2022 Payment Measures Updates and Specifications Report

Acute Myocardial Infarction — Version 11.0
Heart Failure — Version 9.0
Pneumonia — Version 9.0
Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) — Version 8.0

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Table of Contents

List of Tables **4**
List of Figures **5**
1. HOW TO USE THIS REPORT **7**
2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY **9**
2.1. Background on Payment Measures 9
2.2. Overview of Measure Methodology 9
2.2.1 Cohort 9
2.2.2 Outcome 12
2.2.3 Risk-Adjustment Variables 14
2.2.4 Data Sources 15
2.2.5 Measure Calculation 16
2.2.6 Categorizing Hospital Payments 17
3. UPDATES TO MEASURES FOR 2022 PUBLIC REPORTING **18**
3.1. Rationale for Measure Updates 18
3.2. Detailed Discussion of Measure Updates 19
3.2.1 Annual Updates to ICD-10 Code-Based Measure Specifications 19
3.2.2 COVID-19 20
3.2.3 Update to Risk Adjustment Methodology 22
3.2.4 Additional Notes 24
3.3. Changes to SAS Packs 24
4. RESULTS FOR 2022 PUBLIC REPORTING **25**
4.1. Assessment of Updated Models 25
4.2. AMI Payment 2022 Model Results 26
4.2.1 Index Cohort Exclusions 26
4.2.2 Frequency of AMI Model Variables 28
4.2.3 AMI Model Parameters and Performance 28
4.2.4 Distribution of Hospital Volumes and Payments for AMI 28
4.2.5 Distribution of Hospitals by Payment Category in the 29-Month Dataset 29
4.3. HF Payment 2022 Model Results 35
4.3.1 Index Cohort Exclusions 35
4.3.2 Frequency of HF Model Variables 37
4.3.3 HF Model Parameters and Performance 37
4.3.4 Distribution of Hospital Volumes and Payments for HF 37
4.3.5 Distribution of Hospitals by Payment Category in the 29-Month Dataset 38
4.4. Pneumonia Payment 2022 Model Results 45
4.4.1 Index Cohort Exclusions 45
4.4.2 Frequency of Pneumonia Model Variables 47
4.4.3 Pneumonia Model Parameters and Performance 47
4.4.4 Distribution of Hospital Volumes and Payments for Pneumonia 47
4.4.5 Distribution of Hospitals by Payment Category in the 29-Month Dataset 47

4.5. THA/TKA Payment 2022 Model Results 55
4.5.1 Index Cohort Exclusions 55
4.5.2 Frequency of THA/TKA Model Variables 57
4.5.3 THA/TKA Model Parameters and Performance 57
4.5.4 Distribution of Hospital Volumes and Payment for THA/TKA 57
4.5.5 Distribution of Hospitals by Payment Category in the 27-Month Dataset 58
5. GLOSSARY 67
6. REFERENCES 69
7. APPENDICES 71
Appendix A. Statistical Approach for AMI, HF, Pneumonia, and THA/TKA Measures 71
Hierarchical Generalized Linear Model 71
Risk-Standardized Measure Score Calculation 72
Creating Interval Estimates 72
Bootstrapping Algorithm 73
Appendix B. Data QA 74
Phase I 74
Phase II 74
Phase III 74
Appendix C. Annual Updates 75
Appendix D. Measure Specifications 80
Appendix D.1 Hospital-Level RSP Associated with a 30-Day Episode of Care for AMI (NQF #2431) 80
Appendix D.2 Hospital-Level RSP Associated with a 30-Day Episode of Care for HF (NQF #2436) 83
Appendix D.3 Hospital-Level RSP Associated with a 30-Day Episode of Care for Pneumonia (NQF #2579) 85
Appendix D.4 Hospital-Level RSP Associated with a 90-Day Episode of Care for Elective Primary THA and/or TKA (NQF #3474) 88

List of Tables

Table 4.2.1 — Frequency of AMI Model Variables over Different Time Periods 29
Table 4.2.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients for AMI over Different Time Periods 30
Table 4.2.3— Adjusted PR and 95% CIs for the AMI Hierarchical Generalized Linear Regression Model over Different Time Periods 31
Table 4.2.4 — AMI Generalized Linear Model Performance over Different Time Periods 33
Table 4.2.5 — Distribution of Hospital AMI Admission Volumes over Different Time Periods 33
Table 4.2.6 — Distribution of Hospital AMI RSPs over Different Time Periods ($2020) 33
Table 4.2.7 — Between-Hospital Variance for AMI over Different Time Periods 34
Table 4.3.1 — Frequency of HF Model Variables over Different Time Periods 38
Table 4.3.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients for HF over Different Time Periods 39
Table 4.3.3 — Adjusted PR and 95% CIs for the HF Hierarchical Generalized Linear Regression Model over Different Time Periods 40
Table 4.3.4 — HF Generalized Linear Model Performance over Different Time Periods 42
Table 4.3.5 — Distribution of Hospital HF Admission Volumes over Different Time Periods 42
Table 4.3.6 — Distribution of Hospital HF RSPs over Different Time Periods ($2020) 43
Table 4.3.7 — Between-Hospital Variance for HF over Different Time Periods 43
Table 4.4.1 — Frequency of Pneumonia Model Variables over Different Time Periods 48
Table 4.4.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients and 95% CIs for Pneumonia over Different Time Periods ($2020) 50
Table 4.4.3 — Pneumonia Generalized Linear Model Performance over Different Time Periods 53
Table 4.4.4 — Distribution of Hospital Pneumonia Admission Volumes over Different Time Periods 53
Table 4.4.5 — Distribution of Hospital Pneumonia RSPs over Different Time Periods ($2020) 53
Table 4.4.6 — Between-Hospital Variance for Pneumonia over Different Time Periods 54
Table 4.5.1 — Frequency of THA/TKA Model Variables over Different Time Periods 58
Table 4.5.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients for THA/TKA over Different Time Periods 60
Table 4.5.3 — Adjusted PR and 95% CIs for the THA/TKA Hierarchical Generalized Linear Regression Model over Different Time Periods 62
Table 4.5.4 — THA/TKA Generalized Linear Model Performance over Different Time Periods 65
Table 4.5.5 — Distribution of Hospital THA/TKA Admission Volumes over Different Time Periods 65
Table 4.5.6 — Distribution of Hospital THA/TKA RSPs over Different Time Periods ($2020) 65
Table 4.5.7 — Between-Hospital Variance for THA/TKA over Different Time Periods 65
Table A.1 — Exponential Family Distributions and Link Functions for the Payment Measures 71
Table D.4.1 — Common Procedural Terminology (CPT) Codes Defining Joint Manipulation Under Anesthesia Procedures 90

List of Figures

Figure 4.2.1 — AMI Cohort Exclusions in the July 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020) 27
Figure 4.2.2 — Distribution of Hospital AMI 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020) 34
Figure 4.3.1 — HF Cohort Exclusions in the July 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020) 36
Figure 4.3.2 — Distribution of Hospital HF 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020) 44
Figure 4.4.1 — Pneumonia Cohort Exclusions in the July 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020) 46
Figure 4.4.2 — Distribution of Hospital Pneumonia 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020) 54
Figure 4.5.1 — THA/TKA Cohort Exclusions in the April 1, 2018 – March 31, 2021 Dataset (excluding October 3, 2019 through June 30, 2020) 56
Figure 4.5.2 — Distribution of Hospital THA/TKA 90-Day Episode-of-Care RSPs between April 1, 2018 and March 31, 2021, excluding October 3, 2019 through June 30, 2020 ($2020) 66

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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 here on Care Compare. 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:

- 2022 AMI Payment Measure Code Specifications
- 2022 HF Payment Measure Code Specifications
- 2022 Pneumonia Payment Measure Code Specifications
- 2022 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 – 2022 measure updates**
- **Section 4 – 2022 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
- 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' section and 'Archived Measure Methodology' section (under 'Resources') on the payment measures page here on *QualityNet*.

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

If you have questions about the information in this report or the complementary supplemental files, please submit your inquiry using the QualityNet Q&A tool: https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program: Inpatient Claims-Based Measures > Payment (AMI, heart failure, pneumonia, hip/knee) > Understanding Measure Methodology.

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 (CAHs). In 2015, CMS began publicly reporting two additional hospital 30-day payment measures, 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 CAHs.

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.

Results for all four of these payment measures are posted and updated annually here on Care Compare.

CMS contracted with the Yale New Haven Health Services Corporation — Center for Outcomes Research and Evaluation (YNHHSC/CORE) to update the AMI, HF, pneumonia, and THA/TKA payment measures for 2022 public reporting through a process of measure reevaluation.

2.2. Overview of Measure Methodology

The 2022 risk-adjusted payment measures use specifications from the original 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) 2023, as well as their use in future FYs, please refer to the FY 2022 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 that meet ALL of the following criteria:
        - A principal discharge diagnosis of sepsis (that is not severe)

    - A secondary diagnosis of pneumonia coded as present on admission (POA)
    - No secondary diagnosis of sepsis that is both severe and 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.

The International Classification of Diseases, Tenth Revision (ICD-10) codes used to define the cohort inclusions for each measure are listed in the 2022 supplemental files posted here on *QualityNet*.

Elective primary THA/TKA procedures are defined as those THA/TKA procedures *without* 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.)
- 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
- 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 THA/TKA payment measure uses ICD-10-PCS codes on claims to define a THA/TKA procedure. It also uses ICD-10-PCS codes as well as International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes on claims to identify a THA/TKA procedure as non-elective or non-primary (and disqualify the admission from cohort inclusion). These codes are listed in the 2022 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;
- 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; or
- with a principal diagnosis code of COVID-19 (ICD-10-CM code U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim.

These code specifications are outlined in the 2022 supplemental files here on *QualityNet*.

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

- 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 up to 12 months prior to the index admission are excluded as index admissions because these patients represent a clinically distinct group. Claims data from January 1, 2020 through June 30, 2020 hospitalizations were not used due to the declared COVID-19 public health emergency (PHE), as discussed in Section 3.2.2; as a result, the pre-index admission time frame would be less than 12 months for some patients, depending on their index admission date. The International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-PCS) codes used to identify LVAD and heart transplant procedures are provided in the 2022 HF Payment Measure Code Specifications supplemental file 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 one of the following three time periods, only one index admission for that condition or procedure is randomly selected for inclusion in the cohort, and additional admissions within that time period are excluded:

- AMI, HF, and pneumonia:
  - July 1, 2018 – June 30, 2019
  - July 1, 2019 – December 1, 2019
  - July 1, 2020 – June 30, 2021
- TKA/TKA:
  - April 1, 2018 – March 31, 2019
  - April 1, 2019 – October 2, 2019
  - July 1, 2020 – March 31, 2021

If two index admissions occur during the transition between the first two time periods of the measurement period for a measure and both are randomly selected for inclusion in the measure, the measure includes only the first admission. Please refer to Appendix D for additional details on these scenarios.

As a part of data processing prior to the measure calculation, records are removed for non-short-term acute care facilities, such as psychiatric facilities, rehabilitation facilities,

or long-term care hospitals. Additional data cleaning steps include removing claims with stays longer than one year, claims with overlapping dates, claims for patients not listed in the Medicare Enrollment Database, and records with ineligible provider IDs.

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.

Claims with a diagnosis code of COVID-19 (U07.1) are not eligible for use in determining the payment outcome and are excluded. Note, a secondary diagnosis code of COVID-19 on an inpatient claim must be coded as POA to be ineligible. These code specifications are outlined in the 2022 supplemental files here on *QualityNet*.

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.11 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, with the exception of the COVID-19 claims (described in the Payments subsection above), 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:

- THA and TKA procedures require ongoing post-discharge care.
- The 90-day time frame incentivizes hospitals to optimize post-discharge care.

- 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.
- 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 the first two time periods of 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 up to 12 months prior to the index admission, and all claims for the index admission itself. Inpatient, outpatient, and physician claims data from January 1, 2020 through June 30, 2020 encounters are not used due to the declared COVID-19 PHE (as discussed in Section 3.2.2); as a result, the pre-index admission time frame would be less than 12 months for some patients, depending on their index admission date.

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 (or less), are included in risk adjustment. Complications that arise during the course of the hospitalization are not used in risk adjustment.

The process for determining patient comorbidities present at the time of the index admission from the index admission claim uses a POA algorithm. In brief, a secondary diagnosis ICD-10-CM code on the index admission claim is used in risk adjustment if **one** of the following is true:

1. The POA indicator for the secondary diagnosis code = 'Y' on the index admission.

2. The secondary diagnosis code is classified as a POA-exempt code that is considered "always POA" (as designated by our clinical experts).
3. If the index claim data is void of POA coding (that is, no reported POA indicator values for any of the secondary diagnoses), then the secondary diagnosis is used in risk adjustment if it is NOT mapped to a Condition Category (CC) that is included in the potential complications list.

The POA algorithm applies only in the case of secondary diagnosis codes on the index admission that are assigned to a CC used in risk adjustment of a measure. The ICD-10 code-defined risk variables, such as 'History of COVID-19' (captured, in part, by a secondary diagnosis code of Z86.16 [Personal history of COVID-19] on the index claim), do not use the algorithm.

Refer to the 2022 supplemental files posted here on *QualityNet* for the list of CC-defined risk-adjustment variables and the specifications for the ICD-10 code-defined risk-adjustment variables. The lists of potential complications referred to in Step 3 of the algorithm are also included in the 2022 supplemental files.

CC mappings to ICD-10-CM codes, as well as the "POA-Exempt Codes Considered Always POA for 2022" table (referred to in Step 2 of the algorithm), are available here on *QualityNet.*

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.

