2020 Payment Measures Updates and Specifications Report

Acute Myocardial Infarction – Version 9.0
Heart Failure – Version 7.0
Pneumonia – Version 7.0
Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) – Version 6.0

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) payment measures that are publicly reported. The measures are used to calculate 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 here on *QualityNet*.

Specifications that define the cohort inclusions and exclusions, risk-adjustment variables, and the complications used in the THA/TKA payment measure outcome described in this report are detailed in the following supplemental files:

- 2020 AMI Payment Measure Code Specifications
- 2020 HF Payment Measure Code Specifications
- 2020 Pneumonia Payment Measure Code Specifications
- 2020 THA/TKA Payment Measure Code Specifications

These supplemental files are posted here on *QualityNet.*

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 – 2020 measure updates**
- **Section 4 – 2020 measure results**
- **Section 5 – Glossary**

The appendices include:

- 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: Cohort inclusion/exclusion criteria and outcome criteria.

The original measure methodology reports and prior updates and specifications reports are available in the 'Methodology' and 'Archived Measure Methodology' sections on the payment measures page here on *QualityNet*.

The AMI payment measure methodology is also described in the peer-reviewed medical literature.[1]

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 Service hospitals) and critical access hospitals. In 2015, CMS began publicly reporting two additional hospital 30-day payment measures for HF and pneumonia, and in 2017, the hospital 90-day payment measure for elective primary THA/TKA. These measures also include admissions to non-federal short-term acute care hospitals (including Indian Health Service hospitals) and critical access hospitals.

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 and Evaluation (CORE) to update the AMI, HF, pneumonia, and THA/TKA payment measures for 2020 public reporting through a process of measure reevaluation.

2.2. Overview of Measure Methodology

The 2020 risk-adjusted payment measures use specifications from the initial measure methodology reports posted here on *QualityNet*, with refinements to the measures as listed in Appendix C and described in the prior measures updates and specifications reports posted here on *QualityNet*. An overview of the methodology is presented in this section.

For more information on the CMS programs that use these measures for fiscal year (FY) 2021, as well as their use in future FYs, please refer to the FY 2020 Inpatient Prospective Payment System (IPPS) Final Rule posted here on the CMS website.

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 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 on the index admission claim (Note: Periprosthetic fractures must be additionally coded as present on admission [POA] in order to disqualify a THA/TKA from cohort inclusion, unless exempt from POA reporting.);
- A concurrent partial hip or knee arthroplasty procedure;
- A concurrent revision, resurfacing, or implanted device/prosthesis removal procedure;
- Mechanical complication coded in the principal discharge diagnosis field on the index admission claim; 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 on the index admission claim.

The International Classification of Diseases, 10th Revision (ICD-10) codes used to define the cohort inclusions for each measure are listed in the supplemental files posted here on *QualityNet*.

The ICD-10 codes that are used to identify a THA/TKA procedure as non-elective or non-primary (and disqualify the admission from cohort inclusion) are posted in the 2020 THA/TKA Payment Measure Code Specifications supplemental file posted here 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 and 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 are provided in the 2020 HF Payment Measure Code Specifications supplemental file posted here on *QualityNet.* The International Classification of Diseases, 9th Revision (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 here on *QualityNet.*

Additionally, for the THA/TKA cohort, 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, when index admissions occur during the transition between two years within the measurement period (that is, June/July 2017 or June/July 2018) 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, when index admissions occur during the transition between two years within the measurement period (that is, March and April-June 2017 or March and April-June 2018) 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 hospitalizations that result from hospital-to-hospital transfers as a single acute episode of care. Transfer patients are identified by tracking

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

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 complication measure.

Medicare reduces payments when patients are transferred to another short-term acute care 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.[2] 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.

Payments are prorated for claims that overlap with the end date of the 30-day/90-day episode of care. If a claim for payment began within the 30-day/90-day episode, but ended after the 30-day/90-day episode, payment is evenly prorated over each day of the claim, and only prorated payments for the days of the claim that fall within the 30-day/90-day outcome time frame are included in the payment outcome.

To isolate payment variation that reflects practice patterns rather than CMS payment adjustments, payments are standardized for each setting as described in the CMS Standardization Methodology for Allowed Amount v.9 document posted here on *QualityNet*. 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 National Quality Forum (NQF) and publicly reported by CMS, which provides stakeholders with a consistent time period for assessing healthcare value.

The THA/TKA measure assesses 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/joint infections and other wound complications, 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) a patient began their index admission with an emergency department visit, observation stay, or care received in another outpatient location within the same facility (for example, outpatient diagnostic imaging), (b) the patient was admitted as an inpatient to that hospital within three days of that outpatient encounter, and (c) the care was combined into one claim, the date the outpatient care started would be used to 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), payments for these admissions would be eligible for capture in the payment outcome.

2.2.3 Risk-Adjustment Variables

To account for differences in case mix among hospitals, the measures include an adjustment for factors such as age, comorbid disease, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending 12 months prior to the index admission, and all claims for the index admission itself.

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

The measures do not include an adjustment for social risk factors because the association between social risk factors and health outcomes can be due, in part, to differences in the quality of health care that groups of patients with varying social risk factors receive. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important quality differences. The measures were re-endorsed by the NQF without adjustment for patient-level social risk factors in the last endorsement maintenance submission prior to 2020.

Refer to the supplemental files posted here on *QualityNet* for the list of comorbidity risk-adjustment variables and list of potential complications that are excluded from risk adjustment if they occur only during the index admission for each measure. The Condition Categories (CCs) outlined in the tables are used to identify risk-adjustment variables in claims for discharges on or after October 1, 2015 as well as discharges prior to October 1, 2015. The ICD-10 codes provided in the tables are used to identify certain risk-adjustment variables (for example, 'History of percutaneous transluminal coronary angioplasty (PTCA)') in discharges on or after October 1, 2015. 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 here on *QualityNet*.

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

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, 2016 and June 30, 2019 for AMI, HF, and pneumonia and between April 1, 2016 and March 31, 2019 for THA/TKA. The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims for the 12 months prior to the index admission and one

month subsequent to the index admission (or three months, for THA/TKA) for patients admitted in this time period.

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.

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.9 document posted here on *QualityNet.* The CMS Standardization Methodology for Allowed Amount for 2006 through 2019 was applied to the claims to calculate the measures.

Refer to the original methodology reports posted here on *QualityNet* for further descriptions of these data sources and an explanation of the three-year measurement period.

2.2.5 Measure Calculation

The hospital-level episode-of-care RSP for each measure is estimated using a hierarchical generalized linear model (HGLM). 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.[3] 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 on several model diagnostics.[4]

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.[3] 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; 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 4.2.2, Table 4.3.2, Table 4.4.2, and Table 4.5.2, 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 that 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 HGLMs are described fully in Appendix A and in the original methodology reports posted here on *QualityNet*.

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:

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

The distribution of hospitals by payment category in the U.S. for this reporting period is described in Section 4.2.5, Section 4.3.5, Section 4.4.5, and Section 4.5.5, for AMI, HF, pneumonia, and THA/TKA, respectively.

3. UPDATES TO MEASURES FOR 2020 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. Input is solicited from a workgroup composed of up to 20 clinical and measure experts, inclusive of internal and external consultants and subcontractors. As this report describes, for 2020 public reporting, we made the following modifications to the measures:

- Updated the ICD-10 code-based specifications used in the measures. Specifically:
  - Incorporated the code changes that occurred in the FY 2019 version of the ICD-10-CM/PCS (effective with October 1, 2018+ discharges) into the cohort definitions, the risk models, and the complication definitions used in the THA/TKA payment measure; and,
  - Applied a modified version of the FY 2019 V22 CMS-Hierarchical Condition Category (HCC) crosswalk that is maintained by RTI International to the risk models.

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

- Monitored code frequencies to identify any warranted specification changes due to possible changes in coding practices and patterns;
- Reviewed potentially clinically relevant codes that "neighbor" existing codes used in the measures to identify any warranted specification changes;
- Reviewed select pre-existing ICD-10 code-based specifications with our workgroup to confirm the appropriateness of specifications unaffected by the updates;
- Updated the measures' SAS analytic packages (SAS packs) and documentation;
- Evaluated and validated model performance for the three years combined (for AMI, HF, and pneumonia: July 2016-June 2019; for THA/TKA: April 2016-March 2019); and,
- 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 2016-June 2017, July 2017-June 2018, and July 2018-June 2019; for THA/TKA: April 2016-March 2017, April 2017-March 2018, April 2018-March 2019).

3.2. Detailed Discussion of Measure Updates

3.2.1 Updates to ICD-10 Code-Based Measure Specifications

Cohort and Complication Definitions

We examined the FY 2019 version of the ICD-10-CM/PCS, with particular attention to newly added codes and codes that were removed. We then solicited input from our

workgroup to determine which, if any, of the newly implemented ICD-10 codes in the FY 2019 code set should be added to the cohort definitions and the complication definitions used in the THA/TKA payment measure. We reviewed approximately 280 new ICD-10-CM codes and 390 new ICD-10-PCS codes.

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

- The addition of ICD-10-CM codes to the pneumonia cohort inclusion list;
- Changes to the code specifications that identify a THA/TKA procedure as non-elective or non-primary and disqualify the admission from THA/TKA cohort inclusion:
  - Partial arthroplasty code list: The addition of ICD-10-PCS codes;
  - Concurrent revision/resurfacing/removal procedure code list: The addition of ICD-10-PCS codes and removal of certain ICD-10-PCS codes;
- Changes to the code specifications that define the complications used in the THA/TKA payment measure:
  - 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications' code list: The addition of ICD-10-CM codes.

Risk Adjustment

We examined the FY 2019 version of the V22 CMS-HCC crosswalk released in July 2019 for use in 2020 public reporting to determine how the newly implemented ICD-10 codes in the FY 2019 code set were classified, and to examine codes which were reclassified from one HCC to another when the FY 2018 version was updated to the FY 2019 version. We then solicited input from our workgroup to confirm the clinical appropriateness of the HCC classifications of the newly implemented ICD-10 codes and any changes warranted due to the code shifts that occurred. The workgroup also reviewed the newly implemented ICD-10 codes in the FY 2019 version of the ICD-10-CM/PCS to determine which, if any, should be added to the singular ICD-10 code lists that are also used in risk adjustment (conditions that are not captured by CCs).

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

- The addition of ICD-10-CM codes to the code list used to define the 'History of coronary artery bypass graft (CABG) surgery' risk-adjustment variable (used in the AMI payment measure), if present in Medicare claims within 12 months prior to the index admission.

Additional Notes

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

All changes made to the ICD-10 code-based specifications are detailed in the following supplemental files that accompany this report:

- 2020 AMI Payment Measure Code Specifications

- 2020 HF Payment Measure Code Specifications
- 2020 Pneumonia Payment Measure Code Specifications
- 2020 THA/TKA Payment Measure Code Specifications

These supplemental files are posted here on *QualityNet*.

Changes are effective in claims for discharges on or after October 1, 2015.

Note that ICD-10 code listings in this report and the supplemental files reflect the current (FY 2019) labels or narrative descriptions for each code.

3.3. Changes to SAS Packs

We revised the measure SAS packs to accommodate specification updates discussed in Section 3.1 and Section 3.2 above. The new SAS packs and documentation are available upon request by emailing cmsepisodepaymentmeasures@yale.edu. **Do *NOT* submit patient-identifiable information (for example, date of birth, Social Security Number, health insurance claim number) to this address.**

The SAS packs include descriptions of the data files and data elements that feed the model software. Please be aware that CMS does not provide training or technical support for the software. CMS has made the SAS 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 the longitudinal patient data from the entire national sample of acute care hospitals that is used to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2020 PUBLIC REPORTING

4.1. Assessment of Updated Models

The hospital-level episode-of-care RSPs for the measures are estimated using HGLMs. Refer to Section 2 for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and updates and specifications reports on the payment measures page here on *QualityNet* for further details.

We evaluated the performance of the AMI, HF, and pneumonia models and the THA/TKA model using the July 2016 to June 2019 and April 2016 to March 2019 data, respectively, for the 2020 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 2018 dollars (designated with "$2018" in the Section 4 tables and figures below).

For each of the 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.[5] 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 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 2020 Model Results

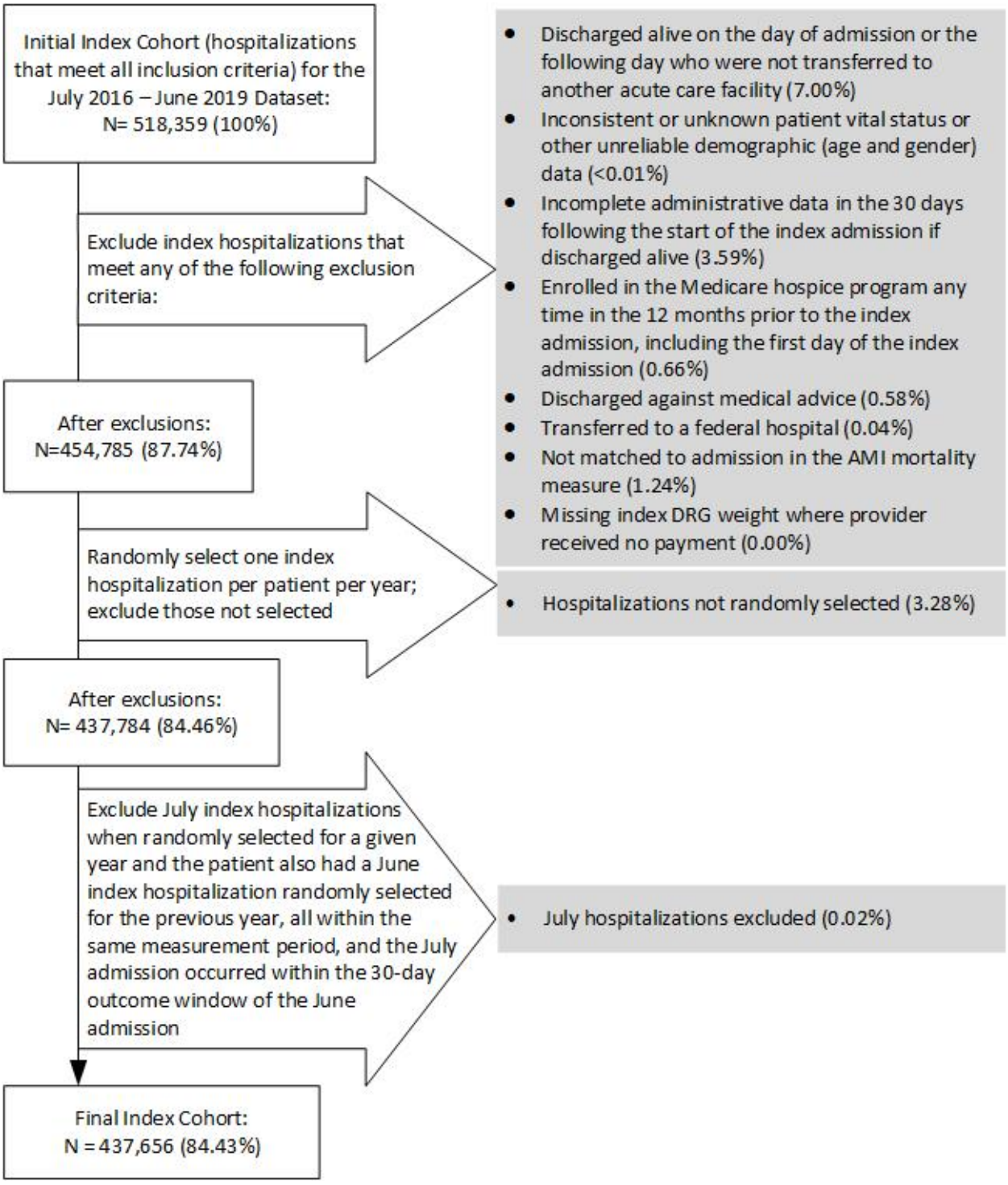
4.2.1 Index Cohort Exclusions

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 2016-June 2019 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 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 during the index admission; and,
- Who were not transferred from another acute care facility.

