disorders (CC 131)	
Dialysis status (CC 134)	Dialysis status (CC 134)	X
Urinary incontinence (CC 143)	Urinary incontinence (CC 143)	
Other female genital disorders (CC 148)	Other female genital disorders (CC 148)	
Decubitus ulcer or chronic skin ulcer (CC 157-161)	Pressure ulcer of skin with necrosis through to muscle, tendon, or bone (CC 157)	X

Description of Risk Variable	CCs and/or ICD Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
	Pressure ulcer of skin with full thickness skin loss (CC 158)	X
	Pressure ulcer of skin with partial thickness skin loss (CC 159)	X
	Pressure pre-ulcer skin changes or unspecified stage (CC 160)	X
	Chronic ulcer of skin, except pressure (CC 161)	
Vertebral fractures without spinal cord injury (CC 169)	Vertebral fractures without spinal cord injury (CC 169)	
Major fracture, except of skull, vertebrae, or hip (CC 171)	Major fracture, except of skull, vertebrae, or hip (CC 171)	X
Internal injuries (CC 172)	Internal injuries (CC 172)	
Traumatic amputations, other injuries (CC 173-174)	Traumatic amputations and complications (CC 173)	
	Other injuries (CC 174)	
Poisonings and allergic and inflammatory reactions (CC 175)	Poisonings and allergic and inflammatory reactions (CC 175)	X
Major symptoms, abnormalities (CC 178)	Major symptoms, abnormalities (CC 178)	
Minor symptoms, signs, findings (CC 179)	Minor symptoms, signs, findings (CC 179)	

## 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 time frame 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:

- **Fracture of the pelvis or lower limbs 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 (ICD-10-CM code list).

- **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 (ICD-10-PCS code list).

- **A concurrent revision, resurfacing, or implanted device/prosthesis removal procedure**

Rationale: Revision procedures may be performed at a disproportionately small number of hospitals and are associated with higher mortality, complication, and readmission rates. Resurfacing procedures are a different type of procedure involving only the joint's articular surface and are typically performed on younger, healthier patients. Elective procedures performed on patients undergoing removal of implanted device/prostheses procedures may be more complicated (ICD-10-PCS code list).

- **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 (ICD-10-CM code list).

- **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 (ICD-10-CM code list).

**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 had limited opportunity to implement high quality care.

**2. Incomplete administrative data in the 90 days following the start of 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. Admissions 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 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. 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 admissions, May admissions, and 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-10-PCS Codes for THA/TKA Cohort**

Table D.4.1 below outlines the ICD-10-PCS codes used to identify THA/TKA procedures for discharges on or after October 1, 2015. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted on *QualityNet*.

ICD-10-PCS Codes	Description
0SR9019	Replacement of Right Hip Joint with Metal Synthetic Substitute, Cemented, Open Approach
0SR901A	Replacement of Right Hip Joint with Metal Synthetic Substitute, Uncemented, Open Approach
0SR901Z	Replacement of Right Hip Joint with Metal Synthetic Substitute, Open Approach
0SR9029	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SR902A	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SR902Z	Replacement of Right Hip Joint with Metal on Polyethylene Synthetic Substitute, Open Approach
0SR9039	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Cemented, Open Approach
0SR903A	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Uncemented, Open Approach
0SR903Z	Replacement of Right Hip Joint with Ceramic Synthetic Substitute, Open Approach
0SR9049	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SR904A	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SR904Z	Replacement of Right Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Open Approach
0SR90J9	Replacement of Right Hip Joint with Synthetic Substitute, Cemented, Open Approach
0SR90JA	Replacement of Right Hip Joint with Synthetic Substitute, Uncemented, Open Approach
0SR90JZ	Replacement of Right Hip Joint with Synthetic Substitute, Open Approach
0SRB019	Replacement of Left Hip Joint with Metal Synthetic Substitute, Cemented, Open Approach
0SRB01A	Replacement of Left Hip Joint with Metal Synthetic Substitute, Uncemented, Open Approach
0SRB01Z	Replacement of Left Hip Joint with Metal Synthetic Substitute, Open Approach
0SRB029	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SRB02A	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SRB02Z	Replacement of Left Hip Joint with Metal on Polyethylene Synthetic Substitute, Open Approach
0SRB039	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Cemented, Open Approach
0SRB03A	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Uncemented, Open Approach
0SRB03Z	Replacement of Left Hip Joint with Ceramic Synthetic Substitute, Open Approach
0SRB049	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Cemented, Open Approach
0SRB04A	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Uncemented, Open Approach
0SRB04Z	Replacement of Left Hip Joint with Ceramic on Polyethylene Synthetic Substitute, Open Approach
0SRB0J9	Replacement of Left Hip Joint with Synthetic Substitute, Cemented, Open Approach