2.2.4 Data Sources

The data sources for these analyses include Medicare administrative claims and enrollment information for patients having hospitalizations with discharge dates between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020, for AMI, HF, and pneumonia, and between April 1, 2018 and March 31, 2021, excluding October 3, 2019 through June 30, 2020, for THA/TKA. The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims from up to 12 months prior to the index admission (as discussed in Section 2.2.3) and 30 days subsequent to the index admission (or 90 days, for THA/TKA) for patients having hospitalizations with discharge dates as noted above.

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.11 document posted here on *QualityNet.* The CMS Standardization Methodology for Allowed Amount for 2006 through 2021 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.

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 outcomes 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 transformed using the inverse-

link-function and 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. These results are also transformed using the inverse-link-function and 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 data in each time 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 2022 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, empirical analyses, and 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 2022 public reporting, we made the following modifications to the measures:

- Updated the ICD-10 code-based specifications used in the measures. Specifically, we:
  - incorporated ICD-10-CM/PCS code changes into the cohort definitions, the risk models, and the complication definitions used by the THA/TKA payment measure that occurred in the following releases:
    - April 1, 2020
    - August 1, 2020
    - October 1, 2020 (FY 2021)
    - January 1, 2021
  - applied a modified version of the FY 2021 V24 CMS-Hierarchical Condition Category (HCC) crosswalk that is maintained by RTI International to the risk models.
- Adjusted the measure specifications and methodologies in response to the COVID-19 PHE.
- Added a POA algorithm to the risk-adjustment methodology.

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 combined 29 months (or 27 months, in the case of the THA/TKA measure):
  - AMI, HF, and pneumonia: July 1, 2018 – June 30, 2021, excluding December 2, 2019 through June 30, 2020
  - THA/TKA: April 1, 2018 – March 31, 2021, excluding October 3, 2019 through June 30, 2020
- Evaluated the stability of the risk-adjustment model over the 29-month/27-month measurement period by examining the model variable frequencies, model coefficients, and the performance of the risk-adjustment model in each time period:
  - AMI, HF, and pneumonia:
    - July 1, 2018 – June 30, 2019

- July 1, 2019 – December 1, 2019
- July 1, 2020 – June 30, 2021

- THA/TKA:
  - April 1, 2018 – March 31, 2019
  - April 1, 2019 – October 2, 2019
  - July 1, 2020 – March 31, 2021

3.2. Detailed Discussion of Measure Updates

3.2.1 Annual Updates to ICD-10 Code-Based Measure Specifications

Cohort Definitions and the Payment Outcome

We examined the code sets from the four ICD-10-CM/PCS releases outlined above, with particular attention to newly added codes. We then solicited input from our workgroup to determine which, if any, of the newly implemented ICD-10 codes in the code sets should be added to the cohort definitions and the complication definitions used by the THA/TKA payment measure. We reviewed approximately 495 new ICD-10-CM codes and 575 new ICD-10-PCS codes. These code totals reflect new code additions since 2021 public reporting.

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-PCS codes to the specifications that define 'Periprosthetic Joint Infection/Wound Infection and Other Wound Complications' THA/TKA-related payments (used by the THA/TKA measure)
- the removal of COVID-19 patients from the cohorts. For more details, refer to Section 3.2.2.
- COVID-19 claims (ICD-10-CM U07.1) are not eligible for the payment outcome and are excluded. For more details, refer to Section 3.2.2.

Analyses of the changes to the specifications suggest minimal impact to payment measure rates.

Risk Adjustment

We examined RTI International's FY 2021 modified version of the V24 CMS-HCC crosswalk to see how the newly implemented ICD-10 codes in the ICD-10-CM/PCS code set releases were classified, and to examine codes which RTI International reclassified from one HCC to another when they updated to the FY 2021 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 where code shifts may have occurred. The workgroup also reviewed the newly implemented ICD-10 codes in the ICD-10-CM/PCS code set releases 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 changes:

- Minor remappings or changes in CC mapping from 2021 to 2022 public reporting, including:
  - Approximately 640 ICD-10-CM codes that were mapped from CC 174 (Other injuries) in 2021 are remapped to CC 175 (Poisonings and allergic and inflammatory reactions).

Analyses of the CC crosswalk changes showed no appreciable shifts in risk variable frequencies or changes in risk variable estimates and suggest minimal impact to payment measure rates.

For information on additional changes made to the risk-adjustment methodologies, refer to Section 3.2.2 and Section 3.2.3.

3.2.2 COVID-19

Changes Due to COVID-19

The following modifications were made to the measures, in response to the COVID-19 PHE:

- Claims data for January 1, 2020 – June 30, 2020 continue to be excluded from use in the measures under CMS's Extraordinary Circumstances Exception (ECE) policy, similar to 2021 public reporting.[5-8] As a result:
  - The measurement period for 2022 public reporting is again reduced to approximately 29 months (or 27 months, for THA/TKA), from the typical three years, similar to 2021 public reporting. The approximately seven months of admissions (or nine months, for THA/TKA) excluded as index admissions incorporates (1) the CMS-excluded January 1, 2020 – June 30, 2020 claims referred to above, and (2) December 2, 2019 – December 31, 2019 claims (or October 3, 2019 – December 31, 2019, for THA/TKA), where payment outcome determination using the 30-day/90-day outcome window would require claims from CMS's excluded January 1, 2020 – June 30, 2020 time frame.
  - The typical 12-month look-back period for use of claims data in risk adjustment and in identifying patients with a procedure code for LVAD implantation or heart transplantation prior to the index admission (an exclusion for the HF payment measure cohort) totals less than 12 months for those patients whose 12-month period includes any portion of the January 1, 2020 – June 30, 2020 time frame.
- A new 'History of COVID-19' risk variable has been added to the risk-adjustment model for all four measures.
- COVID-19 index admissions are excluded from the cohorts. COVID-19 index admissions are defined by a principal diagnosis code of COVID-19 **or** a secondary diagnosis code of COVID-19 coded as POA on the index admission claim.

- Claims with a diagnosis code of COVID-19 (U07.1) are not eligible for use in determining the payment outcome and are excluded. Note, a secondary diagnosis code of COVID-19 on an inpatient claim must be coded as POA to be ineligible.
- A brief summary of how COVID-19 is addressed in each measure, including code specifications, can be found in the 2022 supplemental files here on *QualityNet*.

Rationale for COVID-19 Modifications

CMS's decision in March 2020 to exclude claims data for January 1, 2020 – June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy was done to assist healthcare providers who were directing their resources toward caring for patients and ensuring the health and safety of staff.

The COVID-19 PHE continues to have significant and enduring effects on the provision of medical care in the country and around the world. It affects care decisions. National or regional shortages or changes in healthcare personnel, medical supplies, equipment, diagnostic tools, and patient case volumes or facility-level case mix may affect quality measurement data. Adjustments to public reporting methodologies and specifications for 2022 help to ensure the intent of the measures is maintained.

For more information on the COVID-19 PHE, please refer to the FY 2022 IPPS Final Rule posted here on the CMS website.

Effect of COVID-19 Modifications

The frequencies of a secondary diagnosis code of COVID-19 coded as POA (or a principal diagnosis code of COVID-19, for the THA/TKA measure) tend to be very small (< 1%) for the AMI, HF, and THA/TKA measures, and more substantial but relatively small for the pneumonia payment measure (approximately 3.5%). These cases can be mitigated by updating the measure specifications to exclude COVID-19 cases.

Note that a new ICD-10-CM code J12.82, "Pneumonia due to coronavirus disease 2019," has been added to the ICD-10-CM code set, effective with January 1, 2021+ discharges. However, these cases are not included in the pneumonia payment measure cohort because of the following two methodologies:

- Coding guidance instructs that J12.82 is used only as a secondary diagnosis in conjunction with the COVID-19 code (U07.1) as the principal discharge diagnosis. [Index admissions with U07.1 as the principal discharge diagnosis are excluded from the cohorts.]
- In terms of the pneumonia payment measure cohort that includes admissions with a principal diagnosis of sepsis and secondary diagnosis of pneumonia POA: The J12.82 code is not in the list of pneumonia inclusion codes for 2022 public reporting. Therefore, admissions on or after January 1, 2021 coded with a principal diagnosis of sepsis and a secondary diagnosis of J12.82 (the new ICD-10-CM code) are not included in the cohort.

Please refer to the FY 2022 IPPS Final Rule posted here on the CMS website for more information.

3.2.3 Update to Risk Adjustment Methodology

Addition of POA Coding to Risk Adjustment

A POA algorithm was added to the risk-adjustment methodology used to pull risk-adjustment variables from the index admission claim. In brief, a secondary diagnosis ICD-10-CM code on the index admission is used in risk adjustment if **one** of the following is true:

1. The POA indicator for the secondary diagnosis code = 'Y' on the index admission.
2. The secondary diagnosis code is classified as a POA-exempt code that is considered "always POA" (as designated by our clinical experts).
3. If the index claim data is void of POA coding (that is, no reported POA indicator values for any of the secondary diagnoses), then the secondary diagnosis is used in risk adjustment if it is NOT mapped to a CC that is included in the potential complications list.

In submitting claims, CMS requires IPPS hospitals to denote whether each principal and secondary diagnosis was POA for all ICD-10-CM codes, except for POA-exempt codes. Although the majority of the codes on the POA-exempt list reflect conditions that are always POA (for example, subsequent or sequela encounters, congenital conditions), some of the POA-exempt codes may not reflect health status at the time of admission. We conducted a focused review of the POA-exempt list with our clinical experts, to determine which of those codes should be considered "always POA."

The "POA-Exempt Codes Considered Always POA for 2022" table (referred to in Step 2 of the algorithm) is available here on *QualityNet.*

The POA algorithm applies only in the case of secondary diagnosis codes on the index admission that are assigned to a CC used in risk adjustment of a measure. ICD-10 code-defined risk variables, such as 'History of COVID-19' (captured, in part, by a secondary diagnosis code of Z86.16 [Personal history of COVID-19] on the index claim), do not use the algorithm.

Rationale for Addition of POA Coding

Many stakeholders have expressed concerns that POA indicators have not been used in risk adjustment, arguing that (1) POA coding is a logical reflection of comorbidities, and (2) use of POA indicators would help particularly in cases where the patient has not been hospitalized or had provider visits in the last year or where a comorbid condition present at the time of admission is relatively new. In both of these scenarios, historical claims (up to 12 months prior to the index admission) that include that comorbid condition would not be present. Stakeholder feedback strongly supports the incorporation of POA.

POA indicators more accurately distinguish complications of care from conditions already present at admission, in comparison to the previous methodology that utilized only the potential complications list.[9] Our analyses show that all IPPS hospitals code POA indicators, while a small proportion of CAHs do not. Therefore, the POA algorithm

incorporates the previous potential complications list methodology for claims in which POA indicators are missing.

Effect of POA Coding to Risk Adjustment

To explore the impact of POA indicators on the measures, we conducted extensive analyses. Our findings[9] include:

- Model performance with POA coding was similar to performance without POA.
- Models with POA likely provide a better estimate of a patient's risk than models without POA.
- The difference in hospital RSPs comparing models with and without POA was very small.

3.2.4 Additional Notes

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

Changes made to the specifications are detailed in the following supplemental files that accompany this report:

- 2022 AMI Payment Measure Code Specifications
- 2022 HF Payment Measure Code Specifications
- 2022 Pneumonia Payment Measure Code Specifications
- 2022 THA/TKA Payment Measure Code Specifications

These supplemental files are posted here on *QualityNet*.

The ICD-10 code listings in this report and the 2022 supplemental files reflect the current (FY 2021) 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. Please submit your request using the QualityNet Q&A tool: https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program: Inpatient Claims-Based Measures > Payment (AMI, heart failure, pneumonia, hip/knee) > Understanding Measure Methodology. **Do *NOT* submit patient-identifiable information (for example, date of birth, Social Security number, Medicare Beneficiary Identifier/health insurance claim number) into this tool.**

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 2022 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 1, 2018 through June 30, 2021 data (excluding December 2, 2019 through June 30, 2020) and the April 1, 2018 through March 31, 2021 data (excluding October 3, 2019 through June 30, 2020), respectively, for the 2022 reporting period. We examined the differences in the frequencies of patient risk factors and the model parameter coefficients. Before evaluation, all payments were inflation-adjusted to 2020 dollars (designated with "$2020" 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 time period of data and for the 29-month/27-month 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.[10] 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.

Please note that, due to seasonal fluctuations and other factors, the statistics from the second and shorter time period (July 1, 2019 – December 1, 2019, or April 1, 2019 – October 2, 2019 for THA/TKA) that are presented in the tables within these sections are not directly comparable to the other two time periods.