Figure 4.2.1 – AMI Cohort Exclusions in the July 2016-June 2019 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 quite stable over the measurement period. The largest changes in the frequencies (those greater than 2% absolute change) include decreases in 'Age (>=85)' (24.5% to 22.4%), 'Dementia' (15.7% to 13.6%), and 'Hypertension and hypertensive disease' (83.8% to 81.3%).

Refer to Table 4.2.1 for more detail.

4.2.3 AMI Model Parameters and Performance

Table 4.2.2 shows the hierarchical generalized linear regression model variable coefficients by individual year and for the combined three-year dataset. Table 4.2.3 shows the risk-adjusted payment ratios (PRs) and 95% confidence intervals (CIs) for the AMI payment model by individual year and for the combined three-year dataset. The quasi-R^2 for the AMI payment model was 0.08, 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^2s from other patient-level risk-adjustment models for healthcare payment.[6]

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 2019 public reporting (Table 4.2.4).

4.2.4 Distribution of Hospital Volumes and Payments for AMI

Between July 2016-June 2017 and July 2018-June 2019, the national mean payment increased from $25,337 to $25,649 ($2018).

Table 4.2.5 shows the distribution of hospital admission volumes, and Table 4.2.6 shows the distribution of hospital RSPs. Table 4.2.7 shows the between-hospital variance by individual year, as well as for the combined three-year dataset. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

Figure 4.2.2 shows the overall distribution of the hospital RSPs for the combined three-year dataset. The data are normally distributed. The expected 30-day RSP if a patient is treated at a hospital one standard deviation (SD) above the national average was 1.19 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.[3]

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

Of 4,082 hospitals in the study cohort, 166 had a payment "Less than the National Average Payment," 1,853 had a payment "No Different than the National Average

Payment," and 186 had a payment "Greater than the National Average Payment." 1,877 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 Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Total N	156,262	145,595	135,799	437,656
Age (>=85)	24.5	23.2	22.4	23.4
Age (65 - 74)	39.4	40.5	40.8	40.2
Age (75 - 84)	36.1	36.3	36.9	36.4
History of coronary artery bypass graft (CABG) surgery	17.8	17.5	17.1	17.5
History of percutaneous transluminal coronary angioplasty (PTCA)	24.8	25.9	26.3	25.6
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	4.3	4.2	4.3	4.3
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	46.9	46.4	46.5	46.6
Protein-calorie malnutrition (CC 21)	6.7	6.7	6.7	6.7
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	87.8	89.0	89.4	88.7
Other significant endocrine and metabolic disorders (CC 23)	8.2	8.4	8.7	8.4
Other gastrointestinal disorders (CC 38)	56.8	56.6	56.8	56.7
Osteoporosis and other bone/cartilage disorders (CC 43)	15.1	15.0	15.3	15.1
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	46.1	45.8	45.1	45.7
Delirium and encephalopathy (CC 50)	5.3	5.3	5.5	5.4
Dementia (CC 51-52)	15.7	14.5	13.6	14.7
Drug/alcohol psychosis (CC 54)	0.2	0.3	0.2	0.2
Drug/alcohol abuse/dependence (CC 55-56)	17.3	17.9	17.9	17.7
Severe mental illness (CC 57-58)	5.7	6.3	6.6	6.2
Reactive and unspecified psychosis (CC 59)	0.7	0.6	0.5	0.6
Depression/anxiety (CC 61-62)	18.0	18.0	18.2	18.1
Congestive heart failure (CC 85)	28.1	27.4	27.0	27.5
Coronary atherosclerosis or angina (CC 88-89)	82.3	82.2	82.6	82.3
Heart infection/inflammation, except rheumatic (CC 90)	2.3	2.5	2.5	2.5
Valvular and rheumatic heart disease (CC 91)	31.9	31.8	31.5	31.7
Congenital cardiac/circulatory defects (CC 92-93)	1.1	1.1	1.2	1.1
Hypertension and hypertensive disease (CC 94-95)	83.8	81.9	81.3	82.4
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	14.3	14.0	14.1	14.1
Vascular disease and complications (CC 106-108)	28.0	27.7	27.7	27.8
Other respiratory disorders (CC 118)	33.4	34.5	33.9	33.9
Legally blind (CC 119)	0.9	0.8	0.7	0.8
Dialysis status (CC 134)	3.9	3.9	4.0	3.9

Variable (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Internal injuries (CC 172)	0.7	0.6	0.6	0.6

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

Variable	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Intercept	9.834	9.853	9.835	9.840
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 - 74)	0.183	0.179	0.170	0.178
Age (75 - 84)	0.170	0.167	0.158	0.166
History of coronary artery bypass graft (CABG) surgery	-0.188	-0.187	-0.190	-0.188
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.073	-0.073	-0.079	-0.075
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	-0.071	-0.067	-0.060	-0.066
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	0.084	0.085	0.085	0.084
Protein-calorie malnutrition (CC 21)	0.138	0.121	0.137	0.131
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	-0.015	-0.014	0.007	-0.007
Other significant endocrine and metabolic disorders (CC 23)	0.021	0.021	0.013	0.019
Other gastrointestinal disorders (CC 38)	-0.031	-0.034	-0.029	-0.030
Osteoporosis and other bone/cartilage disorders (CC 43)	-0.054	-0.062	-0.053	-0.056
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.220	0.243	0.251	0.236
Delirium and encephalopathy (CC 50)	-0.045	-0.043	-0.040	-0.044
Dementia (CC 51-52)	-0.073	-0.085	-0.093	-0.083
Drug/alcohol psychosis (CC 54)	0.301	0.229	0.249	0.256
Drug/alcohol abuse/dependence (CC 55-56)	0.008	0.020	0.012	0.013
Severe mental illness (CC 57-58)	0.004	-0.001	-0.006	-0.002
Reactive and unspecified psychosis (CC 59)	-0.001	0.018	0.002	0.006
Depression/anxiety (CC 61-62)	-0.034	-0.024	-0.032	-0.029
Congestive heart failure (CC 85)	-0.049	-0.057	-0.068	-0.057
Coronary atherosclerosis or angina (CC 88-89)	0.138	0.124	0.133	0.131
Heart infection/inflammation, except rheumatic (CC 90)	0.191	0.221	0.221	0.209
Valvular and rheumatic heart disease (CC 91)	0.082	0.079	0.078	0.080
Congenital cardiac/circulatory defects (CC 92-93)	0.104	0.066	0.077	0.085
Hypertension and hypertensive disease (CC 94-95)	-0.070	-0.077	-0.084	-0.076
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	0.018	0.023	0.031	0.023
Vascular disease and complications (CC 106-108)	0.009	-0.005	0.007	0.004
Other respiratory disorders (CC 118)	0.053	0.053	0.051	0.052
Legally blind (CC 119)	-0.044	-0.020	-0.023	-0.031
Dialysis status (CC 134)	0.106	0.126	0.117	0.113

Variable	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Internal injuries (CC 172)	0.104	0.177	0.161	0.143

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

Variable	07/2016-06/2017 PR (95% CI)	07/2017-06/2018 PR (95% CI)	07/2018-06/2019 PR (95% CI)	07/2016-06/2019 PR (95% CI)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 - 74)	1.20 (1.19 - 1.21)	1.20 (1.18 - 1.21)	1.19 (1.17 - 1.20)	1.20 (1.19 - 1.20)
Age (75 - 84)	1.18 (1.17 - 1.20)	1.18 (1.17 - 1.19)	1.17 (1.16 - 1.18)	1.18 (1.17 - 1.19)
History of coronary artery bypass graft (CABG) surgery	0.83 (0.82 - 0.84)	0.83 (0.82 - 0.84)	0.83 (0.82 - 0.84)	0.83 (0.82 - 0.83)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.93 (0.92 - 0.94)	0.93 (0.92 - 0.94)	0.92 (0.92 - 0.93)	0.93 (0.92 - 0.93)
Metastatic cancer, acute leukemia and other severe cancers (CC 8-9)	0.93 (0.91 - 0.95)	0.94 (0.92 - 0.95)	0.94 (0.92 - 0.96)	0.94 (0.93 - 0.95)
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	1.09 (1.08 - 1.10)	1.09 (1.08 - 1.10)	1.09 (1.08 - 1.10)	1.09 (1.08 - 1.09)
Protein-calorie malnutrition (CC 21)	1.15 (1.13 - 1.17)	1.13 (1.11 - 1.15)	1.15 (1.13 - 1.17)	1.14 (1.13 - 1.15)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	0.99 (0.97 - 1.00)	0.99 (0.97 - 1.00)	1.01 (0.99 - 1.02)	0.99 (0.99 - 1.00)
Other significant endocrine and metabolic disorders (CC 23)	1.02 (1.00 - 1.04)	1.02 (1.00 - 1.04)	1.01 (0.99 - 1.03)	1.02 (1.01 - 1.03)
Other gastrointestinal disorders (CC 38)	0.97 (0.96 - 0.98)	0.97 (0.96 - 0.98)	0.97 (0.96 - 0.98)	0.97 (0.97 - 0.97)
Osteoporosis and other bone/cartilage disorders (CC 43)	0.95 (0.94 - 0.96)	0.94 (0.93 - 0.95)	0.95 (0.94 - 0.96)	0.95 (0.94 - 0.95)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.25 (1.24 - 1.26)	1.28 (1.26 - 1.29)	1.29 (1.27 - 1.30)	1.27 (1.26 - 1.27)
Delirium and encephalopathy (CC 50)	0.96 (0.94 - 0.97)	0.96 (0.94 - 0.98)	0.96 (0.94 - 0.98)	0.96 (0.95 - 0.97)
Dementia (CC 51-52)	0.93 (0.92 - 0.94)	0.92 (0.91 - 0.93)	0.91 (0.90 - 0.92)	0.92 (0.91 - 0.93)
Drug/alcohol psychosis (CC 54)	1.35 (1.24 - 1.48)	1.26 (1.15 - 1.37)	1.28 (1.17 - 1.41)	1.29 (1.23 - 1.36)
Drug/alcohol abuse/dependence (CC 55-56)	1.01 (1.00 - 1.02)	1.02 (1.01 - 1.03)	1.01 (1.00 - 1.02)	1.01 (1.01 - 1.02)
Severe mental illness (CC 57-58)	1.00 (0.99 - 1.02)	1.00 (0.98 - 1.02)	0.99 (0.98 - 1.01)	1.00 (0.99 - 1.01)
Reactive and unspecified psychosis (CC 59)	1.00 (0.96 - 1.04)	1.02 (0.97 - 1.07)	1.00 (0.95 - 1.06)	1.01 (0.98 - 1.04)

Variable	07/2016-06/2017 PR (95% CI)	07/2017-06/2018 PR (95% CI)	07/2018-06/2019 PR (95% CI)	07/2016-06/2019 PR (95% CI)
Depression/anxiety (CC 61-62)	0.97 (0.96 - 0.98)	0.98 (0.97 - 0.99)	0.97 (0.96 - 0.98)	0.97 (0.97 - 0.98)
Congestive heart failure (CC 85)	0.95 (0.94 - 0.96)	0.95 (0.94 - 0.95)	0.93 (0.92 - 0.94)	0.94 (0.94 - 0.95)
Coronary atherosclerosis or angina (CC 88-89)	1.15 (1.14 - 1.16)	1.13 (1.12 - 1.14)	1.14 (1.13 - 1.16)	1.14 (1.13 - 1.15)
Heart infection/inflammation, except rheumatic (CC 90)	1.21 (1.18 - 1.25)	1.25 (1.21 - 1.28)	1.25 (1.21 - 1.29)	1.23 (1.21 - 1.25)
Valvular and rheumatic heart disease (CC 91)	1.09 (1.08 - 1.09)	1.08 (1.07 - 1.09)	1.08 (1.07 - 1.09)	1.08 (1.08 - 1.09)
Congenital cardiac/circulatory defects (CC 92-93)	1.11 (1.07 - 1.15)	1.07 (1.03 - 1.11)	1.08 (1.04 - 1.12)	1.09 (1.06 - 1.11)
Hypertension and hypertensive disease (CC 94-95)	0.93 (0.92 - 0.94)	0.93 (0.92 - 0.94)	0.92 (0.91 - 0.93)	0.93 (0.92 - 0.93)
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	1.02 (1.01 - 1.03)	1.02 (1.01 - 1.04)	1.03 (1.02 - 1.04)	1.02 (1.02 - 1.03)
Vascular disease and complications (CC 106-108)	1.01 (1.00 - 1.02)	0.99 (0.99 - 1.00)	1.01 (1.00 - 1.02)	1.00 (1.00 - 1.01)
Other respiratory disorders (CC 118)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.06)	1.05 (1.04 - 1.06)	1.05 (1.05 - 1.06)
Legally blind (CC 119)	0.96 (0.92 - 0.99)	0.98 (0.94 - 1.02)	0.98 (0.93 - 1.03)	0.97 (0.95 - 0.99)
Dialysis status (CC 134)	1.11 (1.08 - 1.14)	1.13 (1.10 - 1.17)	1.12 (1.09 - 1.16)	1.12 (1.10 - 1.14)
Internal injuries (CC 172)	1.11 (1.06 - 1.16)	1.19 (1.13 - 1.26)	1.17 (1.11 - 1.24)	1.15 (1.12 - 1.19)

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Predictive ratios (lowest decile – highest decile)	0.95 – 0.91	0.96 – 0.92	0.96 – 0.91	0.95 – 0.91
Quasi-R^2	0.07	0.08	0.08	0.08

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	3,691	3,587	3,501	4,082
Mean number of admissions (SD)	42 (56)	41 (53)	39 (51)	107 (154)
Range (min. – max.)	1 – 461	1 – 486	1 – 394	1 – 1,341
25th percentile	3	3	3	5
50th percentile	18	18	17	33
75th percentile	62	61	58	159

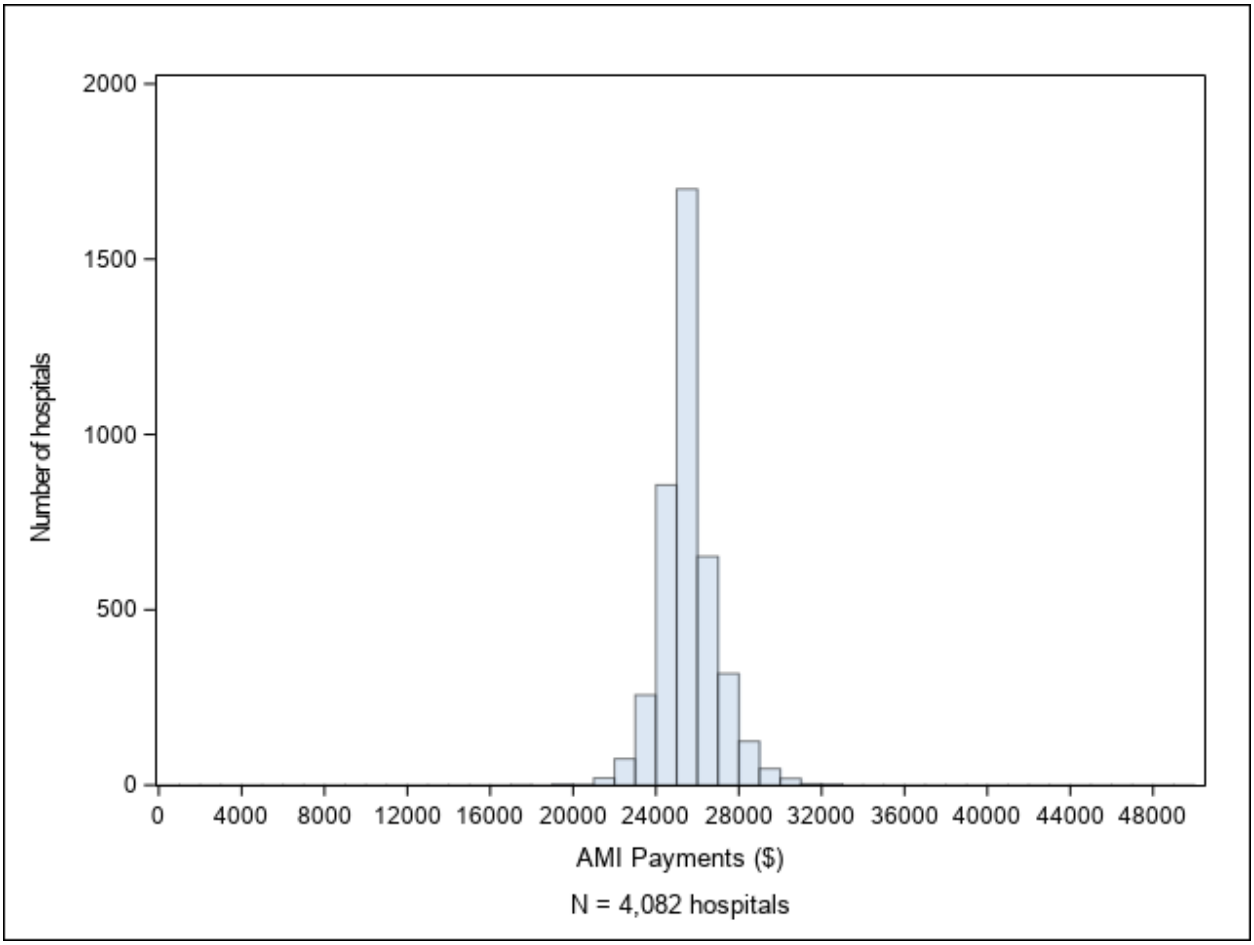
Table 4.2.6 – Distribution of Hospital AMI RSPs over Different Time Periods ($2018)