ICD-10-PCS Codes	Description
OSRB0JA	Replacement of Left Hip Joint with Synthetic Substitute, Uncemented, Open Approach
OSRB0JZ	Replacement of Left Hip Joint with Synthetic Substitute, Open Approach
OSRC0J9	Replacement of Right Knee Joint with Synthetic Substitute, Cemented, Open Approach
OSRC0JA	Replacement of Right Knee Joint with Synthetic Substitute, Uncemented, Open Approach
OSRC0JZ	Replacement of Right Knee Joint with Synthetic Substitute, Open Approach
OSRD0J9	Replacement of Left Knee Joint with Synthetic Substitute, Cemented, Open Approach
OSRD0JA	Replacement of Left Knee Joint with Synthetic Substitute, Uncemented, Open Approach
OSRD0JZ	Replacement of Left Knee Joint with Synthetic Substitute, Open Approach

### **Risk Adjustment**

**Table D.4.2 – Risk Variables for THA/TKA Measure**

The CCs outlined in Table D.4.2 below are used to identify risk variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015.

For a list of ICD-9 codes used to identify ‘Index admissions with an elective THA procedure’ in discharges prior to October 1, 2015, please refer to the 2016 payment measures updates and specifications report posted on *QualityNet*.

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by “X”)
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
Index admissions with an elective THA procedure	ICD-10-PCS codes OSR9019, OSR901A, OSR901Z, OSR9029, OSR902A, OSR902Z, OSR9039, OSR903A, OSR903Z, OSR9049, OSR904A, OSR904Z, OSR90J9, OSR90JA, OSR90JZ, OSRB019, OSRB01A, OSRB01Z, OSRB029, OSRB02A, OSRB02Z, OSRB039, OSRB03A, OSRB03Z, OSRB049, OSRB04A, OSRB04Z, OSRB0J9, OSRB0JA, OSRB0JZ	
Procedure type (bilateral joint replacement)	n/a	
Procedure type (single joint replacement)	n/a	
Procedure type (staged joint replacements)	n/a	
Severe infection; other infectious diseases (CC 1, 3-7)	HIV/AIDS (CC 1)	
	Bacterial, fungal, and parasitic central nervous system infections (CC 3)	
	Viral and late effects central nervous system infections (CC 4)	
	Tuberculosis (CC 5)	
	Opportunistic infections (CC 6)	



Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by “X”)
	Other infectious diseases (CC 7)	X
Metastatic cancer or acute leukemia (CC 8)	Metastatic cancer or acute leukemia (CC 8)	
Cancer (CC 9-14)	Lung and other severe cancers (CC 9)	
	Lymphoma and other cancers (CC 10)	
	Colorectal, bladder, and other cancers (CC 11)	
	Breast, prostate, and other cancers and tumors (CC 12)	
	Other respiratory and heart neoplasms (CC 13)	
	Other digestive and urinary neoplasms (CC 14)	
Benign neoplasms of skin, breast, eye (CC 16)	Benign neoplasms of skin, breast, eye (CC 16)	
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	Diabetes with acute complications (CC 17)	X
	Diabetes with chronic complications (CC 18)	
	Diabetes without complications (CC 19)	
	Proliferative diabetic retinopathy and vitreous hemorrhage (CC 122)	
	Diabetic and other vascular retinopathies (CC 123)	
Protein-calorie malnutrition (CC 21)	Protein-calorie malnutrition (CC 21)	
Morbid obesity (CC 22)	Morbid obesity (CC 22)	
Other significant endocrine and metabolic disorders (CC 23)	Other significant endocrine and metabolic disorders (CC 23)	
Disorders of thyroid, cholesterol, lipids (CC 25-26)	Disorders of lipid metabolism (CC 25)	X
	Other endocrine/metabolic/nutritional disorders (CC 26)	X
Appendicitis (CC 37)	Appendicitis (CC 37)	
Bone/joint/muscle infections/necrosis (CC 39)	Bone/joint/muscle infections/necrosis (CC 39)	X
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	
Disorders of the vertebrae and spinal discs (CC 41)	Disorders of the vertebrae and spinal discs (CC 41)	
Osteoarthritis of hip or knee (CC 42)	Osteoarthritis of hip or knee (CC 42)	
Other musculoskeletal and connective tissue disorders (CC 45)	Other musculoskeletal and connective tissue disorders (CC 45)	X
Severe hematological disorders (CC 46)	Severe hematological disorders (CC 46)	
Coagulation defects and other specified hematological disorders (CC 48)	Coagulation defects and other specified hematological disorders (CC 48)	X
Delirium and encephalopathy (CC 50)	Delirium and encephalopathy (CC 50)	X
	Dementia with complications (CC 51)	

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Dementia or other specified brain disorders (CC 51-53)	Dementia without complications (CC 52)	
	Nonpsychotic organic brain syndromes/conditions (CC 53)	
Major psychiatric disorders (CC 57-59)	Schizophrenia (CC 57)	
	Major depressive, bipolar, and paranoid disorders (CC 58)	
	Reactive and unspecified psychosis (CC 59)	
Depression/anxiety (CC 61-62)	Depression (CC 61)	
	Anxiety disorders (CC 62)	
Other psychiatric disorders (CC 63)	Other psychiatric disorders (CC 63)	
Mental retardation or developmental disability (CC 64-68)	Profound intellectual disability/developmental disorder (CC 64)	
	Severe intellectual disability/developmental disorder (CC 65)	
	Moderate intellectual disability/developmental disorder (CC 66)	
	Mild intellectual disability, autism, down syndrome (CC 67)	
	Other developmental disorders (CC 68)	
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	Quadriplegia (CC 70)	
	Paraplegia (CC 71)	
	Spinal cord disorders/injuries (CC 72)	
	Amyotrophic lateral sclerosis and other motor neuron disease (CC 73)	
	Cerebral palsy (CC 74)	
	Hemiplegia/hemiparesis (CC 103)	X
	Monoplegia, other paralytic syndromes (CC 104)	X
	Amputation status, lower limb/amputation complications (CC 189)	X
	Amputation status, upper limb (CC 190)	X
Polyneuropathy; other neuropathies (CC 75, 81)	Myasthenia gravis/myoneural disorders and Guillain-Barre syndrome/inflammatory and toxic neuropathy (CC 75)	
	Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	X
Multiple sclerosis (CC 77)	Multiple sclerosis (CC 77)	
Parkinson's and Huntington's diseases (CC 78)	Parkinson's and Huntington's diseases (CC 78)	
Seizure disorders and convulsions (CC 79)	Seizure disorders and convulsions (CC 79)	
Congestive heart failure (CC 85)	Congestive heart failure (CC 85)	X
Acute coronary syndrome (CC 86-87)	Acute myocardial infarction (CC 86)	X