4.2. AMI Payment 2022 Model Results

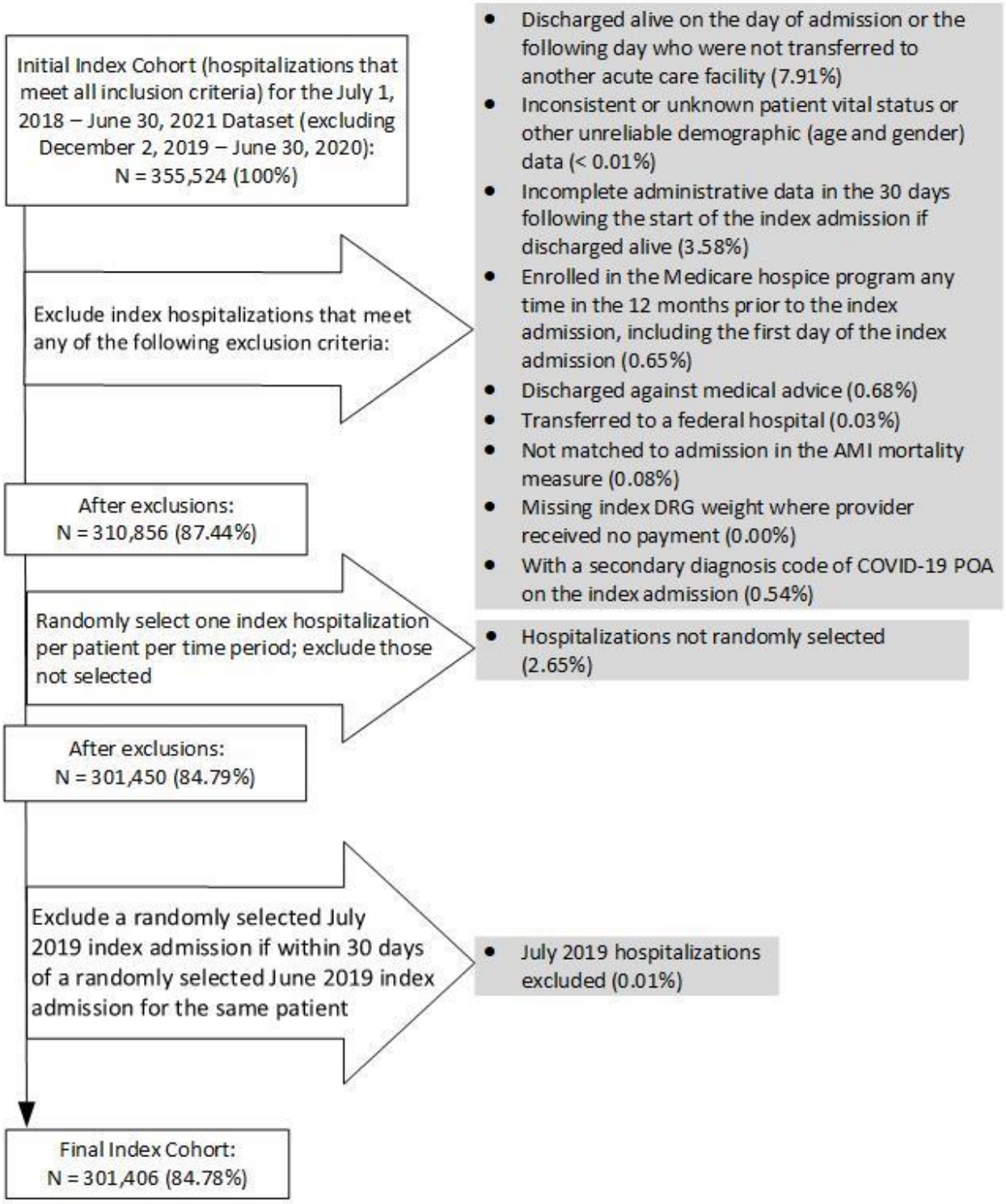
4.2.1 Index Cohort Exclusions

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 1, 2018 – June 30, 2021 dataset (excluding December 2, 2019 through June 30, 2020) 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 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020)



4.2.2 Frequency of AMI Model Variables

We examined the frequencies of clinical and demographic variables. Frequencies of model variables were relatively stable over the measurement period.

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 parameter coefficients by individual time period and for the combined 29-month dataset. Table 4.2.3 shows the risk-adjusted payment ratios (PRs) and 95% confidence intervals (CIs) for the AMI payment model by individual time period and for the combined 29-month dataset. The quasi-R^2 for the AMI payment model was 0.06, suggesting that approximately 6% 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.[11]

Overall, the variable effect sizes were relatively constant across time periods. In addition, model performance was stable over the 29-month period; the quasi-R^2 and predictive ratios remained similar to the model used for 2021 public reporting (Table 4.2.4).

4.2.4 Distribution of Hospital Volumes and Payments for AMI

The national mean payment for the combined 29-month dataset was $26,800 ($2020). For the three time periods, the national mean payments were as follows:

- July 1, 2018 – June 30, 2019: $26,909 ($2020)
- July 1, 2019 – December 1, 2019: $26,866 ($2020)
- July 1, 2020 – June 30, 2021: $26,627 ($2020)

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 time period, as well as for the combined 29-month 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 29-month dataset, which indicates that the hospital RSPs are approximately 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 Payment Category in the 29-Month Dataset

Of 3,796 hospitals in the study cohort, 103 had a payment "Less than the National Average Payment," 1,690 had a payment "No Different than the National Average Payment," and 144 had a payment "Greater than the National Average Payment." 1,859 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)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Total N	136,666	56,304	108,436	301,406
Age (>=85)	22.3	21.7	21.0	21.7
Age (65 – 74)	40.9	41.3	41.8	41.3
Age (75 – 84)	36.8	37.1	37.3	37.0
History of COVID-19	-	-	4.1	1.5
History of coronary artery bypass graft (CABG) surgery	13.5	13.2	12.0	12.9
History of percutaneous transluminal coronary angioplasty (PTCA)	19.4	19.2	18.2	18.9
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	4.3	4.5	4.3	4.3
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	48.3	48.5	46.3	47.6
Protein-calorie malnutrition (CC 21)	6.4	6.3	5.4	6.0
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	89.2	90.0	88.5	89.1
Other significant endocrine and metabolic disorders (CC 23)	8.6	8.8	8.0	8.4
Other gastrointestinal disorders (CC 38)	55.4	56.5	49.4	53.4
Osteoporosis and other bone/cartilage disorders (CC 43)	15.2	15.6	12.4	14.3
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	39.9	40.3	36.3	38.7
Delirium and encephalopathy (CC 50)	8.7	8.7	7.4	8.2
Dementia (CC 51 – 52)	13.5	13.2	11.3	12.6
Substance use with psychotic complications (CC 54)	0.2	0.1	0.1	0.1
Drug/alcohol abuse/dependence (CC 55 – 56, 202 – 203)	17.9	18.2	16.3	17.4
Severe mental illness (CC 57, 59)	6.6	7.4	6.1	6.6
Reactive and unspecified psychosis (CC 58)	0.5	0.4	0.3	0.4
Depression/anxiety (CC 61 – 62)	18.1	18.9	16.5	17.6
Congestive heart failure (CC 85)	50.3	49.9	48.9	49.8
Coronary atherosclerosis or angina (CC 88 – 89)	82.5	83.1	82.1	82.5

Variable (% unless otherwise indicated)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Heart infection/inflammation, except rheumatic (CC 90)	2.1	2.4	2.1	2.1
Valvular and rheumatic heart disease (CC 91)	31.5	31.4	27.8	30.1
Congenital cardiac/circulatory defects (CC 92 – 93)	1.1	1.1	1.0	1.1
Hypertension and hypertensive disease (CC 94 – 95)	81.6	81.6	74.2	79.0
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	16.2	16.4	12.2	14.8
Vascular disease and complications (CC 106 – 108)	31.7	31.7	26.7	29.9
Other respiratory disorders (CC 118)	32.3	32.0	23.0	28.9
Legally blind (CC 119)	0.7	0.7	0.5	0.6
Dialysis status (CC 134)	4.4	4.5	4.3	4.4
Internal injuries (CC 172)	0.5	0.5	0.4	0.5

Table 4.2.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients for AMI over Different Time Periods

Variable	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Intercept	9.921	9.904	9.905	9.911
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 – 74)	0.200	0.220	0.237	0.217
Age (75 – 84)	0.186	0.200	0.214	0.197
History of COVID-19	-	-	-0.014	-0.028
History of coronary artery bypass graft (CABG) surgery	-0.258	-0.252	-0.249	-0.252
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.124	-0.103	-0.124	-0.119
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	-0.036	0.004	-0.013	-0.022
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.076	0.089	0.094	0.085
Protein-calorie malnutrition (CC 21)	0.080	0.062	0.079	0.075
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	-0.002	-0.021	-0.038	-0.019
Other significant endocrine and metabolic disorders (CC 23)	-0.002	-0.005	0.032	0.007
Other gastrointestinal disorders (CC 38)	-0.044	-0.050	-0.051	-0.047
Osteoporosis and other bone/cartilage disorders (CC 43)	-0.046	-0.052	-0.071	-0.054
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.028	0.053	0.034	0.035
Delirium and encephalopathy (CC 50)	0.051	0.045	0.074	0.056
Dementia (CC 51 – 52)	-0.112	-0.117	-0.117	-0.113

Variable	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Substance use with psychotic complications (CC 54)	0.081	0.110	0.074	0.086
Drug/alcohol abuse/dependence (CC 55 – 56, 202 – 203)	0.002	0.010	-0.001	0.003
Severe mental illness (CC 57, 59)	-0.005	0.001	-0.019	-0.010
Reactive and unspecified psychosis (CC 58)	-0.052	-0.014	-0.058	-0.042
Depression/anxiety (CC 61 – 62)	-0.036	-0.034	-0.042	-0.037
Congestive heart failure (CC 85)	0.159	0.149	0.167	0.159
Coronary atherosclerosis or angina (CC 88 – 89)	0.108	0.105	0.083	0.097
Heart infection/inflammation, except rheumatic (CC 90)	0.083	0.093	0.148	0.107
Valvular and rheumatic heart disease (CC 91)	0.050	0.038	0.051	0.049
Congenital cardiac/circulatory defects (CC 92 – 93)	0.088	0.147	0.115	0.109
Hypertension and hypertensive disease (CC 94 – 95)	-0.065	-0.055	-0.067	-0.063
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	0.064	0.056	0.066	0.062
Vascular disease and complications (CC 106 – 108)	0.031	0.032	0.048	0.036
Other respiratory disorders (CC 118)	-0.022	-0.021	-0.004	-0.014
Legally blind (CC 119)	-0.062	-0.129	-0.001	-0.052
Dialysis status (CC 134)	0.178	0.200	0.159	0.176
Internal injuries (CC 172)	0.068	0.098	0.147	0.099

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

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 – 74)	1.22 (1.21 – 1.24)	1.25 (1.22 – 1.27)	1.27 (1.25 – 1.28)	1.24 (1.23 – 1.25)
Age (75 – 84)	1.20 (1.19 – 1.22)	1.22 (1.20 – 1.24)	1.24 (1.22 – 1.25)	1.22 (1.21 – 1.23)
History of COVID-19	-	-	0.99 (0.96 – 1.01)	0.97 (0.95 – 1.00)
History of coronary artery bypass graft (CABG) surgery	0.77 (0.76 – 0.78)	0.78 (0.76 – 0.79)	0.78 (0.77 – 0.79)	0.78 (0.77 – 0.78)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.88 (0.87 – 0.89)	0.90 (0.89 – 0.92)	0.88 (0.87 – 0.89)	0.89 (0.88 – 0.89)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	0.96 (0.95 – 0.98)	1.00 (0.97 – 1.04)	0.99 (0.96 – 1.01)	0.98 (0.96 – 0.99)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.08 (1.07 – 1.09)	1.09 (1.08 – 1.11)	1.10 (1.09 – 1.11)	1.09 (1.08 – 1.09)

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Protein-calorie malnutrition (CC 21)	1.08 (1.06 – 1.10)	1.06 (1.03 – 1.09)	1.08 (1.06 – 1.11)	1.08 (1.06 – 1.09)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	1.00 (0.98 – 1.01)	0.98 (0.96 – 1.00)	0.96 (0.95 – 0.98)	0.98 (0.97 – 0.99)
Other significant endocrine and metabolic disorders (CC 23)	1.00 (0.98 – 1.02)	1.00 (0.97 – 1.03)	1.03 (1.01 – 1.06)	1.01 (0.99 – 1.02)
Other gastrointestinal disorders (CC 38)	0.96 (0.95 – 0.96)	0.95 (0.94 – 0.96)	0.95 (0.94 – 0.96)	0.95 (0.95 – 0.96)
Osteoporosis and other bone/cartilage disorders (CC 43)	0.95 (0.94 – 0.97)	0.95 (0.93 – 0.97)	0.93 (0.92 – 0.94)	0.95 (0.94 – 0.96)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.03 (1.02 – 1.04)	1.05 (1.04 – 1.07)	1.03 (1.02 – 1.05)	1.04 (1.03 – 1.04)
Delirium and encephalopathy (CC 50)	1.05 (1.04 – 1.07)	1.05 (1.02 – 1.07)	1.08 (1.06 – 1.10)	1.06 (1.05 – 1.07)
Dementia (CC 51 – 52)	0.89 (0.88 – 0.90)	0.89 (0.87 – 0.91)	0.89 (0.88 – 0.90)	0.89 (0.89 – 0.90)
Substance use with psychotic complications (CC 54)	1.08 (0.98 – 1.20)	1.12 (0.93 – 1.34)	1.08 (0.93 – 1.25)	1.09 (1.01 – 1.18)
Drug/alcohol abuse/dependence (CC 55 – 56, 202 – 203)	1.00 (0.99 – 1.01)	1.01 (0.99 – 1.03)	1.00 (0.99 – 1.01)	1.00 (1.00 – 1.01)
Severe mental illness (CC 57, 59)	0.99 (0.98 – 1.01)	1.00 (0.98 – 1.03)	0.98 (0.96 – 1.00)	0.99 (0.98 – 1.00)
Reactive and unspecified psychosis (CC 58)	0.95 (0.89 – 1.01)	0.99 (0.89 – 1.09)	0.94 (0.87 – 1.03)	0.96 (0.92 – 1.00)
Depression/anxiety (CC 61 – 62)	0.96 (0.95 – 0.98)	0.97 (0.95 – 0.98)	0.96 (0.95 – 0.97)	0.96 (0.96 – 0.97)
Congestive heart failure (CC 85)	1.17 (1.16 – 1.18)	1.16 (1.14 – 1.18)	1.18 (1.17 – 1.19)	1.17 (1.16 – 1.18)
Coronary atherosclerosis or angina (CC 88 – 89)	1.11 (1.10 – 1.13)	1.11 (1.09 – 1.13)	1.09 (1.07 – 1.10)	1.10 (1.09 – 1.11)
Heart infection/inflammation, except rheumatic (CC 90)	1.09 (1.05 – 1.12)	1.10 (1.05 – 1.15)	1.16 (1.12 – 1.20)	1.11 (1.09 – 1.14)
Valvular and rheumatic heart disease (CC 91)	1.05 (1.04 – 1.06)	1.04 (1.02 – 1.05)	1.05 (1.04 – 1.06)	1.05 (1.04 – 1.06)
Congenital cardiac/circulatory defects (CC 92 – 93)	1.09 (1.05 – 1.14)	1.16 (1.08 – 1.24)	1.12 (1.07 – 1.18)	1.11 (1.08 – 1.15)
Hypertension and hypertensive disease (CC 94 – 95)	0.94 (0.93 – 0.95)	0.95 (0.93 – 0.96)	0.93 (0.92 – 0.95)	0.94 (0.93 – 0.95)
Precerebral arterial occlusion and transient cerebral ischemia (CC 101)	1.07 (1.05 – 1.08)	1.06 (1.04 – 1.08)	1.07 (1.05 – 1.08)	1.06 (1.05 – 1.07)
Vascular disease and complications (CC 106 – 108)	1.03 (1.02 – 1.04)	1.03 (1.02 – 1.05)	1.05 (1.04 – 1.06)	1.04 (1.03 – 1.04)