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	3,691	3,587	3,501	4,082
Mean (SD)	25,360 (1,099)	25,636 (1,044)	25,672 (1,095)	25,561 (1,351)
Range (min. – max.)	20,592 – 30,714	21,304 – 31,906	21,546 – 32,595	17,488 – 32,810
25th percentile	24,843	25,147	25,145	24,859
50th percentile	25,248	25,539	25,542	25,422
75th percentile	25,812	26,083	26,125	26,165

Table 4.2.7 – Between-Hospital Variance for AMI over Different Time Periods

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Between-hospital variance (SE)	0.007 (0.0005)	0.007 (0.0005)	0.007 (0.0006)	0.007 (0.0004)

Figure 4.2.2 – Distribution of Hospital AMI 30-Day Episode-of-Care RSPs between July 2016 and June 2019 ($2018)



4.3. HF Payment 2020 Model Results

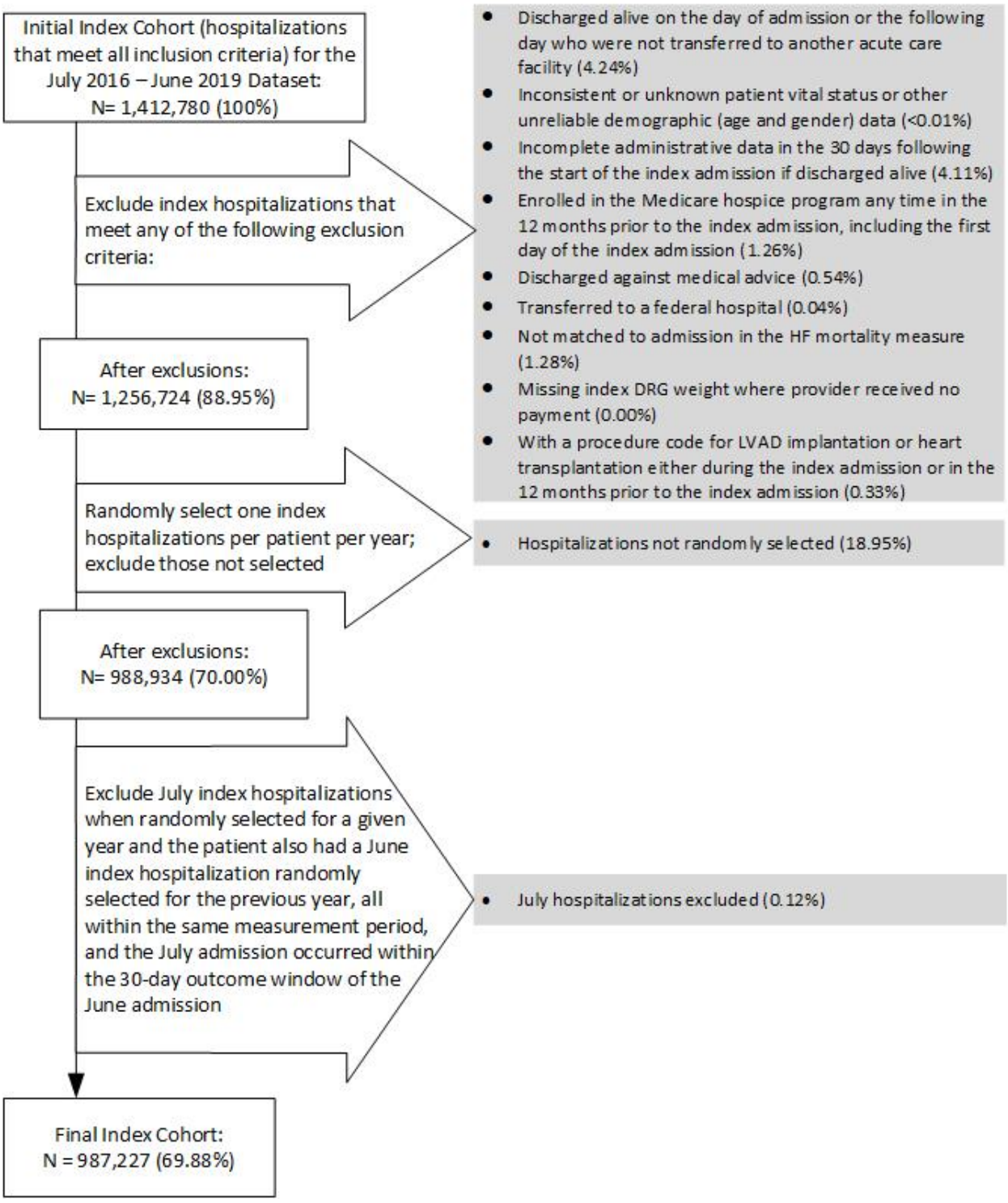
4.3.1 Index Cohort Exclusions

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 2016-June 2019 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 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 during the index admission; and,
- Who were not transferred from another acute care facility.

Figure 4.3.1 – HF Cohort Exclusions in the July 2016-June 2019 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 quite stable over the measurement period. The largest changes in the frequencies (those greater than 2% absolute change) include decreases in 'Hypertension' (85.2% to 80.3%) and 'Pneumonia' (42.5% to 40.4%).

Refer to Table 4.3.1 for more detail.

4.3.3 HF Model Parameters and Performance

Table 4.3.2 shows hierarchical generalized linear regression model variable coefficients by individual year and for the combined three-year dataset. Table 4.3.3 shows the risk-adjusted PRs and 95% CIs for the HF payment model by individual year and for the combined three-year dataset. The quasi-R^2 for the HF payment model was 0.03, suggesting that approximately 3% of the variation in payment can be explained by patient-level risk factors. This quasi-R^2 is in line with R^2s from other patient-level risk-adjustment models for healthcare payment.[6]

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 2019 public reporting (Table 4.3.4).

4.3.4 Distribution of Hospital Volumes and Payments for HF

Between July 2016-June 2017 and July 2018-June 2019, the national mean payment decreased from $17,747 to $17,400 ($2018).

Table 4.3.5 shows the distribution of hospital admission volumes, and Table 4.3.6 shows the distribution of hospital RSPs. Table 4.3.7 shows the between-hospital variance by individual year, as well as for the combined three-year dataset. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

Figure 4.3.2 shows the overall distribution of the hospital RSPs for the combined three-year dataset. The data are normally distributed. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was 1.22 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.[3]

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

Of 4,502 hospitals in the study cohort, 409 had a payment "Less than the National Average Payment," 2,515 had a payment "No Different than the National Average Payment," and 542 had a payment "Greater than the National Average Payment." 1,036

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 (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Total N	322,586	333,072	331,569	987,227
Age (>=85)	36.5	36.0	35.6	36.0
Age (65 - 74)	27.0	27.3	27.4	27.2
Age (75 - 84)	36.6	36.6	37.1	36.8
Severe infection (CC 1, 3-6)	1.7	1.6	1.6	1.6
Other infectious diseases (CC 7)	37.0	36.6	36.2	36.6
Protein-calorie malnutrition (CC 21)	11.2	11.8	12.0	11.7
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	90.0	90.9	91.4	90.8
Other significant endocrine and metabolic disorders (CC 23)	12.6	13.4	13.9	13.3
Other gastrointestinal disorders (CC 38)	66.0	66.0	66.4	66.1
Bone/joint/muscle infections/necrosis (CC 39)	2.7	2.9	2.9	2.8
Other musculoskeletal and connective tissue disorders (CC 45)	75.3	74.9	74.9	75.0
Delirium and encephalopathy (CC 50)	10.7	11.5	12.0	11.4
Dementia or other specified brain disorders (CC 51-53)	24.0	23.4	23.0	23.5
Severe mental illness (CC 57-58)	7.8	8.4	9.3	8.5
Other psychiatric disorders (CC 63)	23.8	24.3	24.9	24.3
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 diagnosis codes 799.01 and 799.02, for discharges prior to October 1, 2015)	32.8	33.9	34.6	33.8
Coronary atherosclerosis or angina (CC 88-89)	69.8	69.2	68.4	69.1
Heart infection/inflammation, except rheumatic (CC 90)	4.3	4.5	4.9	4.6
Major congenital cardiac/circulatory defect (CC 92)	0.1	0.1	0.1	0.1
Hypertension (CC 95)	85.2	81.5	80.3	82.3
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	67.6	67.7	68.1	67.8
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	19.8	19.5	19.3	19.6
Vascular or circulatory disease (CC 106-109)	53.0	53.4	53.9	53.5
Pneumonia (CC 114-116)	42.5	42.2	40.4	41.7
Other ear, nose, throat, and mouth disorders (CC 131)	33.1	33.9	34.0	33.6
Dialysis status (CC 134)	4.9	5.3	5.5	5.2
Renal failure (CC 135-140)	65.5	66.9	67.3	66.6
Decubitus ulcer of skin (CC 157-160)	6.3	6.3	6.4	6.3
Chronic ulcer of skin, except pressure (CC 161)	10.7	11.0	11.2	10.9
Cellulitis, local skin infection (CC 164)	17.3	17.4	17.3	17.3
Hip fracture/dislocation (CC 170)	3.4	3.3	3.2	3.3

Variable (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Internal injuries (CC 172)	1.1	1.0	0.9	1.0

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

Variable	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Intercept	9.590	9.574	9.551	9.568
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 - 74)	0.061	0.055	0.061	0.061
Age (75 - 84)	0.042	0.048	0.050	0.048
Severe infection (CC 1, 3-6)	0.048	0.052	0.036	0.044
Other infectious diseases (CC 7)	0.021	0.019	0.019	0.019
Protein-calorie malnutrition (CC 21)	0.114	0.099	0.103	0.104
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	0.008	0.000	0.005	0.003
Other significant endocrine and metabolic disorders (CC 23)	0.050	0.048	0.046	0.047
Other gastrointestinal disorders (CC 38)	0.002	0.009	0.006	0.007
Bone/joint/muscle infections/necrosis (CC 39)	0.045	0.050	0.049	0.048
Other musculoskeletal and connective tissue disorders (CC 45)	-0.001	0.001	0.009	0.003
Delirium and encephalopathy (CC 50)	0.024	0.017	0.013	0.017
Dementia or other specified brain disorders (CC 51-53)	0.032	0.030	0.029	0.031
Severe mental illness (CC 57-58)	0.028	0.032	0.026	0.026
Other psychiatric disorders (CC 63)	0.010	0.009	0.009	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 diagnosis codes 799.01 and 799.02, for discharges prior to October 1, 2015)	0.019	0.014	0.009	0.014
Coronary atherosclerosis or angina (CC 88-89)	0.030	0.028	0.035	0.029
Heart infection/inflammation, except rheumatic (CC 90)	0.075	0.074	0.063	0.069
Major congenital cardiac/circulatory defect (CC 92)	0.068	0.049	0.114	0.077
Hypertension (CC 95)	-0.037	-0.025	-0.017	-0.024
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	-0.040	-0.030	-0.036	-0.036
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	0.008	0.020	0.015	0.014
Vascular or circulatory disease (CC 106-109)	0.015	0.015	0.011	0.012
Pneumonia (CC 114-116)	0.067	0.059	0.054	0.060
Other ear, nose, throat, and mouth disorders (CC 131)	-0.013	-0.016	-0.015	-0.015
Dialysis status (CC 134)	0.096	0.087	0.092	0.090
Renal failure (CC 135-140)	0.102	0.120	0.101	0.107
Decubitus ulcer of skin (CC 157-160)	0.043	0.042	0.035	0.039
Chronic ulcer of skin, except pressure (CC 161)	0.060	0.062	0.066	0.062

Variable	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Cellulitis, local skin infection (CC 164)	0.009	0.008	0.012	0.010
Hip fracture/dislocation (CC 170)	0.024	0.029	0.023	0.025
Internal injuries (CC 172)	0.032	0.019	0.070	0.039

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

Variable	07/2016-06/2017 PR (95% CI)	07/2017-06/2018 PR (95% CI)	07/2018-06/2019 PR (95% CI)	07/2016-06/2019 PR (95% CI)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 - 74)	1.06 (1.06 - 1.07)	1.06 (1.05 - 1.06)	1.06 (1.06 - 1.07)	1.06 (1.06 - 1.07)
Age (75 - 84)	1.04 (1.04 - 1.05)	1.05 (1.04 - 1.05)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.05)
Severe infection (CC 1, 3-6)	1.05 (1.03 - 1.07)	1.05 (1.03 - 1.07)	1.04 (1.02 - 1.06)	1.05 (1.03 - 1.06)
Other infectious diseases (CC 7)	1.02 (1.02 - 1.03)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.02 - 1.02)
Protein-calorie malnutrition (CC 21)	1.12 (1.11 - 1.13)	1.10 (1.10 - 1.11)	1.11 (1.10 - 1.12)	1.11 (1.10 - 1.11)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25-26)	1.01 (1.00 - 1.02)	1.00 (0.99 - 1.01)	1.01 (1.00 - 1.01)	1.00 (1.00 - 1.01)
Other significant endocrine and metabolic disorders (CC 23)	1.05 (1.04 - 1.06)	1.05 (1.04 - 1.06)	1.05 (1.04 - 1.06)	1.05 (1.04 - 1.05)
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)	1.05 (1.03 - 1.06)	1.05 (1.04 - 1.07)	1.05 (1.04 - 1.07)	1.05 (1.04 - 1.06)
Other musculoskeletal and connective tissue disorders (CC 45)	1.00 (0.99 - 1.01)	1.00 (1.00 - 1.01)	1.01 (1.00 - 1.01)	1.00 (1.00 - 1.01)
Delirium and encephalopathy (CC 50)	1.02 (1.02 - 1.03)	1.02 (1.01 - 1.03)	1.01 (1.01 - 1.02)	1.02 (1.01 - 1.02)
Dementia or other specified brain disorders (CC 51-53)	1.03 (1.03 - 1.04)	1.03 (1.02 - 1.04)	1.03 (1.02 - 1.04)	1.03 (1.03 - 1.03)
Severe mental illness (CC 57-58)	1.03 (1.02 - 1.04)	1.03 (1.02 - 1.04)	1.03 (1.02 - 1.03)	1.03 (1.02 - 1.03)
Other psychiatric disorders (CC 63)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.01)	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 diagnosis codes 799.01 and 799.02, for discharges prior to October 1, 2015)	1.02 (1.01 - 1.03)	1.01 (1.01 - 1.02)	1.01 (1.00 - 1.01)	1.01 (1.01 - 1.02)