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
	Unstable angina and other acute ischemic heart disease (CC 87)	X
Valvular and rheumatic heart disease (CC 91)	Valvular and rheumatic heart disease (CC 91)	
Hypertension and hypertensive disease (CC 94-95)	Hypertensive heart disease (CC 94)	
	Hypertension (CC 95)	
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	Specified heart arrhythmias (CC 96)	X
	Other heart rhythm and conduction disorders (CC 97)	X
Stroke (CC 99-100)	Cerebral hemorrhage (CC 99)	X
	Ischemic or unspecified stroke (CC 100)	X
Vascular or circulatory disease (CC 106-109)	Atherosclerosis of the extremities with ulceration or gangrene (CC 106)	X
	Vascular disease with complications (CC 107)	X
	Vascular disease (CC 108)	X
	Other circulatory disease (CC 109)	X
Chronic obstructive pulmonary disease (COPD) (CC 111)	Chronic obstructive pulmonary disease (COPD) (CC 111)	
Pleural effusion/pneumothorax (CC 117)	Pleural effusion/pneumothorax (CC 117)	X
Other respiratory disorders (CC 118)	Other respiratory disorders (CC 118)	
Legally blind (CC 119)	Legally blind (CC 119)	
Dialysis status (CC 134)	Dialysis status (CC 134)	X
Renal failure (CC 135-140)	Acute renal failure (CC 135)	X
	Chronic kidney disease, stage 5 (CC 136)	
	Chronic kidney disease, severe (stage 4) (CC 137)	
	Chronic kidney disease, moderate (stage 3) (CC 138)	
	Chronic kidney disease, mild or unspecified (stages 1-2 or unspecified) (CC 139)	
	Unspecified renal failure (CC 140)	X
Urinary incontinence (CC 143)	Urinary incontinence (CC 143)	
Urinary tract infection (CC 144)	Urinary tract infection (CC 144)	X
Other urinary tract disorders (CC 145)	Other urinary tract disorders (CC 145)	
Decubitus ulcer or chronic skin ulcer (CC 157-161)	Pressure ulcer of skin with necrosis through to muscle, tendon, or bone (CC 157)	X
	Pressure ulcer of skin with full thickness skin loss (CC 158)	X
	Pressure ulcer of skin with partial thickness skin loss (CC 159)	X
	Pressure pre-ulcer skin changes or unspecified stage (CC 160)	X
	Chronic ulcer of skin, except pressure (CC 161)	

Description of Risk Variable	CCs and/or ICD-10 Codes Included	Variables Not Used in Risk Adjustment if Occurred Only during Index Admission (indicated by "X")
Cellulitis, local skin infection (CC 164)	Cellulitis, local skin infection (CC 164)	X
Other dermatological disorders (CC 165)	Other dermatological disorders (CC 165)	
Trauma (CC 166-168, 170-173)	Severe head injury (CC 166)	X
	Major head injury (CC 167)	X
	Concussion or unspecified head injury (CC 168)	X
	Hip fracture/dislocation (CC 170)	X
	Major fracture, except of skull, vertebrae, or hip (CC 171)	X
	Internal injuries (CC 172)	X
	Traumatic amputations and complications (CC 173)	X
Vertebral fractures without spinal cord injury (CC 169)	Vertebral fractures without spinal cord injury (CC 169)	
Other injuries (CC 174)	Other injuries (CC 174)	X
Major symptoms, abnormalities (CC 178)	Major symptoms, abnormalities (CC 178)	
Minor symptoms, signs, findings (CC 179)	Minor symptoms, signs, findings (CC 179)	

## 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 the start of the index 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.4.3](#))
- Ambulatory Surgery Centers (joint manipulation procedures under anesthesia) ([Table D.4.3](#))
- Staged or repeat admission for single-site surgeries within 90 days after the start of the index admission
- Readmissions for complications as defined in the CMS THA/TKA Complication measure (wound/joint infection or mechanical complication) ([Table D.4.4](#))

**Table D.4.3 – 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.4.4 – ICD-10 Codes Defining Complications in CMS’s THA/TKA Complication Measure**

The ICD-10 codes used to define the complications for discharges on or after October 1, 2015 are posted on [QualityNet](#) due to volume. ICD-9 code lists for discharges prior to October 1, 2015 can be found in the 2016 payment measure updates and specifications report posted on [QualityNet](#).

Complication	ICD-10 Codes Defining Complication	Required Coding Placement
Mechanical Complications	ICD-10-CM code list	<ul style="list-style-type: none"> <li>Principal or secondary discharge diagnosis fields</li> </ul>
Peri-prosthetic Joint Infection/Wound Infection	One of the diagnosis codes in ICD-10-CM code list  <u>AND</u>  One of the procedure codes in ICD-10-PCS code list	<ul style="list-style-type: none"> <li>Diagnosis code in principal or secondary discharge diagnosis fields</li> <li>Procedure code in principal or secondary procedure fields</li> </ul>