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Other respiratory disorders (CC 118)	0.98 (0.97 – 0.99)	0.98 (0.97 – 0.99)	1.00 (0.98 – 1.01)	0.99 (0.98 – 0.99)
Legally blind (CC 119)	0.94 (0.89 – 0.99)	0.88 (0.81 – 0.95)	1.00 (0.94 – 1.07)	0.95 (0.92 – 0.98)
Dialysis status (CC 134)	1.20 (1.16 – 1.23)	1.22 (1.17 – 1.28)	1.17 (1.13 – 1.21)	1.19 (1.17 – 1.22)
Internal injuries (CC 172)	1.07 (1.01 – 1.14)	1.10 (1.00 – 1.21)	1.16 (1.06 – 1.26)	1.10 (1.06 – 1.15)

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Predictive ratios (lowest decile – highest decile)	0.98 – 0.96	0.98 – 0.95	0.98 – 0.95	0.98 – 0.96
Quasi-R^2	0.06	0.06	0.06	0.06

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	3,451	2,919	3,241	3,796
Mean number of admissions (SD)	40 (51)	19 (22)	33 (43)	79 (111)
Range (min. – max.)	1 – 402	1 – 172	1 – 316	1 – 876
25^{th} percentile	3	3	3	4
50^{th} percentile	18	12	16	27
75^{th} percentile	59	28	50	119

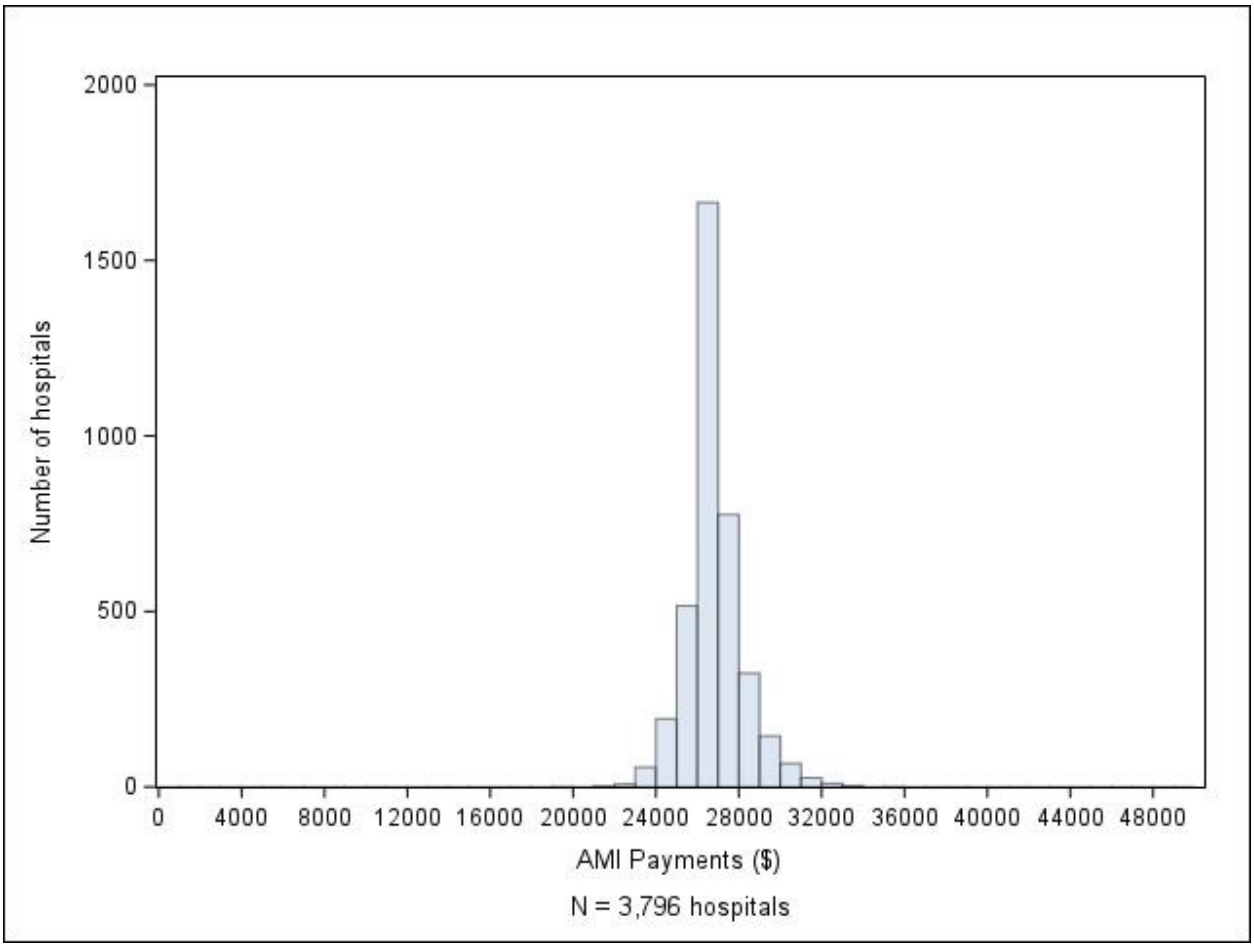
Table 4.2.6 — Distribution of Hospital AMI RSPs over Different Time Periods ($2020)

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	3,451	2,919	3,241	3,796
Mean (SD)	26,935 (1,203)	26,881 (913)	26,651 (1,134)	26,834 (1,366)
Range (min. – max.)	21,920 – 34,868	23,437 – 31,594	22,021 – 32,318	19,954 – 35,344
25^{th} percentile	26,373	26,461	26,100	26,176
50^{th} percentile	26,786	26,783	26,543	26,684
75^{th} percentile	27,398	27,234	27,106	27,388

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Between-hospital variance (SE)	0.008 (0.0006)	0.007 (0.0009)	0.008 (0.0007)	0.008 (0.0004)

Figure 4.2.2 — Distribution of Hospital AMI 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020)



4.3. HF Payment 2022 Model Results

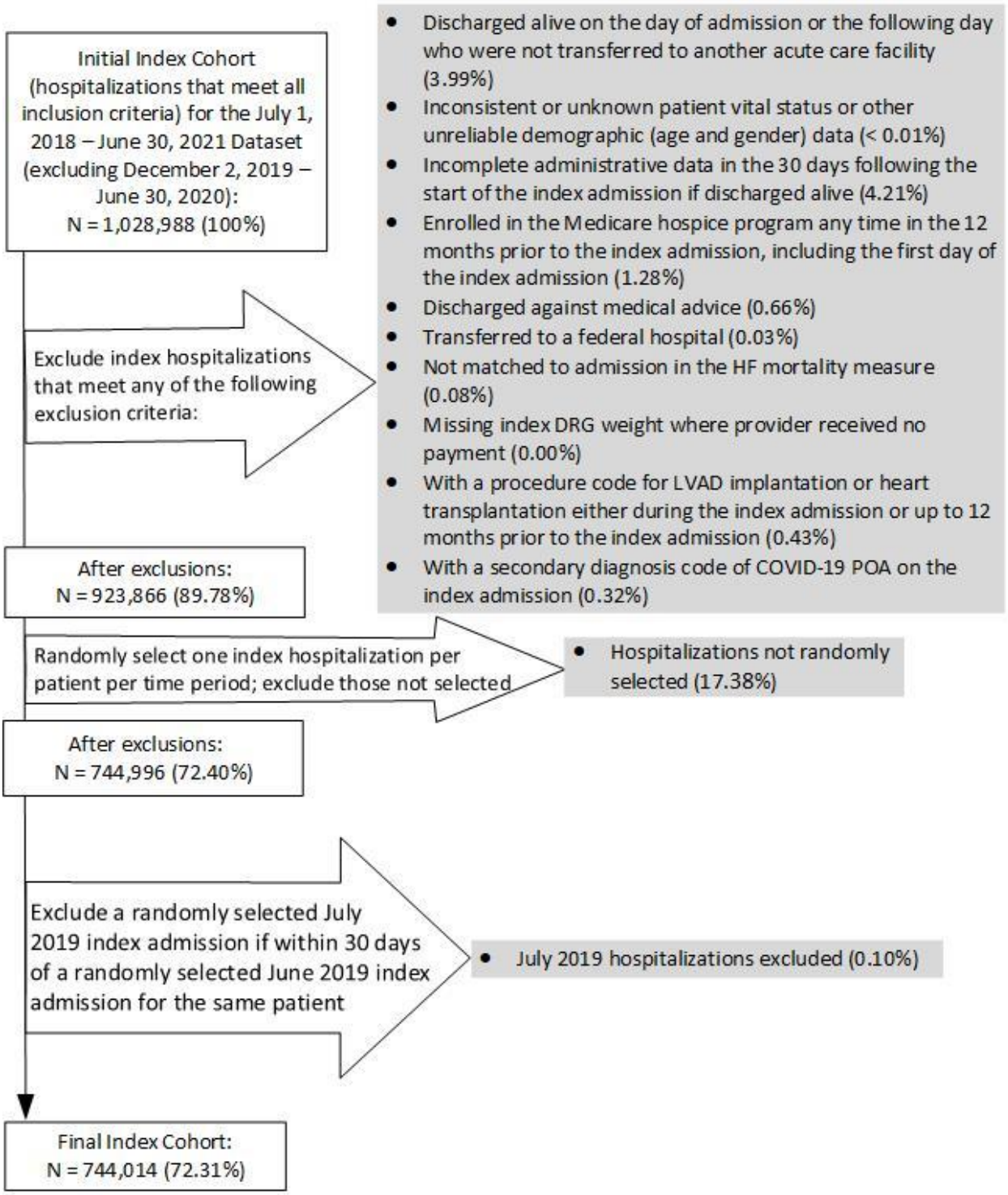
4.3.1 Index Cohort Exclusions

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 1, 2018 – June 30, 2021 dataset (excluding December 2, 2019 through June 30, 2020) 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 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020)



4.3.2 Frequency of HF Model Variables

We examined the frequencies of clinical and demographic variables. Frequencies of model variables were relatively stable over the measurement period.

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 parameter coefficients by individual time period and for the combined 29-month dataset. Table 4.3.3 shows the risk-adjusted PRs and 95% CIs for the HF payment model by individual time period and for the combined 29-month 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.[11]

Overall, the variable effect sizes were relatively constant across time periods. In addition, model performance was stable over the 29-month period; the quasi-R^2 and predictive ratios remained similar to the model used for 2021 public reporting (Table 4.3.4).

4.3.4 Distribution of Hospital Volumes and Payments for HF

The national mean payment for the combined 29-month dataset was $18,280 ($2020). For the three time periods, the national mean payments were as follows:

- July 1, 2018 – June 30, 2019: $18,259 ($2020)
- July 1, 2019 – December 1, 2019: $18,354 ($2020)
- July 1, 2020 – June 30, 2021: $18,266 ($2020)

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 time period, as well as for the combined 29-month 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 29-month dataset, which indicates that the hospital RSPs are approximately normally distributed. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was 1.20 times higher than the expected 30-day RSP if treated at a hospital one SD below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.[3]

4.3.5 Distribution of Hospitals by Payment Category in the 29-Month Dataset

Of 4,445 hospitals in the study cohort, 305 had a payment "Less than the National Average Payment," 2,458 had a payment "No Different than the National Average Payment," and 362 had a payment "Greater than the National Average Payment." 1,320 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)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Total N	335,599	143,011	265,404	744,014
Age (>=85)	35.6	34.8	33.8	34.8
Age (65 – 74)	27.3	27.8	28.5	27.8
Age (75 – 84)	37.1	37.4	37.7	37.4
History of COVID-19	-	-	7.0	2.5
Severe infection (CC 1, 3 – 6)	1.6	1.6	1.2	1.4
Other infectious diseases (CC 7)	39.7	40.5	30.0	36.4
Protein-calorie malnutrition (CC 21)	11.9	12.6	10.3	11.5
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	91.3	92.2	90.1	91.0
Other significant endocrine and metabolic disorders (CC 23)	13.8	14.8	13.2	13.8
Other gastrointestinal disorders (CC 38)	65.6	67.7	58.3	63.4
Bone/joint/muscle infections/necrosis (CC 39)	2.9	3.1	2.4	2.8
Other musculoskeletal and connective tissue disorders (CC 45)	74.8	76.4	64.6	71.5
Delirium and encephalopathy (CC 50)	15.5	16.4	13.5	15.0
Dementia or other specified brain disorders (CC 51 – 53)	23.0	23.4	19.4	21.8
Severe mental illness (CC 57, 59)	9.3	10.3	8.6	9.2
Other psychiatric disorders (CC 63)	24.2	25.7	21.7	23.6
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82 – 84), plus ICD-10-CM codes R09.01 and R09.02	56.3	58.4	56.4	56.7
Coronary atherosclerosis or angina (CC 88 – 89)	68.4	69.3	64.3	67.1
Heart infection/inflammation, except rheumatic (CC 90)	4.8	5.4	4.7	4.9
Major congenital cardiac/circulatory defect (CC 92)	0.1	0.1	0.1	0.1
Hypertension (CC 95)	80.4	80.5	67.8	75.9
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	78.0	79.4	76.1	77.6