Variable	07/2016-06/2017 PR (95% CI)	07/2017-06/2018 PR (95% CI)	07/2018-06/2019 PR (95% CI)	07/2016-06/2019 PR (95% CI)
Coronary atherosclerosis or angina (CC 88-89)	1.03 (1.02 - 1.04)	1.03 (1.02 - 1.03)	1.04 (1.03 - 1.04)	1.03 (1.03 - 1.03)
Heart infection/inflammation, except rheumatic (CC 90)	1.08 (1.07 - 1.09)	1.08 (1.06 - 1.09)	1.07 (1.05 - 1.08)	1.07 (1.06 - 1.08)
Major congenital cardiac/circulatory defect (CC 92)	1.07 (0.99 - 1.16)	1.05 (0.98 - 1.13)	1.12 (1.04 - 1.20)	1.08 (1.03 - 1.13)
Hypertension (CC 95)	0.96 (0.96 - 0.97)	0.98 (0.97 - 0.98)	0.98 (0.98 - 0.99)	0.98 (0.97 - 0.98)
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	0.96 (0.96 - 0.97)	0.97 (0.97 - 0.98)	0.96 (0.96 - 0.97)	0.97 (0.96 - 0.97)
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101-102)	1.01 (1.00 - 1.01)	1.02 (1.01 - 1.03)	1.01 (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 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.02)
Pneumonia (CC 114-116)	1.07 (1.06 - 1.07)	1.06 (1.06 - 1.07)	1.06 (1.05 - 1.06)	1.06 (1.06 - 1.06)
Other ear, nose, throat, and mouth disorders (CC 131)	0.99 (0.98 - 0.99)	0.98 (0.98 - 0.99)	0.99 (0.98 - 0.99)	0.99 (0.98 - 0.99)
Dialysis status (CC 134)	1.10 (1.09 - 1.11)	1.09 (1.08 - 1.10)	1.10 (1.08 - 1.11)	1.09 (1.09 - 1.10)
Renal failure (CC 135-140)	1.11 (1.10 - 1.11)	1.13 (1.12 - 1.13)	1.11 (1.10 - 1.11)	1.11 (1.11 - 1.12)
Decubitus ulcer of skin (CC 157-160)	1.04 (1.03 - 1.05)	1.04 (1.03 - 1.05)	1.04 (1.03 - 1.05)	1.04 (1.03 - 1.05)
Chronic ulcer of skin, except pressure (CC 161)	1.06 (1.05 - 1.07)	1.06 (1.06 - 1.07)	1.07 (1.06 - 1.08)	1.06 (1.06 - 1.07)
Cellulitis, local skin infection (CC 164)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.01)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.01)
Hip fracture/dislocation (CC 170)	1.02 (1.01 - 1.04)	1.03 (1.02 - 1.04)	1.02 (1.01 - 1.04)	1.03 (1.02 - 1.03)
Internal injuries (CC 172)	1.03 (1.01 - 1.06)	1.02 (1.00 - 1.04)	1.07 (1.05 - 1.10)	1.04 (1.03 - 1.05)

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Predictive ratios (lowest decile – highest decile)	1.03 – 1.01	1.03 – 1.02	1.02 – 1.01	1.03 – 1.02
Quasi-R^2	0.03	0.03	0.03	0.03

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	4,380	4,351	4,344	4,502
Mean number of admissions (SD)	74 (93)	77 (98)	76 (99)	219 (287)
Range (min. – max.)	1 – 1,043	1 – 1,085	1 – 1,041	1 – 3,169
25th percentile	11	10	10	27
50th percentile	35	36	34	98
75th percentile	106	110	111	317

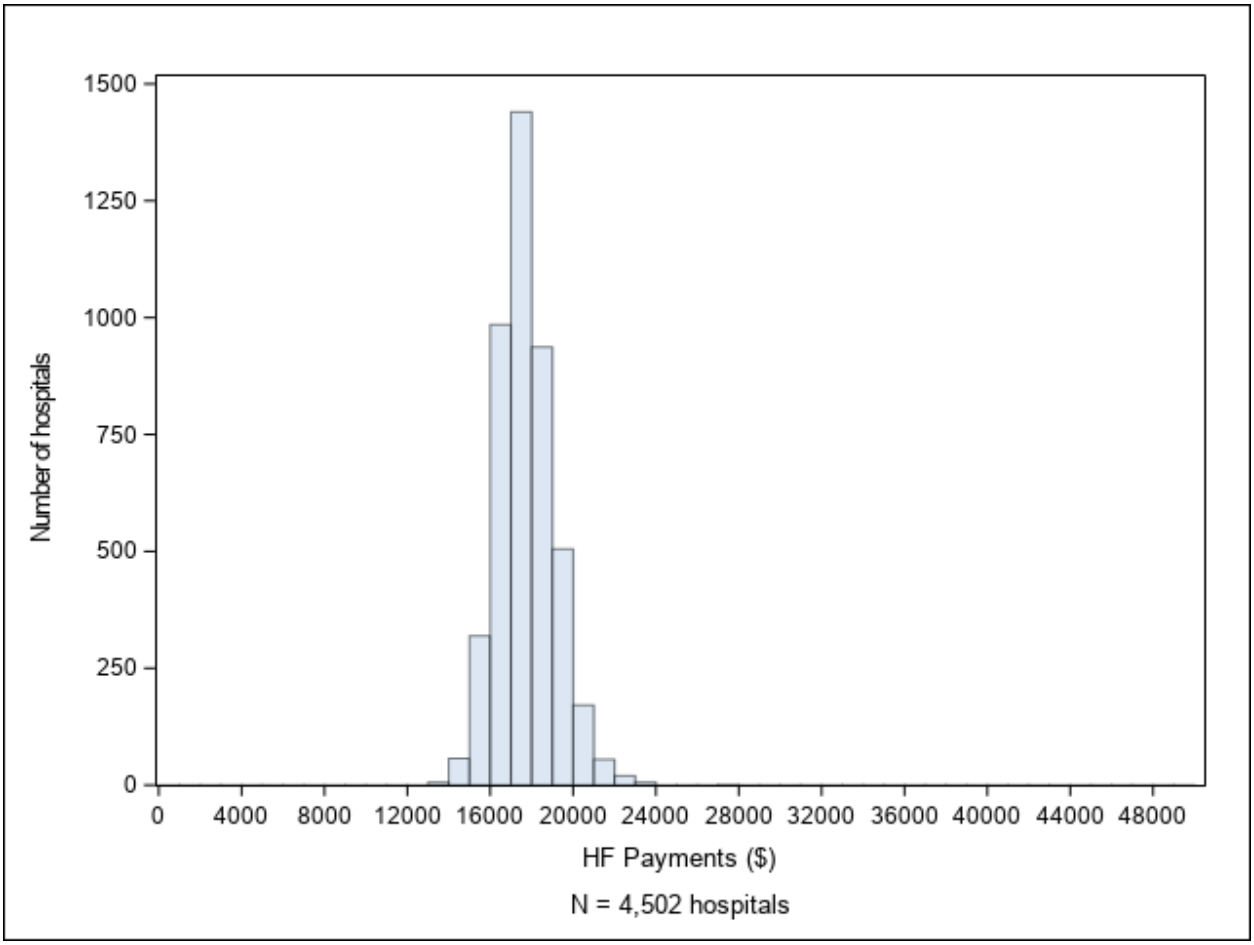
Table 4.3.6 – Distribution of Hospital HF RSPs over Different Time Periods ($2018)

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	4,380	4,351	4,344	4,502
Mean (SD)	17,774 (985)	17,891 (962)	17,427 (968)	17,722 (1,368)
Range (min. – max.)	14,567 – 23,164	14,747 – 22,846	13,929 – 22,393	13,171 – 27,996
25th percentile	17,158	17,284	16,811	16,817
50th percentile	17,670	17,781	17,310	17,607
75th percentile	18,306	18,414	17,957	18,513

Table 4.3.7 – Between-Hospital Variance for HF over Different Time Periods

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Between-hospital variance (SE)	0.008 (0.0004)	0.007 (0.0004)	0.008 (0.0004)	0.010 (0.0004)

Figure 4.3.2 – Distribution of Hospital HF 30-Day Episode-of-Care RSPs between July 2016 and June 2019 ($2018)



4.4. Pneumonia Payment 2020 Model Results

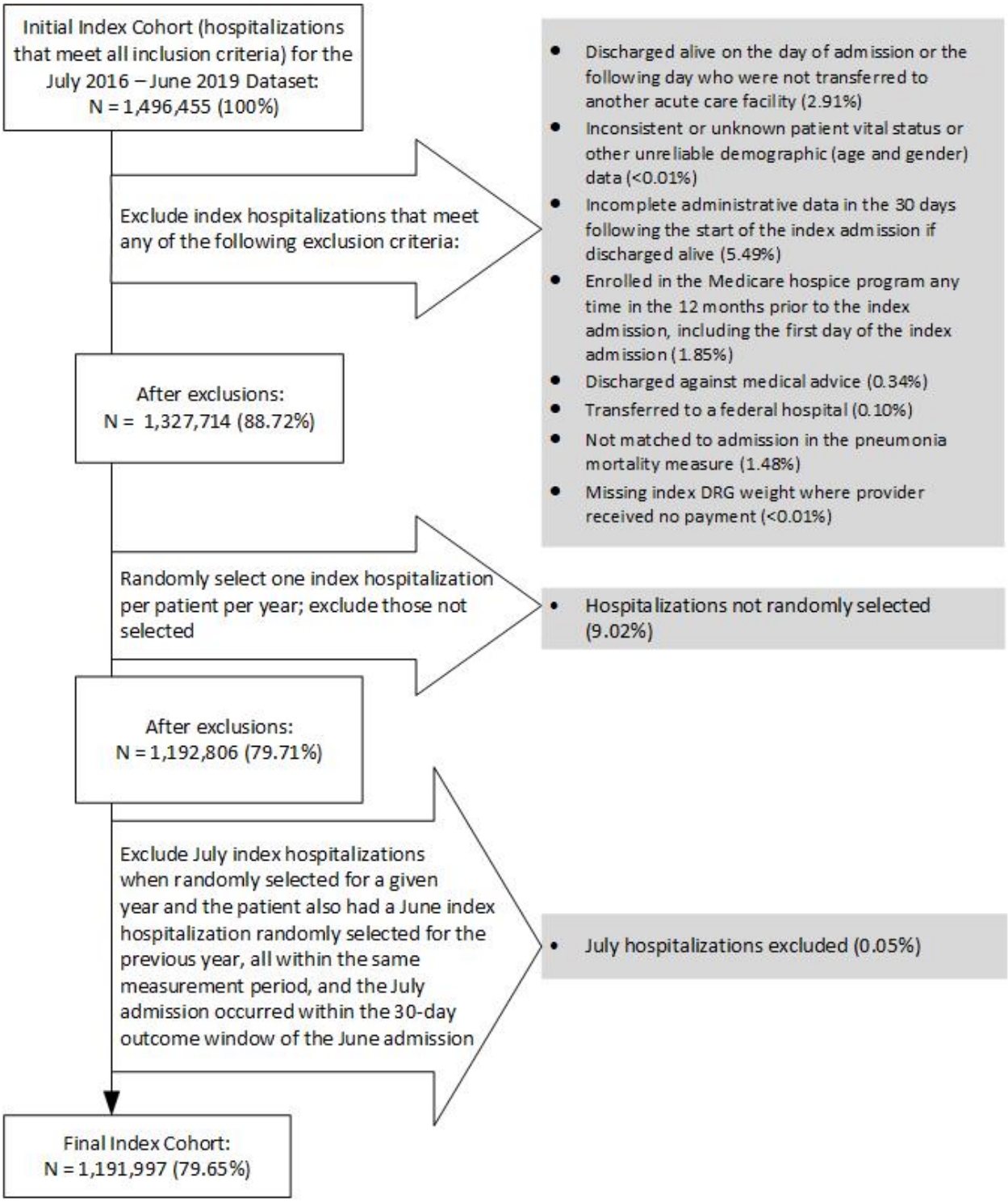
4.4.1 Index Cohort Exclusions

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 2016-June 2019 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 patients:

- Aged 65 or over;
- With either a principal discharge diagnosis of pneumonia or a principal discharge diagnosis of sepsis (not including severe sepsis) with a secondary diagnosis of 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 during the index admission; and,
- Who were not transferred from another acute care facility.

Figure 4.4.1 – Pneumonia Cohort Exclusions in the July 2016-June 2019 Dataset



4.4.2 Frequency of Pneumonia Model Variables

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

- Increases in 'Respiratory arrest/cardiorespiratory failure/respirator dependence' (25.9% to 29.1%), 'Chronic obstructive pulmonary disease (COPD)' (44.7% to 49.6%) and 'Pneumococcal pneumonia, empyema, lung abscess' (4.8% to 10.7%)
- Decreases in 'Age (>=85)' (35.5% to 32.6%), 'Dementia and other specified brain disorders' (35.5% to 33.0%), and 'Asthma' (15.3% to 12.9%).

Refer to Table 4.4.1 for more detail.

4.4.3 Pneumonia Model Parameters and Performance

Table 4.4.2 shows hierarchical generalized linear regression model variable coefficients and 95% CIs for the pneumonia payment model by individual year and for the combined three-year dataset. The pneumonia payment model coefficients can be directly interpreted as dollars. The quasi-R^2 for the pneumonia payment model was 0.08, suggesting that approximately 8% of the variation in payment can be explained by patient-level risk factors. This quasi-R^2 is in line with R^2s from other patient-level risk-adjustment models for healthcare payment.[6]

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 2019 public reporting (Table 4.4.3).

4.4.4 Distribution of Hospital Volumes and Payments for Pneumonia

Between July 2016-June 2017 and July 2018-June 2019, the national mean payment decreased from $18,502 to $18,149 ($2018).

Table 4.4.4 shows the distribution of hospital admission volumes, and Table 4.4.5 shows the distribution of hospital RSPs. Table 4.4.6 shows the between-hospital variance by individual year, as well as for the combined three-year dataset. 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 data are normally distributed. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was $4,553 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.[3]

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

Of 4,564 hospitals in the study cohort, 852 had a payment "Less than the National Average Payment," 2,406 had a payment "No Different than the National Average Payment," and 779 had a payment "Greater than the National Average Payment." 527 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 (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Total N	386,117	414,009	391,871	1,191,997
Age (>=85)	35.5	34.3	32.6	34.2
Age (65 - 74)	28.9	29.6	30.5	29.7
Age (75 - 84)	35.5	36.1	36.9	36.2
Severe infection (CC 1, 3-6)	2.9	2.8	2.9	2.8
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	15.6	15.8	16.8	16.0
Other infectious diseases (CC 7)	39.2	38.2	38.0	38.4
Metastatic cancer and acute leukemia (CC 8)	5.5	5.7	6.3	5.8
Lung and other severe cancers (CC 9)	7.7	7.9	8.6	8.0
Lymphatic, head and neck, brain, and other major cancers (CC 10-11)	9.5	9.5	9.8	9.6
Benign neoplasms of skin, breast, eye (CC 16)	12.9	13.2	13.6	13.3
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	41.7	41.3	41.4	41.5
Protein-calorie malnutrition (CC 21)	17.8	18.3	19.0	18.4
Other significant endocrine and metabolic disorders (CC 23)	10.1	10.4	11.1	10.5
Liver disease (CC 27-30)	3.1	3.3	3.7	3.3
Gallbladder and biliary tract disorders (CC 32)	3.4	3.4	3.6	3.5
Appendicitis (CC 37)	0.2	0.2	0.2	0.2
Bone/joint/muscle infections/necrosis (CC 39)	2.6	2.6	2.8	2.6
Osteoporosis and other bone/cartilage disorders (CC 43)	22.0	22.0	22.2	22.1
Severe hematological disorders (CC 46)	2.1	2.0	2.0	2.0
Disorders of immunity (CC 47)	6.5	6.6	7.1	6.7
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	57.2	56.2	57.0	56.8
Delirium and encephalopathy (CC 50)	13.5	13.9	14.7	14.1
Dementia or other specified brain disorders (CC 51-53)	35.5	34.0	33.0	34.2
Drug/alcohol psychosis or dependence (CC 54-55)	4.1	4.2	4.3	4.2
Major psychiatric disorders (CC 57-59)	12.4	13.1	14.0	13.1
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	12.0	11.7	11.9	11.9

Variable (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Neuropathy; muscular dystrophy (CC 75-76)	1.5	1.6	1.7	1.6
Multiple sclerosis and Parkinson's (CC 77-78)	6.0	5.7	5.7	5.8
Seizure disorders and convulsions (CC 79)	7.3	7.1	7.2	7.2
Coma, brain compression/anoxic damage (CC 80)	1.5	1.6	1.8	1.6
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	22.7	22.6	23.1	22.8
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 diagnosis codes 799.01 and 799.02, for discharges prior to October 1, 2015)	25.9	27.3	29.1	27.4
Congestive heart failure (CC 85)	36.3	36.8	37.9	37.0
Coronary atherosclerosis or angina (CC 88-89)	46.2	46.1	46.4	46.2
Heart infection/inflammation, except rheumatic (CC 90)	2.6	2.6	2.9	2.7
Valvular and rheumatic heart disease (CC 91)	26.5	26.7	27.7	27.0
Hypertensive heart disease (CC 94)	4.0	4.6	4.8	4.5
Stroke (CC 99-100)	9.5	9.2	9.3	9.3
Late effects of cerebrovascular disease, except paralysis (CC 105)	7.5	7.1	7.0	7.2
Chronic obstructive pulmonary disease (COPD) (CC 111)	44.7	47.4	49.6	47.2
Asthma (CC 113)	15.3	13.8	12.9	14.0
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	4.8	7.9	10.7	7.8
Viral and unspecified pneumonia, pleurisy (CC 116)	34.7	33.9	33.6	34.1
Pleural effusion/pneumothorax (CC 117)	17.1	16.9	17.8	17.2
Other respiratory disorders (CC 118)	49.5	51.7	51.5	50.9
Other eye disorders (CC 128)	23.9	24.4	24.5	24.3
Significant ear, nose, and throat disorders (CC 129)	2.3	2.2	2.3	2.2
Other ear, nose, throat, and mouth disorders (CC 131)	37.4	38.5	38.5	38.1
Dialysis status (CC 134)	3.7	3.8	4.0	3.9
Urinary incontinence (CC 143)	11.3	11.4	11.4	11.3
Other female genital disorders (CC 148)	3.4	3.4	3.4	3.4
Decubitus ulcer or chronic skin ulcer (CC 157-161)	13.1	12.9	13.1	13.0
Vertebral fractures without spinal cord injury (CC 169)	5.0	5.1	5.3	5.1
Major fracture, except of skull, vertebrae, or hip (CC 171)	2.5	2.5	2.5	2.5
Internal injuries (CC 172)	1.0	0.9	0.9	1.0
Traumatic amputations, other injuries (CC 173-174)	39.8	39.6	39.9	39.7
Poisonings and allergic and inflammatory reactions (CC 175)	11.5	11.7	12.2	11.8
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02 (for discharges on or after October 1, 2015) and ICD-9-CM diagnosis codes 799.01 and 799.02 (for discharges prior to October 1, 2015)	85.9	86.1	86.8	86.3

Variable (% unless otherwise indicated)	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Minor symptoms, signs, findings (modified) (CC 179)	92.1	92.8	93.4	92.7

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

Variable	07/2016-06/2017 $ (95% CI)	07/2017-06/2018 $ (95% CI)	07/2018-06/2019 $ (95% CI)	07/2016-06/2019 $ (95% CI)
Intercept	12,587 (12,432, 12,742)	12,726 (12,572, 12,881)	12,748 (12,585, 12,911)	12,782 (12,674, 12,890)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 - 74)	-538 (-636, -439)	-548 (-642, -455)	-433 (-530, -336)	-471 (-527, -415)
Age (75 - 84)	-363 (-450, -275)	-269 (-353, -185)	-244 (-331, -157)	-268 (-318, -218)
Severe infection (CC 1, 3-6)	2,344 (2,078, 2,611)	3,043 (2,778, 3,307)	2,654 (2,392, 2,915)	2,655 (2,502, 2,808)
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	258 (129, 386)	171 (50, 293)	252 (130, 373)	211 (139, 282)
Other infectious diseases (CC 7)	388 (307, 470)	454 (375, 532)	442 (361, 522)	420 (374, 466)
Metastatic cancer and acute leukemia (CC 8)	1,331 (1,126, 1,537)	1,500 (1,304, 1,696)	1,637 (1,443, 1,830)	1,457 (1,342, 1,571)
Lung and other severe cancers (CC 9)	518 (353, 682)	582 (426, 738)	721 (567, 876)	595 (503, 686)
Lymphatic, head and neck, brain, and other major cancers (CC 10-11)	317 (179, 455)	413 (282, 545)	329 (196, 461)	359 (281, 436)
Benign neoplasms of skin, breast, eye (CC 16)	-609 (-712, -505)	-534 (-631, -436)	-508 (-607, -409)	-561 (-619, -503)
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	722 (646, 798)	698 (626, 771)	617 (542, 691)	668 (625, 712)
Protein-calorie malnutrition (CC 21)	3,364 (3,242, 3,486)	2,968 (2,855, 3,081)	2,860 (2,747, 2,974)	2,994 (2,927, 3,061)
Other significant endocrine and metabolic disorders (CC 23)	807 (654, 959)	991 (847, 1,135)	928 (784, 1,071)	909 (824, 994)
Liver disease (CC 27-30)	684 (440, 928)	452 (230, 674)	527 (310, 745)	520 (389, 652)
Gallbladder and biliary tract disorders (CC 32)	1,024 (795, 1,253)	1,103 (886, 1,320)	1,059 (842, 1,276)	1,053 (925, 1,181)
Appendicitis (CC 37)	1,585 (553, 2,616)	2,181 (1,193, 3,168)	1,598 (675, 2,521)	1,803 (1,235, 2,372)
Bone/joint/muscle infections/necrosis (CC 39)	2,049 (1,746, 2,352)	2,430 (2,135, 2,725)	2,278 (1,987, 2,570)	2,235 (2,063, 2,407)
Osteoporosis and other bone/cartilage disorders (CC 43)	-458 (-547, -369)	-388 (-473, -303)	-578 (-664, -491)	-472 (-522, -422)

Variable	07/2016-06/2017 $ (95% CI)	07/2017-06/2018 $ (95% CI)	07/2018-06/2019 $ (95% CI)	07/2016-06/2019 $ (95% CI)
Severe hematological disorders (CC 46)	727 (435, 1,020)	955 (664, 1,245)	816 (521, 1,110)	850 (680, 1,020)
Disorders of immunity (CC 47)	1,183 (1,005, 1,362)	1,109 (941, 1,276)	1,075 (907, 1,243)	1,094 (995, 1,194)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1,629 (1,551, 1,706)	1,499 (1,425, 1,573)	1,532 (1,456, 1,608)	1,535 (1,491, 1,578)
Delirium and encephalopathy (CC 50)	364 (226, 502)	494 (364, 624)	334 (203, 465)	360 (283, 437)
Dementia or other specified brain disorders (CC 51-53)	1,119 (1,031, 1,207)	1,027 (942, 1,112)	1,012 (923, 1,100)	1,028 (978, 1,079)
Drug/alcohol psychosis or dependence (CC 54-55)	1,042 (834, 1,250)	1,204 (1,007, 1,402)	1,166 (967, 1,365)	1,153 (1,036, 1,270)
Major psychiatric disorders (CC 57-59)	1,041 (915, 1,168)	957 (840, 1,074)	943 (827, 1,059)	916 (847, 985)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1,839 (1,694, 1,985)	1,759 (1,619, 1,898)	1,844 (1,701, 1,988)	1,786 (1,703, 1,869)
Neuropathy; muscular dystrophy (CC 75-76)	1,688 (1,345, 2,031)	1,756 (1,434, 2,078)	1,550 (1,228, 1,872)	1,656 (1,465, 1,847)
Multiple sclerosis and Parkinson's (CC 77-78)	1,485 (1,312, 1,658)	1,413 (1,243, 1,582)	1,281 (1,109, 1,453)	1,366 (1,267, 1,466)
Seizure disorders and convulsions (CC 79)	841 (678, 1,005)	982 (824, 1,141)	921 (759, 1,082)	900 (806, 993)
Coma, brain compression/anoxic damage (CC 80)	1,349 (952, 1,746)	1,250 (887, 1,612)	1,121 (769, 1,473)	1,201 (987, 1,414)
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	128 (38, 219)	65 (-21, 151)	95 (7, 183)	103 (52, 154)
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 diagnosis codes 799.01 and 799.02, for discharges prior to October 1, 2015)	958 (850, 1,066)	822 (721, 923)	801 (700, 902)	843 (783, 902)
Congestive heart failure (CC 85)	547 (456, 637)	592 (506, 679)	573 (486, 661)	567 (516, 618)
Coronary atherosclerosis or angina (CC 88-89)	148 (71, 225)	79 (6, 153)	138 (63, 214)	111 (67, 154)
Heart infection/inflammation, except rheumatic (CC 90)	1,959 (1,678, 2,239)	1,888 (1,625, 2,150)	2,123 (1,862, 2,385)	1,983 (1,828, 2,138)
Valvular and rheumatic heart disease (CC 91)	657 (565, 748)	569 (482, 656)	613 (525, 701)	598 (547, 650)
Hypertensive heart disease (CC 94)	-140 (-330, 50)	-93 (-263, 78)	-139 (-310, 33)	-182 (-284, -79)

Variable	07/2016-06/2017 $ (95% CI)	07/2017-06/2018 $ (95% CI)	07/2018-06/2019 $ (95% CI)	07/2016-06/2019 $ (95% CI)
Stroke (CC 99-100)	64 (-90, 218)	129 (-20, 279)	58 (-95, 211)	84 (-4, 172)
Late effects of cerebrovascular disease, except paralysis (CC 105)	687 (509, 864)	778 (605, 952)	745 (565, 924)	732 (629, 834)
Chronic obstructive pulmonary disease (COPD) (CC 111)	985 (905, 1,064)	797 (723, 872)	414 (338, 489)	693 (649, 738)
Asthma (CC 113)	-901 (-1,000, -801)	-839 (-936, -741)	-849 (-950, -747)	-832 (-889, -774)
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	-160 (-348, 28)	-200 (-342, -58)	-504 (-631, -377)	-385 (-469, -301)
Viral and unspecified pneumonia, pleurisy (CC 116)	-634 (-724, -544)	-512 (-600, -424)	-554 (-645, -462)	-526 (-578, -474)
Pleural effusion/pneumothorax (CC 117)	561 (440, 683)	659 (543, 775)	697 (580, 814)	630 (562, 699)
Other respiratory disorders (CC 118)	-50 (-126, 26)	-38 (-111, 34)	16 (-58, 91)	-34 (-77, 9)
Other eye disorders (CC 128)	-265 (-349, -181)	-250 (-330, -170)	-294 (-376, -212)	-272 (-320, -224)
Significant ear, nose, and throat disorders (CC 129)	781 (521, 1,041)	804 (549, 1,059)	1,064 (805, 1,323)	889 (740, 1,039)
Other ear, nose, throat, and mouth disorders (CC 131)	-630 (-705, -556)	-657 (-728, -586)	-583 (-656, -510)	-622 (-664, -580)
Dialysis status (CC 134)	2,522 (2,238, 2,807)	2,366 (2,099, 2,634)	2,079 (1,813, 2,345)	2,258 (2,100, 2,415)
Urinary incontinence (CC 143)	352 (232, 472)	370 (256, 483)	356 (239, 473)	362 (294, 429)
Other female genital disorders (CC 148)	-450 (-640, -260)	-449 (-632, -266)	-528 (-715, -342)	-460 (-568, -352)
Decubitus ulcer or chronic skin ulcer (CC 157-161)	1,248 (1,114, 1,382)	1,287 (1,158, 1,415)	1,248 (1,116, 1,379)	1,247 (1,171, 1,323)
Vertebral fractures without spinal cord injury (CC 169)	978 (788, 1,168)	1,036 (857, 1,215)	933 (754, 1,112)	973 (867, 1,079)
Major fracture, except of skull, vertebrae, or hip (CC 171)	486 (226, 745)	448 (201, 695)	565 (312, 819)	504 (357, 650)
Internal injuries (CC 172)	1,779 (1,321, 2,237)	1,772 (1,324, 2,220)	1,899 (1,434, 2,363)	1,828 (1,564, 2,093)
Traumatic amputations, other injuries (CC 173-174)	613 (533, 693)	590 (514, 666)	649 (571, 728)	620 (575, 665)
Poisonings and allergic and inflammatory reactions (CC 175)	-106 (-238, 25)	-168 (-292, -44)	-177 (-302, -51)	-127 (-200, -53)

Variable	07/2016-06/2017 $ (95% CI)	07/2017-06/2018 $ (95% CI)	07/2018-06/2019 $ (95% CI)	07/2016-06/2019 $ (95% CI)
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02 (for discharges on or after October 1, 2015) and ICD-9-CM diagnosis codes 799.01 and 799.02 (for discharges prior to October 1, 2015)	680 (582, 778)	612 (518, 706)	569 (470, 668)	615 (559, 671)
Minor symptoms, signs, findings (modified) (CC 179)	597 (478, 717)	504 (385, 623)	431 (304, 559)	509 (438, 580)

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Predictive ratios (lowest decile – highest decile)	1.05 – 1.06	1.05 – 1.05	1.05 – 1.04	1.05 – 1.05
Quasi-R^2	0.08	0.08	0.07	0.08

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

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	4,473	4,473	4,437	4,564
Mean number of admissions (SD)	86 (96)	93 (106)	88 (103)	261 (301)
Range (min. – max.)	1 – 1,104	1 – 1,262	1 – 1,094	1 – 3,460
25th percentile	20	20	18	54
50th percentile	52	54	50	148
75th percentile	122	132	126	375

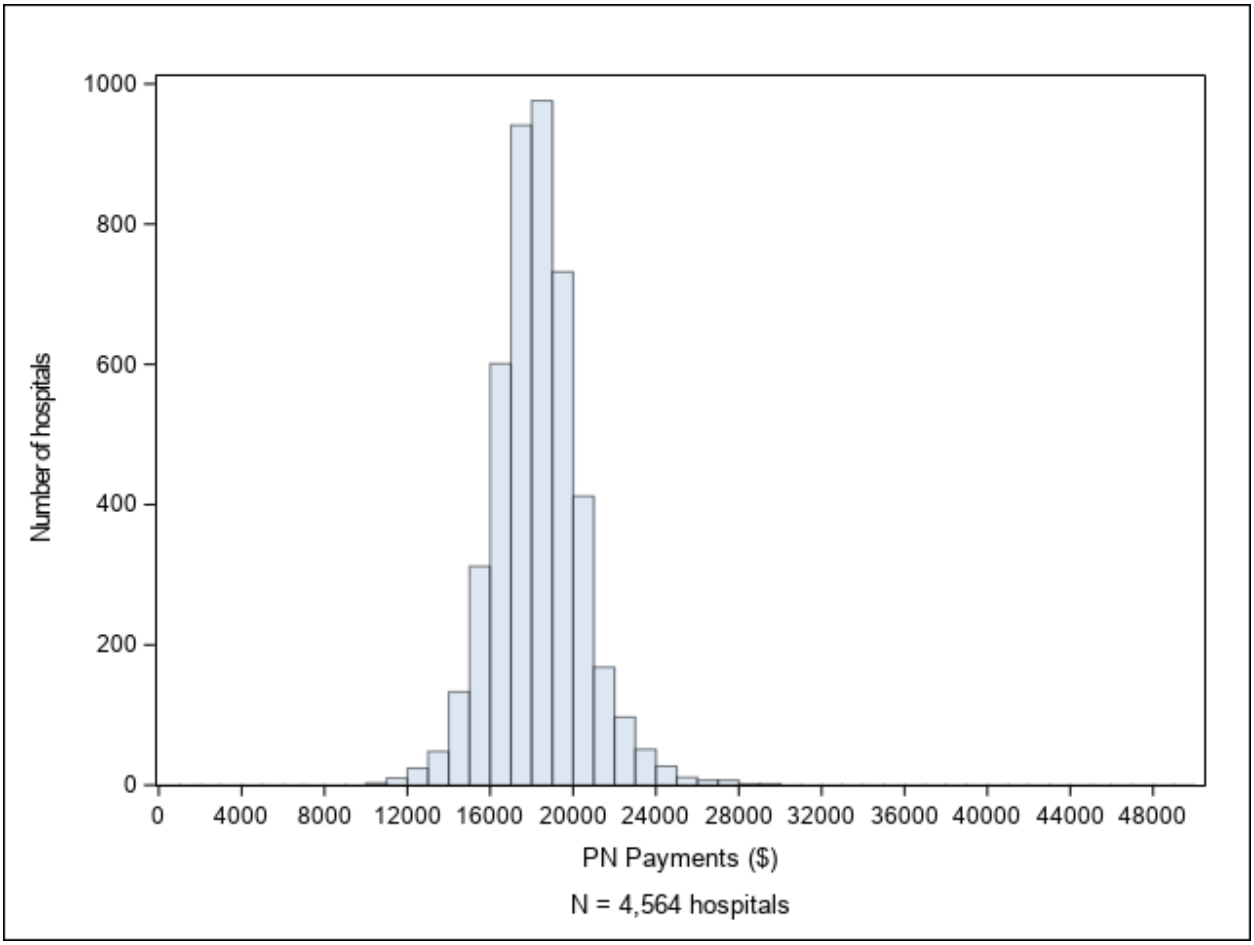
Table 4.4.5 – Distribution of Hospital Pneumonia RSPs over Different Time Periods ($2018)