Variable (% unless otherwise indicated)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101 – 102)	20.2	20.7	15.0	18.4
Vascular or circulatory disease (CC 106 – 109)	58.0	59.9	50.6	55.7
Pneumonia (CC 114 – 116)	41.3	41.6	31.9	38.0
Other ear, nose, throat, and mouth disorders (CC 131)	33.9	34.5	20.6	29.3
Dialysis status (CC 134)	6.1	6.5	6.1	6.2
Renal failure (CC 135 – 140)	70.0	72.3	69.4	70.2
Decubitus ulcer of skin (CC 157 – 160)	8.0	8.4	6.8	7.7
Chronic ulcer of skin, except pressure (CC 161)	11.1	11.8	9.4	10.7
Cellulitis, local skin infection (CC 164)	19.0	19.7	14.5	17.6
Hip fracture/dislocation (CC 170)	3.3	3.4	2.3	3.0
Internal injuries (CC 172)	0.9	0.9	0.6	0.8

Table 4.3.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients for HF over Different Time Periods

Variable	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Intercept	9.557	9.574	9.534	9.556
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 – 74)	0.062	0.067	0.103	0.079
Age (75 – 84)	0.048	0.051	0.078	0.061
History of COVID-19	-	-	-0.034	-0.022
Severe infection (CC 1, 3 – 6)	0.030	0.030	0.040	0.032
Other infectious diseases (CC 7)	0.027	0.023	0.025	0.024
Protein-calorie malnutrition (CC 21)	0.078	0.076	0.076	0.076
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	-0.005	-0.007	-0.010	-0.007
Other significant endocrine and metabolic disorders (CC 23)	0.028	0.029	0.024	0.027
Other gastrointestinal disorders (CC 38)	-0.008	-0.006	-0.012	-0.009
Bone/joint/muscle infections/necrosis (CC 39)	0.037	0.047	0.057	0.045
Other musculoskeletal and connective tissue disorders (CC 45)	0.003	-0.007	-0.003	-0.002
Delirium and encephalopathy (CC 50)	0.054	0.056	0.062	0.057
Dementia or other specified brain disorders (CC 51 – 53)	0.020	0.010	0.004	0.012
Severe mental illness (CC 57, 59)	0.025	0.027	0.023	0.023
Other psychiatric disorders (CC 63)	0.002	0.004	-0.003	0.001

Variable	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82 – 84), plus ICD-10-CM codes R09.01 and R09.02	0.056	0.054	0.052	0.056
Coronary atherosclerosis or angina (CC 88 – 89)	0.030	0.031	0.043	0.033
Heart infection/inflammation, except rheumatic (CC 90)	0.041	0.062	0.066	0.052
Major congenital cardiac/circulatory defect (CC 92)	0.086	0.138	0.036	0.079
Hypertension (CC 95)	-0.019	-0.023	-0.016	-0.020
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.003	0.003	0.012	0.006
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101 – 102)	0.016	0.016	0.010	0.013
Vascular or circulatory disease (CC 106 – 109)	0.026	0.026	0.031	0.027
Pneumonia (CC 114 – 116)	0.036	0.026	0.043	0.035
Other ear, nose, throat, and mouth disorders (CC 131)	-0.016	-0.006	-0.014	-0.015
Dialysis status (CC 134)	0.130	0.122	0.129	0.126
Renal failure (CC 135 – 140)	0.109	0.100	0.115	0.109
Decubitus ulcer of skin (CC 157 – 160)	0.060	0.076	0.075	0.067
Chronic ulcer of skin, except pressure (CC 161)	0.048	0.038	0.057	0.049
Cellulitis, local skin infection (CC 164)	0.016	0.023	0.031	0.021
Hip fracture/dislocation (CC 170)	0.030	0.040	0.028	0.032
Internal injuries (CC 172)	0.024	0.010	0.020	0.018

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

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 – 74)	1.06 (1.06 – 1.07)	1.07 (1.06 – 1.08)	1.11 (1.10 – 1.12)	1.08 (1.08 – 1.09)
Age (75 – 84)	1.05 (1.04 – 1.06)	1.05 (1.04 – 1.06)	1.08 (1.07 – 1.09)	1.06 (1.06 – 1.07)
History of COVID-19	-	-	0.97 (0.96 – 0.98)	0.98 (0.97 – 0.99)
Severe infection (CC 1, 3 – 6)	1.03 (1.01 – 1.05)	1.03 (1.00 – 1.06)	1.04 (1.02 – 1.07)	1.03 (1.02 – 1.05)

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Other infectious diseases (CC 7)	1.03 (1.02 – 1.03)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.03)	1.02 (1.02 – 1.03)
Protein-calorie malnutrition (CC 21)	1.08 (1.07 – 1.09)	1.08 (1.07 – 1.09)	1.08 (1.07 – 1.09)	1.08 (1.07 – 1.08)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	1.00 (0.99 – 1.00)	0.99 (0.98 – 1.01)	0.99 (0.98 – 1.00)	0.99 (0.99 – 1.00)
Other significant endocrine and metabolic disorders (CC 23)	1.03 (1.02 – 1.04)	1.03 (1.02 – 1.04)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.03)
Other gastrointestinal disorders (CC 38)	0.99 (0.99 – 1.00)	0.99 (0.99 – 1.00)	0.99 (0.98 – 0.99)	0.99 (0.99 – 0.99)
Bone/joint/muscle infections/necrosis (CC 39)	1.04 (1.02 – 1.05)	1.05 (1.03 – 1.07)	1.06 (1.04 – 1.08)	1.05 (1.04 – 1.06)
Other musculoskeletal and connective tissue disorders (CC 45)	1.00 (1.00 – 1.01)	0.99 (0.98 – 1.00)	1.00 (0.99 – 1.00)	1.00 (0.99 – 1.00)
Delirium and encephalopathy (CC 50)	1.06 (1.05 – 1.06)	1.06 (1.05 – 1.07)	1.06 (1.06 – 1.07)	1.06 (1.05 – 1.06)
Dementia or other specified brain disorders (CC 51 – 53)	1.02 (1.01 – 1.03)	1.01 (1.00 – 1.02)	1.00 (1.00 – 1.01)	1.01 (1.01 – 1.02)
Severe mental illness (CC 57, 59)	1.02 (1.02 – 1.03)	1.03 (1.01 – 1.04)	1.02 (1.01 – 1.03)	1.02 (1.02 – 1.03)
Other psychiatric disorders (CC 63)	1.00 (1.00 – 1.01)	1.00 (1.00 – 1.01)	1.00 (0.99 – 1.00)	1.00 (1.00 – 1.00)
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82 – 84), plus ICD-10-CM codes R09.01 and R09.02	1.06 (1.05 – 1.06)	1.06 (1.05 – 1.06)	1.05 (1.05 – 1.06)	1.06 (1.05 – 1.06)
Coronary atherosclerosis or angina (CC 88 – 89)	1.03 (1.03 – 1.04)	1.03 (1.02 – 1.04)	1.04 (1.04 – 1.05)	1.03 (1.03 – 1.04)
Heart infection/inflammation, except rheumatic (CC 90)	1.04 (1.03 – 1.05)	1.06 (1.05 – 1.08)	1.07 (1.05 – 1.08)	1.05 (1.05 – 1.06)
Major congenital cardiac/circulatory defect (CC 92)	1.09 (1.01 – 1.17)	1.15 (1.04 – 1.27)	1.04 (0.95 – 1.13)	1.08 (1.03 – 1.14)
Hypertension (CC 95)	0.98 (0.98 – 0.99)	0.98 (0.97 – 0.99)	0.98 (0.98 – 0.99)	0.98 (0.98 – 0.98)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.00 (1.00 – 1.01)	1.00 (0.99 – 1.01)	1.01 (1.01 – 1.02)	1.01 (1.00 – 1.01)
Precerebral arterial occlusion and transient cerebral ischemia; cerebral atherosclerosis and aneurysm; cerebrovascular disease, unspecified (CC 101 – 102)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.01 (1.00 – 1.02)	1.01 (1.01 – 1.02)
Vascular or circulatory disease (CC 106 – 109)	1.03 (1.02 – 1.03)	1.03 (1.02 – 1.03)	1.03 (1.03 – 1.04)	1.03 (1.02 – 1.03)

Variable	7/1/2018 – 6/30/2019 PR (95% CI)	7/1/2019 – 12/1/2019 PR (95% CI)	7/1/2020 – 6/30/2021 PR (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 PR (95% CI)
Pneumonia (CC 114 – 116)	1.04 (1.03 – 1.04)	1.03 (1.02 – 1.03)	1.04 (1.04 – 1.05)	1.04 (1.03 – 1.04)
Other ear, nose, throat, and mouth disorders (CC 131)	0.98 (0.98 – 0.99)	0.99 (0.99 – 1.00)	0.99 (0.98 – 0.99)	0.98 (0.98 – 0.99)
Dialysis status (CC 134)	1.14 (1.13 – 1.15)	1.13 (1.11 – 1.15)	1.14 (1.12 – 1.15)	1.13 (1.13 – 1.14)
Renal failure (CC 135 – 140)	1.12 (1.11 – 1.12)	1.11 (1.10 – 1.11)	1.12 (1.11 – 1.13)	1.12 (1.11 – 1.12)
Decubitus ulcer of skin (CC 157 – 160)	1.06 (1.05 – 1.07)	1.08 (1.06 – 1.09)	1.08 (1.07 – 1.09)	1.07 (1.06 – 1.08)
Chronic ulcer of skin, except pressure (CC 161)	1.05 (1.04 – 1.06)	1.04 (1.03 – 1.05)	1.06 (1.05 – 1.07)	1.05 (1.04 – 1.06)
Cellulitis, local skin infection (CC 164)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.03 (1.02 – 1.04)	1.02 (1.02 – 1.03)
Hip fracture/dislocation (CC 170)	1.03 (1.02 – 1.04)	1.04 (1.02 – 1.06)	1.03 (1.01 – 1.05)	1.03 (1.02 – 1.04)
Internal injuries (CC 172)	1.02 (1.00 – 1.05)	1.01 (0.97 – 1.05)	1.02 (0.99 – 1.06)	1.02 (1.00 – 1.04)

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Predictive ratios (lowest decile – highest decile)	1.03 – 1.02	1.03 – 1.01	1.02 – 1.02	1.03 – 1.02
Quasi-R^2	0.03	0.03	0.04	0.03

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	4,349	4,072	4,208	4,445
Mean number of admissions (SD)	77 (100)	35 (45)	63 (84)	167 (225)
Range (min. – max.)	1 – 1,053	1 – 402	1 – 938	1 – 2,392
25th percentile	35	17	27	71
50th percentile	10	5	7	19
75th percentile	112	50	89	239

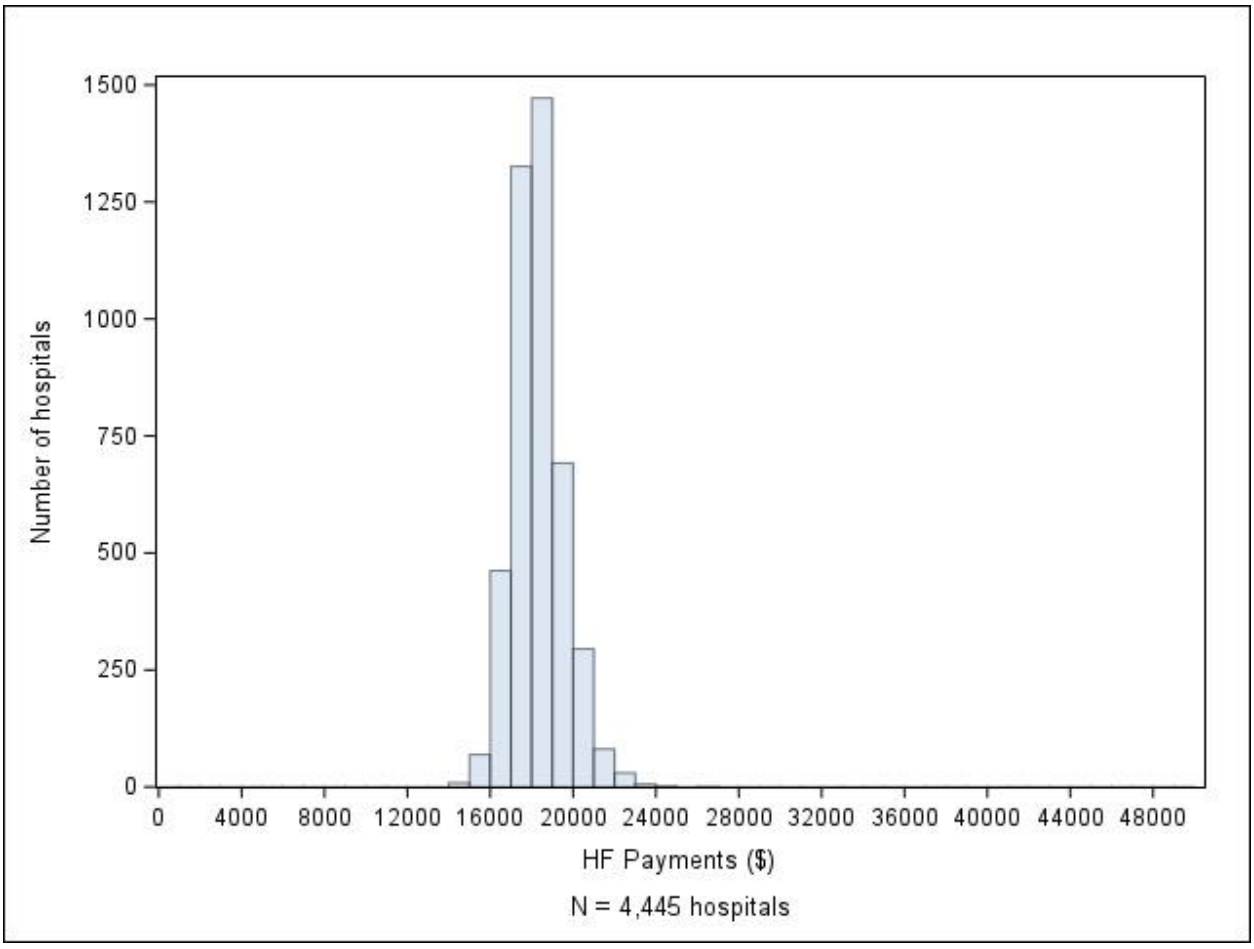
Table 4.3.6 — Distribution of Hospital HF RSPs over Different Time Periods ($2020)