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Number of hospitals	4,473	4,473	4,437	4,564
Mean (SD)	18,468 (1,754)	18,287 (1,742)	18,122 (1,690)	18,283 (2,097)
Range (min. – max.)	10,881 – 25,643	11,675 – 26,095	11,824 – 28,086	10,529 – 29,861
25th percentile	17,360	17,212	17,074	17,015
50th percentile	18,434	18,226	18,037	18,200
75th percentile	19,539	19,314	19,100	19,453

Table 4.4.6 – Between-Hospital Variance for Pneumonia over Different Time Periods

Characteristic	07/2016-06/2017	07/2017-06/2018	07/2018-06/2019	07/2016-06/2019
Between hospital-variance (SE) ($)	4,602,779 (173,669)	4,557,171 (172,489)	4,413,078 (174,812)	5,181,322 (154,674)

Figure 4.4.2 – Distribution of Hospital Pneumonia 30-Day Episode-of-Care RSPs between July 2016 and June 2019 ($2018)



4.5. THA/TKA Payment 2020 Model Results

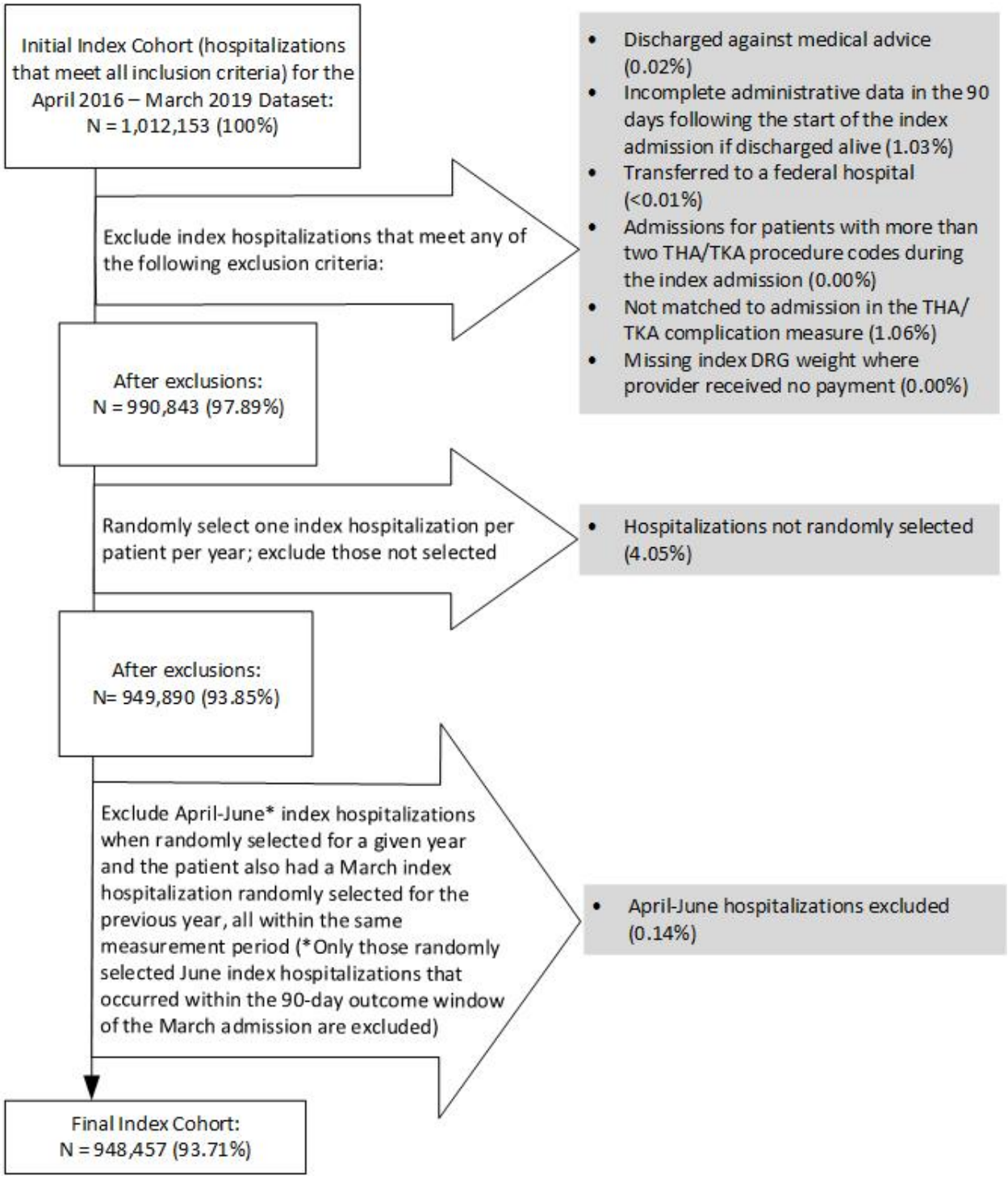
4.5.1 Index Cohort Exclusions

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 2016-March 2019 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 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 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 2016-March 2019 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 quite stable over the measurement period. The largest changes in the frequencies (those greater than 2% absolute change) include increases in 'Index admissions with an elective THA procedure' (33.1% to 40.8%), 'Disorders of thyroid, cholesterol, lipids' (65.4% to 70.3%), 'Other psychiatric disorders' (15.6% to 17.7%), 'Other respiratory disorders' (28.6% to 31.3%), 'Major symptoms, abnormalities' (63.8% to 67.5%), and 'Minor symptoms, signs, findings' (78.3% to 81.7%).

Refer to Table 4.5.1 for more detail.

4.5.3 THA/TKA Model Parameters and Performance

Table 4.5.2 shows the hierarchical generalized linear 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 0.18, suggesting that approximately 18% of the variation in payment can be explained by patient-level risk factors. This quasi-R^2 is in line with R^2s from other patient-level risk-adjustment models for healthcare payment.[6]

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 2019 public reporting (Table 4.5.4).

4.5.4 Distribution of Hospital Volumes and Payment for THA/TKA

Between April 2016-March 2017 and April 2018-March 2019, the national mean payment decreased from $21,764 to $20,192 ($2018).

Table 4.5.5 shows the distribution of hospital admission volumes, and Table 4.5.6 shows the distribution of hospital RSPs. Table 4.5.7 shows the between-hospital variance by individual year, as well as for the combined three-year dataset. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

Figure 4.5.2 shows the overall distribution of the hospital RSPs for the combined three-year dataset. The data are normally distributed. 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.[3]

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

Of 3,417 hospitals in the study cohort, 1,073 had a payment "Less than the National Average Payment," 1,063 had a payment "No Different than the National Average Payment," and 615 had a payment "Greater than the National Average Payment." 666 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 (% unless otherwise indicated)	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Total N	331,895	325,570	290,992	948,457
Mean age (SD)	73.8 (5.9)	73.8 (5.8)	74.0 (5.9)	73.9 (5.9)
Male	37.3	37.3	36.8	37.2
Index admissions with an elective THA procedure	33.1	34.8	40.8	36.0
Procedure type (bilateral joint replacement)	1.9	1.7	1.7	1.8
Procedure type (single joint replacement)	97.3	97.5	97.6	97.5
Procedure type (staged joint replacements)	0.8	0.8	0.7	0.8
Severe infection; other infectious diseases (CC 1, 3-7)	17.1	16.9	17.1	17.1
Metastatic cancer and acute leukemia (CC 8)	0.6	0.6	0.7	0.6
Cancer (CC 9-14)	18.2	18.0	18.4	18.2
Benign neoplasms of skin, breast, eye (CC 16)	20.1	20.3	21.0	20.4
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	27.2	26.9	26.7	26.9
Protein-calorie malnutrition (CC 21)	0.6	0.7	0.7	0.7
Morbid obesity (CC 22)	9.1	9.5	9.8	9.4
Other significant endocrine and metabolic disorders (CC 23)	3.2	3.3	3.5	3.3
Disorders of thyroid, cholesterol, lipids (CC 25-26)	65.4	69.1	70.3	68.2
Appendicitis (CC 37)	0.1	0.1	0.1	0.1
Bone/joint/muscle infections/necrosis (CC 39)	2.5	2.6	2.8	2.6
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	10.1	10.3	10.9	10.4
Disorders of the vertebrae and spinal discs (CC 41)	29.0	29.6	30.7	29.7
Osteoarthritis of hip or knee (CC 42)	97.1	97.3	97.4	97.3
Other musculoskeletal and connective tissue disorders (CC 45)	89.4	89.4	89.9	89.6
Severe hematological disorders (CC 46)	0.4	0.4	0.4	0.4
Coagulation defects and other specified hematological disorders (CC 48)	5.0	5.1	5.2	5.1
Delirium and encephalopathy (CC 50)	1.1	1.2	1.2	1.2
Dementia or other specified brain disorders (CC 51-53)	4.1	4.1	4.3	4.2
Major psychiatric disorders (CC 57-59)	4.6	5.2	5.9	5.2
Depression/anxiety (CC 61-62)	17.6	18.5	19.1	18.4
Other psychiatric disorders (CC 63)	15.6	16.6	17.7	16.6

Variable (% unless otherwise indicated)	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Mental retardation or developmental disability (CC 64-68)	0.2	0.3	0.3	0.2
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1.3	1.4	1.4	1.4
Polyneuropathy; other neuropathies (CC 75, 81)	14.7	15.0	15.5	15.1
Multiple sclerosis (CC 77)	0.3	0.3	0.3	0.3
Parkinson's and Huntington's diseases (CC 78)	1.0	1.0	1.1	1.0
Seizure disorders and convulsions (CC 79)	1.5	1.5	1.6	1.5
Congestive heart failure (CC 85)	8.1	8.3	8.7	8.4
Acute coronary syndrome (CC 86-87)	2.0	2.1	2.2	2.1
Valvular and rheumatic heart disease (CC 91)	13.9	14.0	14.5	14.1
Hypertension and hypertensive disease (CC 94-95)	79.6	78.7	78.4	78.9
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	24.3	24.8	25.5	24.8
Stroke (CC 99-100)	1.8	1.8	2.0	1.9
Vascular or circulatory disease (CC 106-109)	21.3	21.4	22.0	21.6
Chronic obstructive pulmonary disease (COPD) (CC 111)	11.9	11.6	11.7	11.8
Pleural effusion/pneumothorax (CC 117)	1.4	1.4	1.5	1.4
Other respiratory disorders (CC 118)	28.6	30.5	31.3	30.1
Legally blind (CC 119)	0.2	0.1	0.1	0.1
Dialysis status (CC 134)	0.2	0.2	0.2	0.2
Renal failure (CC 135-140)	14.0	14.8	15.7	14.8
Urinary incontinence (CC 143)	8.5	8.6	8.9	8.6
Urinary tract infection (CC 144)	14.4	14.0	13.6	14.0
Other urinary tract disorders (CC 145)	10.2	10.5	10.6	10.4
Decubitus ulcer or chronic skin ulcer (CC 157-161)	2.1	2.1	2.1	2.1
Cellulitis, local skin infection (CC 164)	6.6	6.6	6.6	6.6
Other dermatological disorders (CC 165)	42.3	42.9	43.5	42.9
Trauma (CC 166-168, 170-173)	4.4	4.4	4.7	4.5
Vertebral fractures without spinal cord injury (CC 169)	1.0	1.0	1.1	1.0
Other injuries (CC 174)	25.8	25.4	25.4	25.5
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02 (for discharges on or after October 1, 2015) and ICD-9-CM diagnosis codes 799.01 and 799.02 (for discharges prior to October 1, 2015)	63.8	65.8	67.5	65.6
Minor symptoms, signs, findings (modified) (CC 179)	78.3	80.4	81.7	80.1

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

Variable	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Intercept	9.674	9.644	9.606	9.659
Age minus 65 (years above 65, continuous)	0.013	0.013	0.013	0.013
Male	-0.051	-0.044	-0.038	-0.045
Index admissions with an elective THA procedure	-0.004	-0.009	-0.021	-0.014
Procedure type (bilateral joint replacement)	0.572	0.564	0.572	0.568
Procedure type (single joint replacement)	Reference	Reference	Reference	Reference
Procedure type (staged joint replacements)	0.552	0.563	0.567	0.559
Severe infection; other infectious diseases (CC 1, 3-7)	0.039	0.042	0.036	0.040
Metastatic cancer and acute leukemia (CC 8)	0.038	0.047	0.068	0.048
Cancer (CC 9-14)	-0.004	-0.006	-0.010	-0.006
Benign neoplasms of skin, breast, eye (CC 16)	-0.016	-0.018	-0.020	-0.019
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	0.043	0.041	0.044	0.042
Protein-calorie malnutrition (CC 21)	0.148	0.125	0.148	0.137
Morbid obesity (CC 22)	0.094	0.084	0.080	0.086
Other significant endocrine and metabolic disorders (CC 23)	0.028	0.027	0.026	0.027
Disorders of thyroid, cholesterol, lipids (CC 25-26)	-0.009	-0.013	-0.013	-0.014
Appendicitis (CC 37)	-0.070	-0.022	-0.029	-0.042
Bone/joint/muscle infections/necrosis (CC 39)	0.050	0.066	0.057	0.058
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	0.025	0.021	0.023	0.022
Disorders of the vertebrae and spinal discs (CC 41)	0.010	0.007	0.011	0.009
Osteoarthritis of hip or knee (CC 42)	0.059	0.055	0.056	0.056
Other musculoskeletal and connective tissue disorders (CC 45)	0.019	0.019	0.021	0.020
Severe hematological disorders (CC 46)	0.090	0.101	0.128	0.108
Coagulation defects and other specified hematological disorders (CC 48)	0.011	0.015	0.020	0.015
Delirium and encephalopathy (CC 50)	0.053	0.068	0.089	0.070
Dementia or other specified brain disorders (CC 51-53)	0.102	0.108	0.099	0.103
Major psychiatric disorders (CC 57-59)	0.073	0.068	0.069	0.067
Depression/anxiety (CC 61-62)	0.029	0.028	0.031	0.029
Other psychiatric disorders (CC 63)	0.023	0.022	0.019	0.020
Mental retardation or developmental disability (CC 64-68)	0.163	0.114	0.110	0.125
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	0.110	0.091	0.120	0.107
Polyneuropathy; other neuropathies (CC 75, 81)	0.012	0.014	0.012	0.013
Multiple sclerosis (CC 77)	0.143	0.105	0.119	0.123
Parkinson's and Huntington's diseases (CC 78)	0.173	0.173	0.185	0.176
Seizure disorders and convulsions (CC 79)	0.067	0.067	0.073	0.069
Congestive heart failure (CC 85)	0.062	0.066	0.064	0.064
Acute coronary syndrome (CC 86-87)	0.009	0.013	0.013	0.012
Valvular and rheumatic heart disease (CC 91)	0.009	0.010	0.008	0.009

Variable	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Hypertension and hypertensive disease (CC 94-95)	0.021	0.018	0.015	0.019
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	0.016	0.013	0.017	0.016
Stroke (CC 99-100)	0.033	0.044	0.039	0.039
Vascular or circulatory disease (CC 106-109)	0.030	0.031	0.029	0.030
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.054	0.052	0.054	0.054
Pleural effusion/pneumothorax (CC 117)	-0.019	-0.006	0.002	-0.009
Other respiratory disorders (CC 118)	0.015	0.014	0.012	0.013
Legally blind (CC 119)	0.107	0.109	0.113	0.115
Dialysis status (CC 134)	0.374	0.394	0.375	0.380
Renal failure (CC 135-140)	0.051	0.053	0.050	0.050
Urinary incontinence (CC 143)	0.038	0.041	0.040	0.040
Urinary tract infection (CC 144)	0.016	0.016	0.019	0.018
Other urinary tract disorders (CC 145)	0.002	0.004	0.006	0.004
Decubitus ulcer or chronic skin ulcer (CC 157-161)	0.086	0.092	0.087	0.090
Cellulitis, local skin infection (CC 164)	0.028	0.027	0.032	0.029
Other dermatological disorders (CC 165)	-0.014	-0.016	-0.016	-0.016
Trauma (CC 166-168, 170-173)	0.057	0.045	0.040	0.047
Vertebral fractures without spinal cord injury (CC 169)	0.043	0.042	0.043	0.041
Other injuries (CC 174)	0.016	0.015	0.017	0.017
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02 (for discharges on or after October 1, 2015) and ICD-9-CM diagnosis codes 799.01 and 799.02 (for discharges prior to October 1, 2015)	0.029	0.028	0.029	0.027
Minor symptoms, signs, findings (modified) (CC 179)	0.015	0.013	0.014	0.013

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

Variable	04/2016-03/2017 PR (95% CI)	04/2017-03/2018 PR (95% CI)	04/2018-03/2019 PR (95% CI)	04/2016-03/2019 PR (95% CI)
Age minus 65 (years above 65, continuous)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)
Male	0.95 (0.95 - 0.95)	0.96 (0.95 - 0.96)	0.96 (0.96 - 0.97)	0.96 (0.95 - 0.96)
Index admissions with an elective THA procedure	1.00 (0.99 - 1.00)	0.99 (0.99 - 0.99)	0.98 (0.98 - 0.98)	0.99 (0.98 - 0.99)
Procedure type (bilateral joint replacement)	1.77 (1.75 - 1.79)	1.76 (1.74 - 1.78)	1.77 (1.75 - 1.80)	1.77 (1.75 - 1.78)
Procedure type (single joint replacement)	Reference	Reference	Reference	Reference
Procedure type (staged joint replacements)	1.74 (1.71 - 1.77)	1.76 (1.73 - 1.79)	1.76 (1.73 - 1.80)	1.75 (1.73 - 1.77)
Severe infection; other infectious diseases (CC 1, 3-7)	1.04 (1.04 - 1.04)	1.04 (1.04 - 1.05)	1.04 (1.03 - 1.04)	1.04 (1.04 - 1.04)

Variable	04/2016-03/2017 PR (95% CI)	04/2017-03/2018 PR (95% CI)	04/2018-03/2019 PR (95% CI)	04/2016-03/2019 PR (95% CI)
Metastatic cancer and acute leukemia (CC 8)	1.04 (1.02 - 1.06)	1.05 (1.03 - 1.07)	1.07 (1.05 - 1.09)	1.05 (1.04 - 1.06)
Cancer (CC 9-14)	1.00 (0.99 - 1.00)	0.99 (0.99 - 1.00)	0.99 (0.99 - 0.99)	0.99 (0.99 - 1.00)
Benign neoplasms of skin, breast, eye (CC 16)	0.98 (0.98 - 0.99)	0.98 (0.98 - 0.98)	0.98 (0.98 - 0.98)	0.98 (0.98 - 0.98)
Diabetes mellitus (DM) or DM complications (CC 17-19, 122-123)	1.04 (1.04 - 1.05)	1.04 (1.04 - 1.04)	1.04 (1.04 - 1.05)	1.04 (1.04 - 1.04)
Protein-calorie malnutrition (CC 21)	1.16 (1.14 - 1.18)	1.13 (1.11 - 1.15)	1.16 (1.14 - 1.18)	1.15 (1.14 - 1.16)
Morbid obesity (CC 22)	1.10 (1.09 - 1.10)	1.09 (1.08 - 1.09)	1.08 (1.08 - 1.09)	1.09 (1.09 - 1.09)
Other significant endocrine and metabolic disorders (CC 23)	1.03 (1.02 - 1.04)	1.03 (1.02 - 1.03)	1.03 (1.02 - 1.03)	1.03 (1.02 - 1.03)
Disorders of thyroid, cholesterol, lipids (CC 25-26)	0.99 (0.99 - 0.99)	0.99 (0.98 - 0.99)	0.99 (0.98 - 0.99)	0.99 (0.98 - 0.99)
Appendicitis (CC 37)	0.93 (0.90 - 0.97)	0.98 (0.94 - 1.02)	0.97 (0.93 - 1.01)	0.96 (0.94 - 0.98)
Bone/joint/muscle infections/necrosis (CC 39)	1.05 (1.04 - 1.06)	1.07 (1.06 - 1.08)	1.06 (1.05 - 1.07)	1.06 (1.05 - 1.07)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	1.03 (1.02 - 1.03)	1.02 (1.02 - 1.03)	1.02 (1.02 - 1.03)	1.02 (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)	1.06 (1.05 - 1.07)	1.06 (1.05 - 1.06)	1.06 (1.05 - 1.07)	1.06 (1.05 - 1.06)
Other musculoskeletal and connective tissue disorders (CC 45)	1.02 (1.01 - 1.02)	1.02 (1.02 - 1.02)	1.02 (1.02 - 1.03)	1.02 (1.02 - 1.02)
Severe hematological disorders (CC 46)	1.09 (1.07 - 1.12)	1.11 (1.08 - 1.13)	1.14 (1.11 - 1.17)	1.11 (1.10 - 1.13)
Coagulation defects and other specified hematological disorders (CC 48)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.02 (1.01 - 1.03)	1.01 (1.01 - 1.02)
Delirium and encephalopathy (CC 50)	1.05 (1.04 - 1.07)	1.07 (1.06 - 1.09)	1.09 (1.08 - 1.11)	1.07 (1.06 - 1.08)
Dementia or other specified brain disorders (CC 51-53)	1.11 (1.10 - 1.12)	1.11 (1.11 - 1.12)	1.10 (1.10 - 1.11)	1.11 (1.10 - 1.11)
Major psychiatric disorders (CC 57-59)	1.08 (1.07 - 1.08)	1.07 (1.06 - 1.08)	1.07 (1.06 - 1.08)	1.07 (1.07 - 1.07)
Depression/anxiety (CC 61-62)	1.03 (1.03 - 1.03)	1.03 (1.02 - 1.03)	1.03 (1.03 - 1.04)	1.03 (1.03 - 1.03)
Other psychiatric disorders (CC 63)	1.02 (1.02 - 1.03)	1.02 (1.02 - 1.03)	1.02 (1.01 - 1.02)	1.02 (1.02 - 1.02)
Mental retardation or developmental disability (CC 64-68)	1.18 (1.14 - 1.21)	1.12 (1.09 - 1.15)	1.12 (1.09 - 1.15)	1.13 (1.12 - 1.15)

Variable	04/2016-03/2017 PR (95% CI)	04/2017-03/2018 PR (95% CI)	04/2018-03/2019 PR (95% CI)	04/2016-03/2019 PR (95% CI)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190)	1.12 (1.10 - 1.13)	1.10 (1.08 - 1.11)	1.13 (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 - 1.01)
Multiple sclerosis (CC 77)	1.15 (1.13 - 1.18)	1.11 (1.08 - 1.14)	1.13 (1.10 - 1.16)	1.13 (1.11 - 1.15)
Parkinson's and Huntington's diseases (CC 78)	1.19 (1.17 - 1.21)	1.19 (1.17 - 1.21)	1.20 (1.19 - 1.22)	1.19 (1.18 - 1.20)
Seizure disorders and convulsions (CC 79)	1.07 (1.06 - 1.08)	1.07 (1.06 - 1.08)	1.08 (1.06 - 1.09)	1.07 (1.06 - 1.08)
Congestive heart failure (CC 85)	1.06 (1.06 - 1.07)	1.07 (1.06 - 1.07)	1.07 (1.06 - 1.07)	1.07 (1.06 - 1.07)
Acute coronary syndrome (CC 86-87)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.02)	1.01 (1.01 - 1.02)
Valvular and rheumatic heart disease (CC 91)	1.01 (1.00 - 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 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.02 - 1.02)
Specified arrhythmias and other heart rhythm disorders (CC 96-97)	1.02 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)
Stroke (CC 99-100)	1.03 (1.02 - 1.04)	1.04 (1.03 - 1.06)	1.04 (1.03 - 1.05)	1.04 (1.03 - 1.05)
Vascular or circulatory disease (CC 106-109)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.06 (1.05 - 1.06)	1.05 (1.05 - 1.06)	1.06 (1.05 - 1.06)	1.06 (1.05 - 1.06)
Pleural effusion/pneumothorax (CC 117)	0.98 (0.97 - 0.99)	0.99 (0.98 - 1.01)	1.00 (0.99 - 1.01)	0.99 (0.98 - 1.00)
Other respiratory disorders (CC 118)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.01)
Legally blind (CC 119)	1.11 (1.08 - 1.15)	1.12 (1.07 - 1.16)	1.12 (1.07 - 1.17)	1.12 (1.10 - 1.15)
Dialysis status (CC 134)	1.45 (1.40 - 1.51)	1.48 (1.43 - 1.54)	1.46 (1.40 - 1.52)	1.46 (1.43 - 1.50)
Renal failure (CC 135-140)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.05)
Urinary incontinence (CC 143)	1.04 (1.03 - 1.04)	1.04 (1.04 - 1.05)	1.04 (1.04 - 1.05)	1.04 (1.04 - 1.04)
Urinary tract infection (CC 144)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.02 - 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)	1.00 (1.00 - 1.01)
Decubitus ulcer or chronic skin ulcer (CC 157-161)	1.09 (1.08 - 1.10)	1.10 (1.09 - 1.11)	1.09 (1.08 - 1.10)	1.09 (1.09 - 1.10)

Variable	04/2016-03/2017 PR (95% CI)	04/2017-03/2018 PR (95% CI)	04/2018-03/2019 PR (95% CI)	04/2016-03/2019 PR (95% CI)
Cellulitis, local skin infection (CC 164)	1.03 (1.02 - 1.03)	1.03 (1.02 - 1.03)	1.03 (1.03 - 1.04)	1.03 (1.03 - 1.03)
Other dermatological disorders (CC 165)	0.99 (0.98 - 0.99)	0.98 (0.98 - 0.99)	0.98 (0.98 - 0.99)	0.98 (0.98 - 0.99)
Trauma (CC 166-168, 170-173)	1.06 (1.05 - 1.07)	1.05 (1.04 - 1.05)	1.04 (1.03 - 1.05)	1.05 (1.04 - 1.05)
Vertebral fractures without spinal cord injury (CC 169)	1.04 (1.03 - 1.06)	1.04 (1.03 - 1.06)	1.04 (1.03 - 1.06)	1.04 (1.03 - 1.05)
Other injuries (CC 174)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.01 - 1.02)	1.02 (1.02 - 1.02)
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02 (for discharges on or after October 1, 2015) and ICD-9-CM diagnosis codes 799.01 and 799.02 (for discharges prior to October 1, 2015)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)	1.03 (1.03 - 1.03)
Minor symptoms, signs, findings (modified) (CC 179)	1.02 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.02)	1.01 (1.01 - 1.01)

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

Characteristic	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Predictive ratios (lowest decile – highest decile)	0.98 – 0.98	0.98 – 0.97	0.98 – 0.97	0.98 – 0.98
Quasi-R^2	0.19	0.18	0.17	0.18

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

Characteristic	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Number of hospitals	3,268	3,266	3,249	3,417
Mean number of admissions (SD)	102 (146)	100 (145)	90 (135)	278 (416)
Range (min. – max.)	1 – 2,988	1 – 3,105	1 – 2,861	1 – 8,954
25^{th} percentile	15	15	13	37
50^{th} percentile	51	50	43	130
75^{th} percentile	134	132	115	362

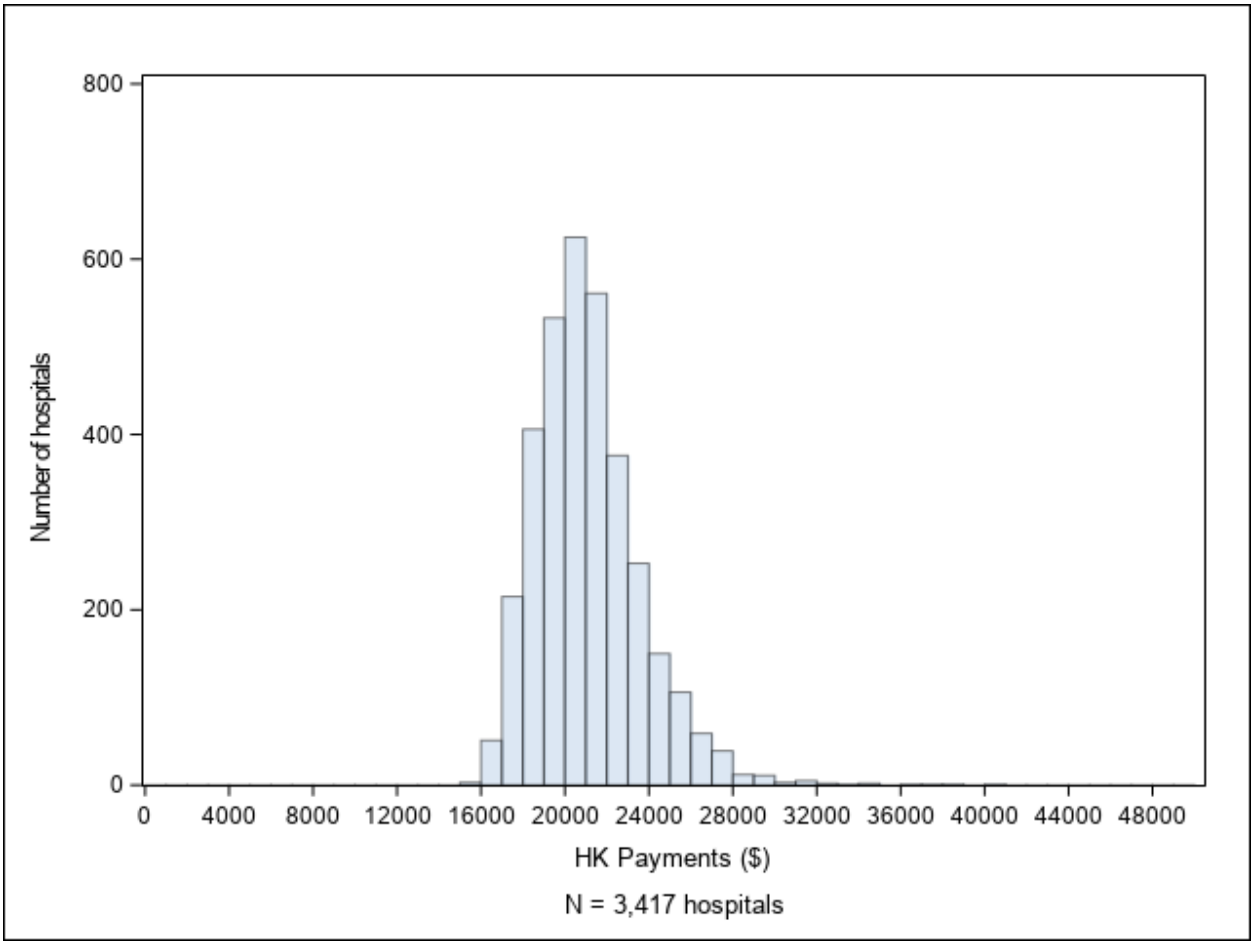
Table 4.5.6 – Distribution of Hospital THA/TKA RSPs over Different Time Periods ($2018)

Characteristic	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Number of hospitals	3,268	3,266	3,249	3,417
Mean (SD)	21,891 (2,414)	20,935 (2,224)	20,288 (2,022)	21,099 (2,513)
Range (min. – max.)	13,839 – 43,562	15,689 – 38,746	12,915 – 37,791	15,825 – 40,984
25th percentile	20,245	19,410	18,943	19,373
50th percentile	21,671	20,691	20,041	20,822
75th percentile	23,240	22,152	21,399	22,427

Table 4.5.7 – Between-Hospital Variance for THA/TKA over Different Time Periods

Characteristic	04/2016-03/2017	04/2017-03/2018	04/2018-03/2019	04/2016-03/2019
Between-hospital variance (SE)	0.015 (0.0005)	0.014 (0.0005)	0.013 (0.0005)	0.016 (0.0005)

Figure 4.5.2 – Distribution of Hospital THA/TKA 90-Day Episode-of-Care RSPs between April 2016 and March 2019 ($2018)



5. GLOSSARY

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

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

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 their primary reason for admission to the hospital.