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	4,349	4,072	4,208	4,445
Mean (SD)	18,286 (1,000)	18,366 (671)	18,291 (970)	18,320 (1,232)
Range (min. – max.)	15,243 – 23,413	15,430 – 22,265	15,197 – 22,523	14,032 – 26,209
25th percentile	18,175	18,287	18,180	18,213
50th percentile	17,662	17,998	17,714	17,516
75th percentile	18,847	18,697	18,811	18,993

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Between-hospital variance (SE)	0.007 (0.0004)	0.006 (0.0004)	0.008 (0.0004)	0.008 (0.0003)

Figure 4.3.2 — Distribution of Hospital HF 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020)



4.4. Pneumonia Payment 2022 Model Results

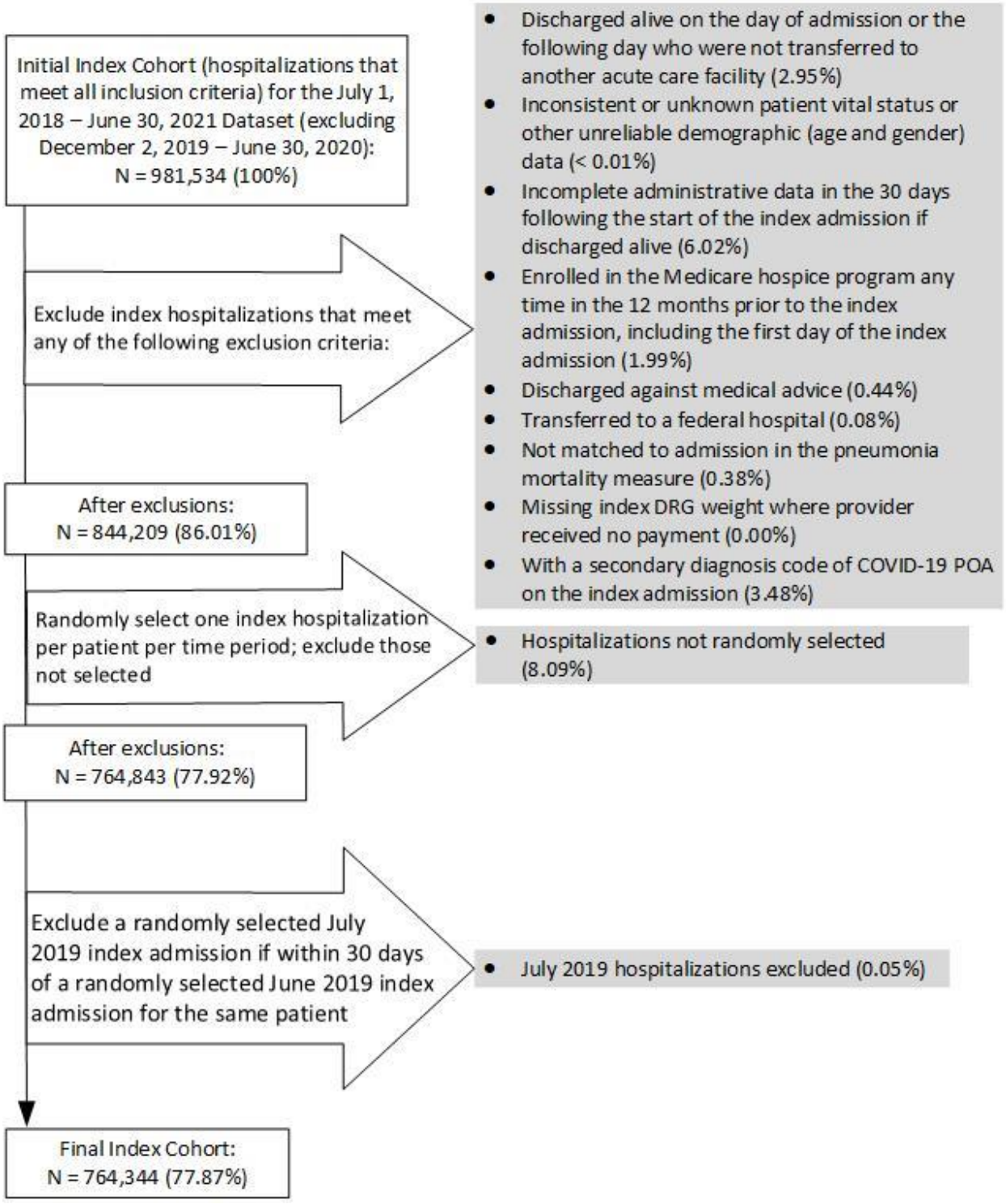
4.4.1 Index Cohort Exclusions

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 1, 2018 – June 30, 2021 dataset (excluding December 2, 2019 through June 30, 2020) 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 one of the following:
  1. A principal discharge diagnosis of pneumonia; or
  2. a. A principal discharge diagnosis of sepsis (that is not severe); and
     b. A secondary diagnosis of pneumonia coded as POA; and
     c. No secondary diagnosis of sepsis that is both severe and 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 1, 2018 – June 30, 2021 Dataset (excluding December 2, 2019 through June 30, 2020)



4.4.2 Frequency of Pneumonia Model Variables

We examined the frequencies of clinical and demographic variables. Frequencies of model variables were relatively stable over the measurement period.

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 parameter coefficients and 95% CIs for the pneumonia payment model by individual time period and for the combined 29-month dataset. The pneumonia payment model coefficients can be directly interpreted as dollars. The quasi-R^2 for the pneumonia payment model was 0.09, suggesting that approximately 9% 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.[11]

Overall, model performance was stable over the 29-month period; the quasi-R^2 and predictive ratios remained similar to the model used for 2021 public reporting (Table 4.4.3).

4.4.4 Distribution of Hospital Volumes and Payments for Pneumonia

The national mean payment for the combined 29-month dataset was $19,490 ($2020). For the three time periods, the national mean payments were as follows:

- July 1, 2018 – June 30, 2019: $19,058 ($2020)
- July 1, 2019 – December 1, 2019: $19,624 ($2020)
- July 1, 2020 – June 30, 2021: $20,165 ($2020)

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 time period, as well as for the combined 29-month 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 29-month dataset, which indicates that the hospital RSPs are approximately normally distributed. The expected 30-day RSP if a patient is treated at a hospital one SD above the national average was $4,317 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 29-Month Dataset

Of 4,520 hospitals in the study cohort, 465 had a payment “Less than the National Average Payment,” 2,699 had a payment “No Different than the National Average

Payment," and 471 had a payment "Greater than the National Average Payment." 885 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)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Total N	395,673	144,489	224,182	764,344
Age (>=85)	32.7	32.6	29.8	31.8
Age (65 – 74)	30.5	30.4	32.6	31.1
Age (75 – 84)	36.8	37.0	37.6	37.1
History of COVID-19	-	-	9.6	2.8
Severe infection (CC 1, 3 – 6)	2.8	3.1	2.5	2.8
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	17.7	20.2	14.9	17.3
Other infectious diseases (CC 7)	44.3	45.5	36.2	42.2
Metastatic cancer and acute leukemia (CC 8)	6.3	7.0	7.3	6.7
Lung and other severe cancers (CC 9)	8.6	9.4	9.2	9.0
Lymphatic, head and neck, brain, and other major cancers (CC 10 – 11)	9.9	10.6	9.6	9.9
Benign neoplasms of skin, breast, eye (CC 16)	13.6	14.1	9.2	12.4
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	43.0	43.1	42.3	42.8
Protein-calorie malnutrition (CC 21)	18.7	20.6	19.4	19.3
Other significant endocrine and metabolic disorders (CC 23)	11.0	11.7	11.0	11.1
Liver disease (CC 27 – 30)	3.9	4.1	4.2	4.0
Gallbladder and biliary tract disorders (CC 32)	3.6	4.0	3.4	3.6
Appendicitis (CC 37)	0.2	0.2	0.2	0.2
Bone/joint/muscle infections/necrosis (CC 39)	2.8	3.0	2.7	2.8
Osteoporosis and other bone/cartilage disorders (CC 43)	22.2	22.8	17.9	21.1
Severe hematological disorders (CC 46)	2.0	2.1	1.9	2.0
Disorders of immunity (CC 47)	7.0	7.6	7.7	7.3
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	56.2	58.3	54.5	56.1
Delirium and encephalopathy (CC 50)	24.9	26.7	27.2	25.9
Dementia or other specified brain disorders (CC 51 – 53)	32.9	34.2	31.6	32.8
Drug/alcohol psychosis or dependence (CC 54 – 55)	4.2	4.6	4.1	4.3
Major psychiatric disorders (CC 57 – 59)	13.9	15.3	14.0	14.2
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	11.5	12.4	11.3	11.6

Variable (% unless otherwise indicated)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Neuropathy; muscular dystrophy (CC 75 – 76)	1.6	1.8	1.6	1.7
Multiple sclerosis and Parkinson's (CC 77 – 78)	5.7	5.9	5.7	5.7
Seizure disorders and convulsions (CC 79)	7.1	7.6	7.3	7.3
Coma, brain compression/anoxic damage (CC 80)	2.5	2.8	2.3	2.5
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	23.0	24.2	20.0	22.4
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82 – 84), plus ICD-10-CM codes R09.01 and R09.02	58.0	58.7	61.3	59.1
Congestive heart failure (CC 85)	49.5	50.5	48.0	49.2
Coronary atherosclerosis or angina (CC 88 – 89)	46.4	46.9	43.6	45.7
Heart infection/inflammation, except rheumatic (CC 90)	2.8	3.2	3.0	2.9
Valvular and rheumatic heart disease (CC 91)	27.8	28.5	23.3	26.6
Hypertensive heart disease (CC 94)	6.4	6.8	5.0	6.1
Stroke (CC 99 – 100)	9.6	10.1	8.3	9.4
Late effects of cerebrovascular disease, except paralysis (CC 105)	7.0	7.6	6.7	7.0
Chronic obstructive pulmonary disease (COPD) (CC 111)	49.6	49.8	44.5	48.1
Asthma (CC 113)	12.9	12.6	9.4	11.8
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	15.5	20.1	7.4	14.0
Viral and unspecified pneumonia, pleurisy (CC 116)	50.7	50.4	49.1	50.2
Pleural effusion/pneumothorax (CC 117)	22.2	24.3	20.3	22.0
Other respiratory disorders (CC 118)	51.0	51.4	38.5	47.4
Other eye disorders (CC 128)	24.5	24.8	16.1	22.1
Significant ear, nose, and throat disorders (CC 129)	2.3	2.4	1.8	2.1
Other ear, nose, throat, and mouth disorders (CC 131)	38.4	39.1	24.4	34.4
Dialysis status (CC 134)	4.2	4.3	4.5	4.3
Urinary incontinence (CC 143)	11.3	11.7	8.9	10.7
Other female genital disorders (CC 148)	3.4	3.4	2.2	3.0
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	15.1	16.5	15.0	15.4
Vertebral fractures without spinal cord injury (CC 169)	5.3	5.7	4.6	5.2
Major fracture, except of skull, vertebrae, or hip (CC 171)	2.6	2.8	2.1	2.5
Internal injuries (CC 172)	0.9	0.9	0.7	0.9
Traumatic amputations, other injuries (CC 173 – 174)	37.9	39.4	28.9	35.5
Poisonings and allergic and inflammatory reactions (CC 175)	16.4	17.3	13.2	15.6

Variable (% unless otherwise indicated)	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02	86.6	88.1	82.1	85.6
Minor symptoms, signs, findings (CC 179)	92.9	93.8	96.2	94.0

Table 4.4.2 — Hierarchical Generalized Linear Regression Model Parameter Coefficients and 95% CIs for Pneumonia over Different Time Periods ($2020)