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

Condition Categories (CCs): Groupings of ICD-9-CM/ICD-10-CM diagnosis codes into clinically relevant categories, from the HCC system.[6,7] CMS uses modified groupings, but not the hierarchical logic of the system, to create risk factor variables. Mappings which show the assignment of ICD-9 and ICD-10 codes to the CCs are available here on *QualityNet*.

Confidence Interval (CI): A CI is a range of values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the 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 Generalized Linear Model (HGLM): 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. A generalized linear model is a type of non-hierarchical HGLM used for binary outcomes.

Hospital-specific effect: A measure of a hospital's quality of care calculated using hierarchical logistic regression, taking into consideration the number of patients who are eligible for the cohort, these patients' risk factors, and 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 directly from Medicare for each individual service provided. Only beneficiaries in Medicare FFS, rather than 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.[5] 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.

6. REFERENCES

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7. APPENDICES

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

The payment measures use HGLMs to estimate RSPs for hospitals. This modeling approach accounts for the within-hospital correlation of the observed outcome, and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes.

In each measure, an HGLM model is estimated. Then for each hospital, a standardized PR is calculated. The RSP is calculated by multiplying the standardized PR for each hospital by the national mean payment.

Hierarchical Generalized Linear Model

For each measure, we fit an HGLM, which accounts for clustering of observations within hospitals. We assume the outcome has a known exponential family distribution and relates linearly to the covariates via a known link function, *h*. Specifically, the distribution and link function are selected based on the algorithm suggested by Manning and Mullahy as well as several model diagnostics.[4] The assumptions for the payment measures are provided in Table A.1.

Table A.1 – Exponential Family Distributions and Link Functions for the Payment Measures

Measure	Exponential Family Distribution	Link Function
AMI	Inverse Gaussian	Log
HF	Gamma	Log
Pneumonia	Gamma	Identity
THA/TKA	Inverse Gaussian	Log

The coefficient for each individual risk factor reported from the pneumonia model indicates that the total payment for a patient with that particular risk factor is expected to be however many dollars higher or lower, on average, than a patient without that risk factor, holding all other risk factors constant. For AMI, HF, and THA/TKA, in contrast, the coefficient for each individual risk factor reported from their models will be on log scale, after being converted to the PR. These coefficients are not expressed in dollars, but rather they indicate that the total payment for a patient with a particular risk factor is expected to be however many times higher or lower, on average, than for a patient without that risk factor, holding all other risk factors constant.

Further, we account for the clustering within hospitals by estimating a hospital-specific effect, α_i, which we assume follows a normal distribution with a mean μ and variance τ^2, the between-hospital variance component.

The following equation defines the HGLM for AMI, HF, and THA/TKA:

$$h\left(\mathrm{E}\left(Y_{ij}\middle|\boldsymbol{Z}_{ij},\omega_i\right)\right) = log\left(E\left(Y_{ij}\middle|\boldsymbol{Z}_{ij},\omega_i\right)\right) = \alpha_i + \boldsymbol{\beta}\boldsymbol{Z}_{ij} \qquad (1)$$

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

i=1,…,I; j=1,…,n_i

The following equation defines the HGLM for pneumonia:

$$h\left(\mathrm{E}\left(Y_{ij}\middle|\boldsymbol{Z}_{ij},\omega_i\right)\right)=E\left(Y_{ij}\middle|\boldsymbol{Z}_{ij},\omega_i\right)=\alpha_i+\boldsymbol{\beta}\boldsymbol{Z}_{ij} \qquad (2)$$

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

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

For equations (1) and (2), where Y_{ij} denotes the outcome for the *j-th* patient at the *i-th* hospital; $\boldsymbol{Z}_{ij}=\left(Z_{ij1},Z_{ij2},\ldots,Z_{ijp}\right)^T$ is a set of *p* patient-specific covariates derived from the data; and *I* denotes the total number of hospitals and n_i denotes the number of index admissions at hospital *i*. The hospital-specific intercept of the *i-th* hospital, α_i, defined above, comprises μ, the adjusted average intercept over all hospitals in the sample, and ω_i, the hospital-specific intercept deviation from μ.[8]

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

Risk-Standardized Measure Score Calculation

Using the HGLM defined by Equation (1) or (2), to obtain the parameter estimates $\hat{\mu}$, $\{\hat{\alpha}_1,\hat{\alpha}_2,\ldots,\hat{\alpha}_I\}$, $\widehat{\boldsymbol{\beta}}$, and $\hat{\tau}^2$, we first compute the predicted payment and expected payment:

$$\text{Predicted Value: } \hat{p}_{ij}=h^{-1}\left(\hat{\alpha}_i+\widehat{\boldsymbol{\beta}}\boldsymbol{Z}_{ij}\right) \qquad (3)$$

$$\text{Expected Value: } \hat{e}_{ij}=h^{-1}\left(\hat{\mu}+\widehat{\boldsymbol{\beta}}\boldsymbol{Z}_{ij}\right) \qquad (4)$$

We then calculate the risk-standardized payment, $\widehat{RSP}_i$:

$$\text{Risk-Standardized Payment: } \widehat{RSP}_i=\frac{\sum_{j=1}^{n_i}\hat{p}_{ij}}{\sum_{j=1}^{n_i}\hat{e}_{ij}}\times\bar{y} \qquad (5)$$

$$\text{where } \bar{y} = \text{national mean payment}$$

Creating Interval Estimates

The measure score is a complex function of parameter estimates; therefore, we use re-sampling and simulation techniques to derive an interval estimate to determine if a hospital's RSP is greater than, less than, or no different than expected. A hospital's RSP is considered greater than expected if the upper bound of their interval estimate falls below the national mean payment, $\bar{y}$, and considered less than expected if the lower bound of their interval estimate falls above $\bar{y}$. A hospital is considered no different than expected if the interval estimate overlaps $\bar{y}$.

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

Bootstrapping Algorithm

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

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

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

Appendix B. Data QA

This production year required updates to all SAS packs to account for updates in ICD-10 codes and associated mappings of clinical groupers. 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 for processing data and creating the input files, nor does it include the QA for the final processing of production data for public reporting, because another contractor conducts that work.

Phase I

The first step in this year's QA process was to review changes in the cohort and outcomes definitions as determined by the measure-specific code set files that were updated to account for changes in ICD-10 coding. This included updates to the HCC clinical category maps.

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

Phase II

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

Phase III

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

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

Appendix C. Annual Updates

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

2020

2020 Measures Updates and Specifications Report (Version 9.0 – AMI) (Version 7.0 – HF and Pneumonia) (Version 6.0 – THA/TKA)

1. Updated the ICD-10 code-based specifications used in the measures. Specifically:
   - Incorporated the code changes that occurred in the FY 2019 version of the ICD-10-CM/PCS (effective with October 1, 2018+ discharges) into the cohort definitions, the risk models, and the complication definitions used in the THA/TKA payment measure;
   - Applied a modified version of the FY 2019 V22 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and,
   - Made additional code specification changes prompted by the activities described in Section 3.
     - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.

2019

2019 Measures Updates and Specifications Report (Version 8.0 – AMI) (Version 6.0 – HF and Pneumonia) (Version 5.0 – THA/TKA)

1. Updated the ICD-10 code-based specifications used in the measures. Specifically:
   - Incorporated the code changes that occurred in the FY 2018 version of the ICD-10-CM/PCS (effective with October 1, 2017+ discharges) into the cohort definitions, the risk models, and the complication definitions used in the THA/TKA payment measure;
   - Applied a modified version of the FY 2018 V22 CMS-Hierarchical Condition Categories (HCC) crosswalk that is maintained by RTI International to the risk models; and,
   - Made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches. For example, ICD-10-CM code I21.9, Acute myocardial infarction, unspecified, was identified through a "neighboring code search" (found near existing code I21.4, Non-ST elevation (N-STEMI) myocardial infarction) and determined through clinical review to be a code which meets measure intent. As a result, it was added to the AMI cohort inclusion list.
     - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
2. Description of the complication category 'Periprosthetic Joint Infection/Wound Infection' was changed to 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications'.
   - Rationale: Description was revised to reflect that conditions beyond periprosthetic joint infection/wound infection, such as wound disruption, are captured under this category; conditions that our clinical experts consider to be relevant and consistent with the intent of the THA/TKA payment measure.

2018

2018 Measures Updates and Specifications Report (Version 7.0 – AMI) (Version 5.0 – HF and Pneumonia) (Version 4.0 – THA/TKA)

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

2017

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

1. Updated the pneumonia measure specifications as described in the Reevaluation and Re-Specification Report of the Hospital-Level 30-Day Risk-Standardized Measures Following Hospitalization for Pneumonia posted here on *QualityNet*:
   - 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); and,
   - Re-specified the risk models, updating the CC-based risk variables to the ICD-10-compatible HCC system version 22 and applying ICD-10 codes for certain risk variables (for example, 'History of percutaneous transluminal coronary angioplasty (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. The U.S. Department of Health and Human Services (HHS) mandated that ICD-10 codes be used for medical coding, effective with October 1, 2015 discharges. The measurement period for 2017 public reporting required data from claims that

include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification was warranted to accommodate ICD-10 coding.

2016

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

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.[10] 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 Technical Expert Panel (TEP) suggested that joint manipulation under anesthesia often takes place within 90 days of an elective primary THA/TKA and should be considered for inclusion in the measure.

2015

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

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

2014

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

1. Updated payment calculation to include a new technology add-on payment.
   - Rationale: New technology payments are meant to ensure that Medicare beneficiaries have access to new technologies that have not been accounted for by the DRG reimbursement rate.
2. Updated payment calculation to include a blood clotting add-on payment.
   - Rationale: Blood clotting add-on payments ensure that inpatient hospitals, inpatient rehabilitation facilities, and long-term care hospitals receive additional reimbursement for blood clotting factor for patients with hemophilia.

3. Updated the payment calculation to include Winsorization of outlier payments.
   - Rationale: Winsorization eliminates extreme values at the upper end of the total payment distribution to improve model prediction and mitigate the impact of possible erroneous claims without attempting to make corrections or excluding patients.
4. Excluded patients with a missing DRG weight during the index admission if there was also no payment on the claim for the provider.
   - Rationale: With neither DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

2013

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

1. Updated the inclusion and exclusion criteria to include Maryland and US territories hospitals.
   - Rationale: The original measure did not include AMI admissions from hospitals in Maryland or US Territories because CMS reimburses hospitals in Maryland and US Territories using a different mechanism than hospitals in the other 49 states and the District of Columbia. These hospitals are now included in the measure and treated as if they were paid under CMS's IPPS.
2. Updated the inclusion and exclusion criteria to exclude hospice patients.
   - Rationale: The original AMI payment measure did not exclude patients with any hospice assignment due to a desire to include the full breadth of AMI index admissions that met our criteria. This decision was not aligned with CMS's publicly reported 30-day AMI mortality measure. After discussion with our TEP, 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.
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and 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: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or 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 and 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.

The ICD-10-CM codes used to define the AMI cohort are outlined in the 2020 AMI Payment Measure Code Specifications supplemental file posted here on *QualityNet*.

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.
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and 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: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or 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 and 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.

   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.

The ICD-10 codes used to define the HF cohort inclusions and exclusions for discharges on or after October 1, 2015 are outlined in the 2020 HF Payment Measure Code Specifications supplemental file posted here on *QualityNet*.

ICD-9 code lists used to identify HF cohort exclusions (LVAD and heart transplant procedures) in claims for discharges prior to October 1, 2015 can be found in the 2016 payment measures updates and specifications report posted here on *QualityNet.*

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; or,**
   - **Sepsis (not including severe sepsis) with a secondary diagnosis of 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.
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and 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: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or 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 and 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.

The ICD-10-CM codes used to define the pneumonia cohort are outlined in the 2020 Pneumonia Payment Measure Code Specifications supplemental file posted here on *QualityNet*.

Outcome

Outcome Criteria for Pneumonia Measure

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 (NQF #3474)

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.
   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 on the index admission claim** (Note: Periprosthetic fractures must be additionally coded as POA in order to disqualify a THA/TKA from cohort inclusion, unless exempt from POA reporting.)
     Rationale: Patients with fractures have higher mortality, complication, and readmission rates, and the procedures are typically not elective.
   - **A concurrent partial hip or knee arthroplasty procedure**
     Rationale: Partial arthroplasty procedures are primarily done for hip and knee fractures and are typically performed on patients who are older, frailer, and have more comorbid conditions.
   - **A concurrent revision, resurfacing, or implanted device/prosthesis removal procedure**
     Rationale: Revision procedures may be performed at a disproportionately small number of hospitals and are associated with higher mortality, complication, and readmission rates. Resurfacing procedures are a different type of procedure involving only the joint's articular surface and are typically performed on younger, healthier patients. Elective procedures performed on patients undergoing removal of implanted device/prostheses procedures may be more complicated.
   - **Mechanical complication coded in the principal discharge diagnosis field on the index admission claim**
     Rationale: A complication coded as the principal discharge diagnosis suggests the procedure was more likely the result of a previous procedure. These patients may require more technically complex arthroplasty procedures and may be at increased risk for complications, particularly mechanical complications, and readmission.
   - **Malignant neoplasm of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or a disseminated malignant neoplasm coded in the principal discharge diagnosis field on the index admission claim**
     Rationale**:** Patients with these malignant neoplasms are at increased risk for complications and readmission, and the procedure may not be elective.
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and 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: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or 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**
   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. Coding in such cases 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.

The ICD-10 codes used to identify THA/TKA procedures and to identify a THA/TKA procedure as non-elective or non-primary (and disqualify the admission from cohort inclusion) in claims are outlined in the 2020 THA/TKA Payment Measure Code Specifications supplemental file posted here on *QualityNet*.

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
- SNFs
- Home health
- Outpatient hospital (joint manipulation procedures under anesthesia) (Table D.4.1)
- ASCs (joint manipulation procedures under anesthesia) (Table D.4.1)
- 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 (Mechanical Complications and Periprosthetic Joint Infection/Wound Infection and Other Wound Complications). The ICD-10 codes used to define these complications are listed in the 2020 THA/TKA Payment Measure Code Specifications supplemental file posted here on *QualityNet*.

Table D.4.1 – 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)