Variable	7/1/2018 – 6/30/2019 $ (95% CI)	7/1/2019 – 12/1/2019 $ (95%CI)	7/1/2020 – 6/30/2021 $ (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 $ (95% CI)
Intercept	12,299 (12,135 – 12,464)	12,286 (12,016 – 12,557)	14,165 (13,867 – 14,463)	12,750 (12,613 – 12,887)
Age (>=85)	Reference	Reference	Reference	Reference
Age (65 – 74)	-433 (-532 – -333)	-330 (-497 – -163)	468 (327 – 610)	-82 (-156 – -9)
Age (75 – 84)	-201 (-290 – -111)	-97 (-248 – 54)	388 (261 – 516)	27 (-39 – 94)
History of COVID-19	-	-	-1,006 (-1,192 – -821)	-265 (-441 – -89)
Severe infection (CC 1, 3 – 6)	2,161 (1,894 – 2,428)	1,651 (1,231 – 2,071)	2,002 (1,601 – 2,402)	1,966 (1,769 – 2,163)
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	-420 (-538 – -302)	-666 (-853 – -479)	-412 (-589 – -235)	-511 (-598 – -423)
Other infectious diseases (CC 7)	793 (714 – 871)	756 (624 – 887)	861 (746 – 976)	746 (687 – 804)
Metastatic cancer and acute leukemia (CC 8)	1,920 (1,720 – 2,120)	1,844 (1,525 – 2,163)	1,227 (976 – 1,479)	1,681 (1,540 – 1,823)
Lung and other severe cancers (CC 9)	836 (677 – 994)	764 (508 – 1,019)	590 (380 – 801)	757 (643 – 871)
Lymphatic, head and neck, brain, and other major cancers (CC 10 – 11)	517 (380 – 653)	721 (497 – 945)	623 (428 – 818)	593 (492 – 694)
Benign neoplasms of skin, breast, eye (CC 16)	-430 (-531 – -328)	-370 (-539 – -202)	-585 (-753 – -417)	-510 (-588 – -432)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	466 (390 – 542)	597 (469 – 725)	714 (606 – 822)	543 (487 – 600)
Protein-calorie malnutrition (CC 21)	2,442 (2,325 – 2,559)	2,621 (2,432 – 2,810)	2,545 (2,386 – 2,704)	2,438 (2,353 – 2,523)
Other significant endocrine and metabolic disorders (CC 23)	643 (495 – 790)	515 (276 – 753)	665 (456 – 874)	633 (525 – 741)
Liver disease (CC 27 – 30)	936 (714 – 1,158)	1,057 (697 – 1,418)	1,204 (904 – 1,504)	1,036 (875 – 1,197)

Variable	7/1/2018 – 6/30/2019 $ (95% CI)	7/1/2019 – 12/1/2019 $ (95%CI)	7/1/2020 – 6/30/2021 $ (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 $ (95% CI)
Gallbladder and biliary tract disorders (CC 32)	1,006 (784 – 1,228)	1,366 (1,006 – 1,726)	1,446 (1,118 – 1,774)	1,198 (1,034 – 1,363)
Appendicitis (CC 37)	1,209 (279 – 2,138)	1,773 (268 – 3,277)	3,906 (2,311 – 5,502)	2,126 (1,404 – 2,848)
Bone/joint/muscle infections/necrosis (CC 39)	2,174 (1,875 – 2,473)	2,439 (1,950 – 2,927)	3,121 (2,679 – 3,563)	2,507 (2,285 – 2,729)
Osteoporosis and other bone/cartilage disorders (CC 43)	-494 (-583 – -406)	-420 (-568 – -271)	-426 (-562 – -291)	-490 (-556 – -423)
Severe hematological disorders (CC 46)	1,003 (699 – 1,308)	796 (305 – 1,287)	1,456 (1,021 – 1,891)	1,098 (874 – 1,321)
Disorders of immunity (CC 47)	940 (767 – 1,113)	1,098 (818 – 1,379)	925 (695 – 1,155)	974 (850 – 1,099)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	964 (887 – 1,042)	954 (823 – 1,085)	873 (764 – 982)	923 (866 – 981)
Delirium and encephalopathy (CC 50)	2,453 (2,346 – 2,560)	2,573 (2,400 – 2,747)	2,742 (2,600 – 2,884)	2,547 (2,470 – 2,624)
Dementia or other specified brain disorders (CC 51 – 53)	732 (640 – 823)	665 (513 – 817)	366 (239 – 493)	565 (498 – 632)
Drug/alcohol psychosis or dependence (CC 54 – 55)	788 (583 – 992)	251 (-70 – 573)	233 (-48 – 514)	527 (380 – 675)
Major psychiatric disorders (CC 57 – 59)	869 (749 – 989)	1,037 (843 – 1,230)	669 (504 – 834)	797 (710 – 884)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1,630 (1,480 – 1,781)	1,721 (1,477 – 1,966)	1,672 (1,461 – 1,884)	1,638 (1,528 – 1,748)
Neuropathy; muscular dystrophy (CC 75 – 76)	1,482 (1,152 – 1,811)	1,373 (846 – 1,900)	1,795 (1,318 – 2,271)	1,576 (1,333 – 1,818)
Multiple sclerosis and Parkinson's (CC 77 – 78)	1,336 (1,158 – 1,514)	1,625 (1,328 – 1,921)	1,348 (1,104 – 1,593)	1,367 (1,237 – 1,497)
Seizure disorders and convulsions (CC 79)	516 (350 – 682)	630 (358 – 903)	616 (387 – 844)	545 (424 – 666)
Coma, brain compression/anoxic damage (CC 80)	2,281 (1,959 – 2,603)	3,025 (2,497 – 3,553)	3,342 (2,857 – 3,827)	2,637 (2,397 – 2,876)
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	-9 (-99 – 81)	-57 (-206 – 91)	-87 (-220 – 46)	-29 (-96 – 38)
Respiratory arrest/cardiorespiratory failure/respirator dependence (CC 82 – 84), plus ICD-10-CM codes R09.01 and R09.02	1,768 (1,691 – 1,846)	1,906 (1,776 – 2,037)	1,613 (1,505 – 1,722)	1,772 (1,715 – 1,829)
Congestive heart failure (CC 85)	1,661 (1,579 – 1,744)	1,720 (1,581 – 1,859)	1,730 (1,615 – 1,845)	1,695 (1,634 – 1,756)

Variable	7/1/2018 – 6/30/2019 $ (95% CI)	7/1/2019 – 12/1/2019 $ (95%CI)	7/1/2020 – 6/30/2021 $ (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 $ (95% CI)
Coronary atherosclerosis or angina (CC 88 – 89)	-105 (-182 – -27)	-181 (-312 – -51)	-256 (-365 – -146)	-175 (-232 – -118)
Heart infection/inflammation, except rheumatic (CC 90)	1,496 (1,227 – 1,765)	1,626 (1,201 – 2,051)	1,393 (1,033 – 1,753)	1,502 (1,309 – 1,695)
Valvular and rheumatic heart disease (CC 91)	239 (149 – 330)	198 (48 – 348)	240 (106 – 374)	206 (138 – 273)
Hypertensive heart disease (CC 94)	-63 (-220 – 94)	79 (-179 – 337)	109 (-139 – 358)	-69 (-188 – 50)
Stroke (CC 99 – 100)	478 (321 – 635)	573 (314 – 832)	1,081 (844 – 1,318)	640 (523 – 757)
Late effects of cerebrovascular disease, except paralysis (CC 105)	491 (305 – 676)	291 (-7 – 589)	230 (-30 – 489)	378 (242 – 513)
Chronic obstructive pulmonary disease (COPD) (CC 111)	-46 (-123 – 32)	-164 (-295 – -33)	-271 (-381 – -162)	-180 (-237 – -122)
Asthma (CC 113)	-848 (-952 – -743)	-840 (-1,018 – -663)	-644 (-814 – -475)	-816 (-896 – -736)
Pneumococcal pneumonia, empyema, lung abscess (CC 115)	950 (840 – 1,060)	994 (826 – 1,162)	1,139 (912 – 1,365)	864 (779 – 950)
Viral and unspecified pneumonia, pleurisy (CC 116)	1,734 (1,657 – 1,811)	1,444 (1,313 – 1,574)	2,320 (2,211 – 2,429)	1,811 (1,754 – 1,868)
Pleural effusion/pneumothorax (CC 117)	1,314 (1,207 – 1,420)	1,106 (934 – 1,277)	1,246 (1,096 – 1,397)	1,248 (1,170 – 1,325)
Other respiratory disorders (CC 118)	-569 (-645 – -494)	-539 (-668 – -411)	-92 (-204 – 20)	-498 (-554 – -441)
Other eye disorders (CC 128)	-255 (-339 – -171)	-321 (-461 – -180)	-228 (-367 – -89)	-338 (-402 – -273)
Significant ear, nose, and throat disorders (CC 129)	976 (711 – 1,240)	809 (383 – 1,234)	1,554 (1,121 – 1,988)	1,078 (877 – 1,279)
Other ear, nose, throat, and mouth disorders (CC 131)	-543 (-618 – -468)	-467 (-593 – -341)	-372 (-491 – -253)	-580 (-637 – -524)
Dialysis status (CC 134)	2,470 (2,201 – 2,738)	3,078 (2,628 – 3,528)	2,849 (2,477 – 3,221)	2,654 (2,456 – 2,851)
Urinary incontinence (CC 143)	344 (223 – 464)	196 (-2 – 393)	175 (-10 – 361)	283 (193 – 374)
Other female genital disorders (CC 148)	-499 (-691 – -307)	-693 (-1,013 – -373)	-473 (-812 – -134)	-569 (-718 – -420)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1,492 (1,363 – 1,621)	1,624 (1,415 – 1,832)	1,996 (1,814 – 2,179)	1,662 (1,568 – 1,756)
Vertebral fractures without spinal cord injury (CC 169)	1,009 (824 – 1,194)	1,021 (721 – 1,320)	1,369 (1,090 – 1,647)	1,114 (976 – 1,252)
Major fracture, except of skull, vertebrae, or hip (CC 171)	909 (653 – 1,166)	1,090 (669 – 1,511)	1,462 (1,055 – 1,870)	1,076 (882 – 1,270)

Variable	7/1/2018 – 6/30/2019 $ (95% CI)	7/1/2019 – 12/1/2019 $ (95%CI)	7/1/2020 – 6/30/2021 $ (95% CI)	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021 $ (95% CI)
Internal injuries (CC 172)	970 (495, 1,445)	1,476 (688, 2,264)	1,214 (486, 1,942)	1,111 (755, 1,468)
Traumatic amputations, other injuries (CC 173 – 174)	307 (225, 388)	243 (108, 378)	178 (55, 302)	224 (163, 285)
Poisonings and allergic and inflammatory reactions (CC 175)	-41 (-151, 69)	33 (-149, 216)	-188 (-356, -20)	-92 (-174, -9)
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02	395 (295, 494)	474 (300, 648)	158 (28, 288)	294 (222, 367)
Minor symptoms, signs, findings (CC 179)	-25 (-153, 103)	60 (-166, 287)	-1,688 (-1,955, -1,421)	-109 (-211, -6)

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Predictive ratios (lowest decile – highest decile)	1.07 – 1.07	1.07 – 1.08	1.06 – 1.06	1.07 – 1.07
Quasi-R^2	0.09	0.09	0.08	0.09

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	4,440	4,293	4,316	4,520
Mean number of admissions (SD)	89 (104)	34 (39)	52 (62)	169 (202)
Range (min. – max.)	1 – 1,107	1 – 427	1 – 805	1 – 2,339
25^{th} percentile	51	19	28	92
50^{th} percentile	18	7	10	32
75^{th} percentile	127	47	74	241

Table 4.4.5 — Distribution of Hospital Pneumonia RSPs over Different Time Periods ($2020)

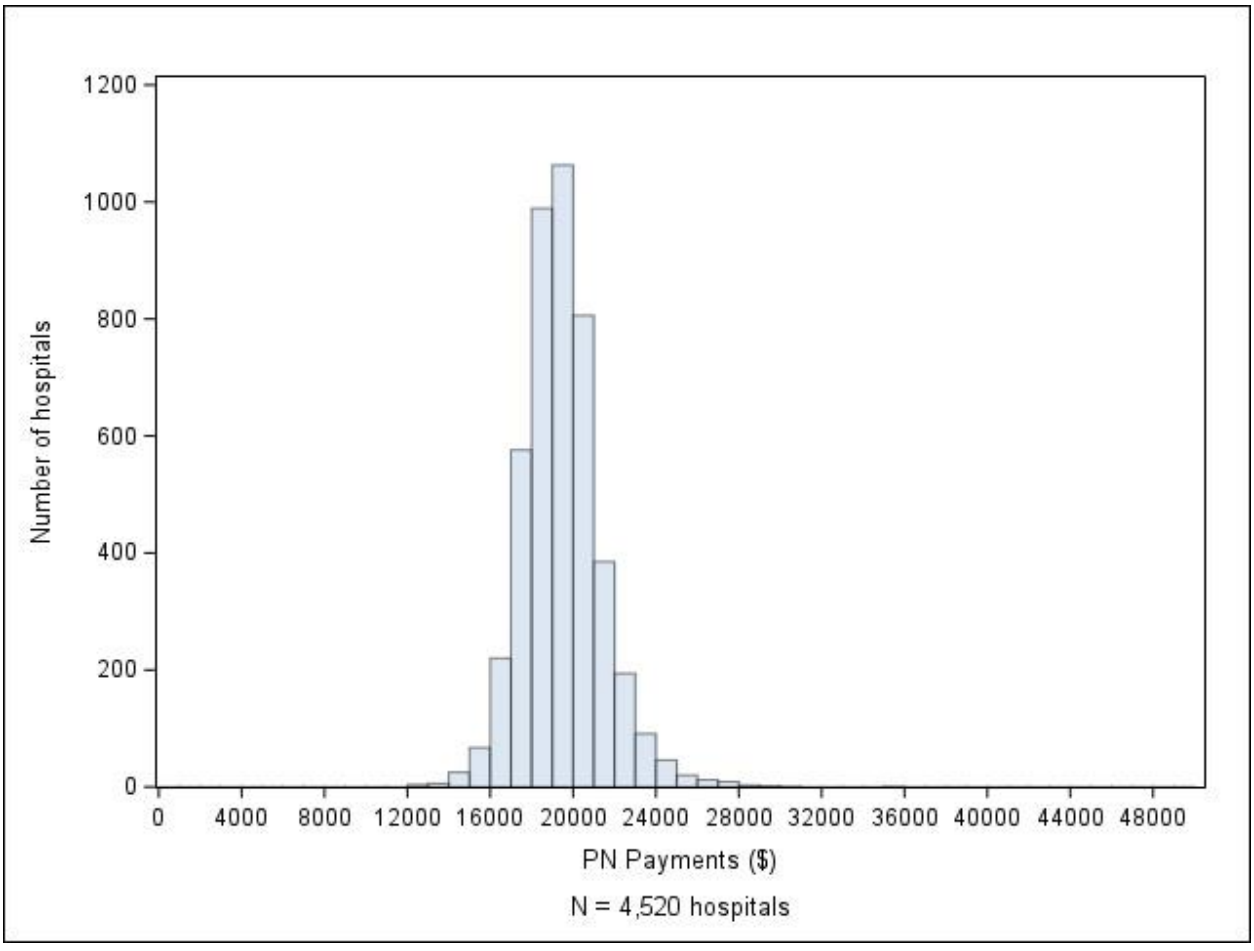
Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Number of hospitals	4,440	4,293	4,316	4,520
Mean (SD)	19,039 (1,610)	19,607 (1,129)	20,143 (1,533)	19,463 (1,906)
Range (min. – max.)	13,205 – 30,610	14,653 – 25,722	14,354 – 29,530	12,386 – 35,946

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
25th percentile	18,929	19,532	20,024	19,342
50th percentile	18,027	18,914	19,161	18,255
75th percentile	19,962	20,272	20,993	20,459

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

Characteristic	7/1/2018 – 6/30/2019	7/1/2019 – 12/1/2019	7/1/2020 – 6/30/2021	7/1/2018 – 12/1/2019 and 7/1/2020 – 6/30/2021
Between hospital-variance (SE) ($)	4,060,406 (173,450)	3,283,024 (206,356)	4,455,743 (227,380)	4,660,198 (165,903)

Figure 4.4.2 — Distribution of Hospital Pneumonia 30-Day Episode-of-Care RSPs between July 1, 2018 and June 30, 2021, excluding December 2, 2019 through June 30, 2020 ($2020)



4.5. THA/TKA Payment 2022 Model Results

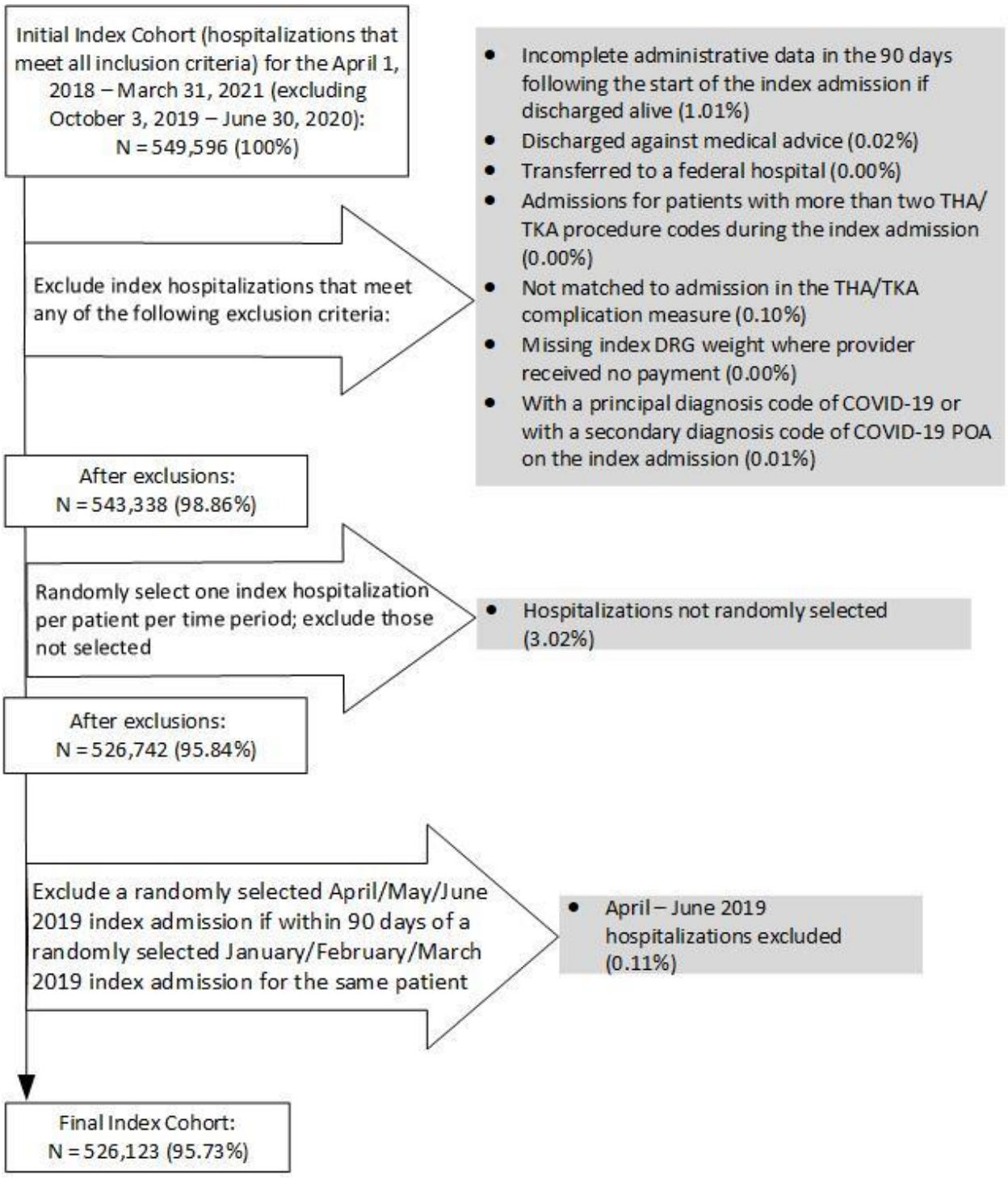
4.5.1 Index Cohort Exclusions

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 1, 2018 – March 31, 2021 dataset (excluding October 3, 2019 through June 30, 2020) 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 1, 2018 – March 31, 2021 Dataset (excluding October 3, 2019 through June 30, 2020)



4.5.2 Frequency of THA/TKA Model Variables

We examined the frequencies of clinical and demographic variables. Frequencies of model variables were relatively stable over the measurement period.

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 parameter coefficients by individual time period and for the combined 27-month dataset. Table 4.5.3 shows the risk-adjusted PRs and 95% CIs for the THA/TKA payment model by individual time period and for the combined 27-month dataset. The quasi-R^2 for the THA/TKA payment model was 0.17, suggesting that approximately 17% 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.[11]

Overall, the variable effect sizes were relatively constant across time periods. In addition, model performance was stable over the 27-month period; the quasi-R^2 and predictive ratios remained similar to the model used for 2021 public reporting (Table 4.5.4).

4.5.4 Distribution of Hospital Volumes and Payment for THA/TKA

The national mean payment for the combined 27-month dataset was $20,793 ($2020). For the three time periods, the national mean payments were as follows:

- April 1, 2018 – March 31, 2019: $21,075 ($2020)
- April 1, 2019 – October 2, 2019: $20,616 ($2020)
- July 1, 2020 – March 31, 2021: $20,145 ($2020)

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 time period, as well as for the combined 27-month 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 27-month dataset, which indicates that the hospital RSPs are approximately normally distributed. The expected 90-day RSP if a patient is treated at a hospital one SD above the national average was 1.27 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 27-Month Dataset

Of 3,348 hospitals in the study cohort, 789 had a payment "Less than the National Average Payment," 1,236 had a payment "No Different than the National Average Payment," and 409 had a payment "Greater than the National Average Payment." 914 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)	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Total N	293,981	142,838	89,304	526,123
Mean age (SD)	74.0 (5.9)	74.2 (5.9)	74.3 (6.0)	74.1 (5.9)
Male	36.8	35.5	37.4	36.5
History of COVID-19	-	-	2.1	0.4
Index admissions with an elective THA procedure	40.7	44.4	40.1	41.6
Procedure type (bilateral joint replacement)	1.7	1.5	2.3	1.7
Procedure type (single joint replacement)	97.6	97.7	97.1	97.6
Procedure type (staged joint replacements)	0.7	0.8	0.7	0.7
Severe infection; other infectious diseases (CC 1, 3 – 7)	17.7	17.7	13.2	16.9
Metastatic cancer and acute leukemia (CC 8)	0.7	0.7	0.8	0.7
Cancer (CC 9 – 14)	18.4	18.9	14.9	17.9
Benign neoplasms of skin, breast, eye (CC 16)	20.9	21.6	14.0	19.9
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122-123)	27.2	27.6	26.0	27.1
Protein-calorie malnutrition (CC 21)	0.7	0.8	0.7	0.7
Morbid obesity (CC 22)	9.9	10.4	10.4	10.1
Other significant endocrine and metabolic disorders (CC 23)	3.4	3.7	3.5	3.5
Disorders of thyroid, cholesterol, lipids (CC 25 – 26)	81.9	82.5	79.5	81.6
Appendicitis (CC 37)	0.1	0.1	0.1	0.1
Bone/joint/muscle infections/necrosis (CC 39)	3.4	3.5	3.2	3.4
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	10.9	11.2	9.8	10.8
Disorders of the vertebrae and spinal discs (CC 41)	30.6	31.9	25.5	30.1
Osteoarthritis of hip or knee (CC 42)	97.4	97.6	92.2	96.6
Other musculoskeletal and connective tissue disorders (CC 45)	91.7	92.2	84.3	90.6
Severe hematological disorders (CC 46)	0.4	0.4	0.3	0.4

Variable (% unless otherwise indicated)	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Coagulation defects and other specified hematological disorders (CC 48)	6.1	6.4	5.6	6.1
Delirium and encephalopathy (CC 50)	1.3	1.5	1.2	1.4
Dementia or other specified brain disorders (CC 51 – 53)	4.3	4.4	3.8	4.3
Major psychiatric disorders (CC 57 – 59)	5.9	6.5	6.5	6.2
Depression/anxiety (CC 61 – 62)	19.1	19.9	19.5	19.4
Other psychiatric disorders (CC 63)	17.5	18.6	18.3	18.0
Mental retardation or developmental disability (CC 64 – 68)	0.3	0.3	0.3	0.3
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.6	1.7	1.5	1.6
Polyneuropathy; other neuropathies (CC 75, 81)	19.4	20.1	17.7	19.3
Multiple sclerosis (CC 77)	0.3	0.3	0.3	0.3
Parkinson's and Huntington's diseases (CC 78)	1.1	1.2	1.2	1.1
Seizure disorders and convulsions (CC 79)	1.5	1.6	1.5	1.6
Congestive heart failure (CC 85)	10.5	10.9	11.0	10.7
Acute coronary syndrome (CC 86 – 87)	2.2	2.3	1.7	2.2
Valvular and rheumatic heart disease (CC 91)	14.5	14.9	12.4	14.3
Hypertension and hypertensive disease (CC 94 – 95)	78.5	78.7	75.0	77.9
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	27.9	28.7	27.2	28.0
Stroke (CC 99 – 100)	2.0	2.0	1.6	1.9
Vascular or circulatory disease (CC 106 – 109)	23.7	24.5	20.8	23.4
Chronic obstructive pulmonary disease (COPD) (CC 111)	11.7	12.0	11.1	11.7
Pleural effusion/pneumothorax (CC 117)	1.5	1.6	1.1	1.5
Other respiratory disorders (CC 118)	30.8	30.6	25.9	29.9
Legally blind (CC 119)	0.1	0.2	0.1	0.1
Dialysis status (CC 134)	0.2	0.2	0.3	0.2
Renal failure (CC 135 – 140)	15.7	16.6	17.2	16.2
Urinary incontinence (CC 143)	8.8	9.1	7.5	8.6
Urinary tract infection (CC 144)	14.1	14.3	9.5	13.4
Other urinary tract disorders (CC 145)	10.3	10.7	7.4	9.9
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	2.2	2.3	1.9	2.1
Cellulitis, local skin infection (CC 164)	6.7	6.8	4.4	6.3
Other dermatological disorders (CC 165)	43.3	43.5	31.7	41.4
Trauma (CC 166 – 168, 170 – 173)	4.7	4.9	3.4	4.6

Variable (% unless otherwise indicated)	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Vertebral fractures without spinal cord injury (CC 169)	1.1	1.1	0.8	1.0
Other injuries (CC 174)	25.5	25.8	17.3	24.2
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02	66.9	68.0	60.2	66.1
Minor symptoms, signs, findings (CC 179)	80.8	81.6	82.3	81.3

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

Variable	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Intercept	9.649	9.625	9.652	9.650
Years over 65 (continuous)	0.013	0.012	0.010	0.012
Male	-0.038	-0.035	-0.026	-0.035
History of COVID-19	-	-	0.006	-0.020
Index admissions with an elective THA procedure	-0.022	-0.033	0.007	-0.020
Procedure type (bilateral joint replacement)	0.572	0.545	0.544	0.560
Procedure type (single joint replacement)	Reference	Reference	Reference	Reference
Procedure type (staged joint replacements)	0.569	0.576	0.568	0.569
Severe infection; other infectious diseases (CC 1, 3 – 7)	0.036	0.043	0.049	0.041
Metastatic cancer and acute leukemia (CC 8)	0.068	0.075	0.095	0.074
Cancer (CC 9 – 14)	-0.009	-0.006	-0.005	-0.007
Benign neoplasms of skin, breast, eye (CC 16)	-0.020	-0.021	-0.026	-0.020
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.044	0.043	0.044	0.043
Protein-calorie malnutrition (CC 21)	0.116	0.130	0.142	0.125
Morbid obesity (CC 22)	0.081	0.089	0.090	0.085
Other significant endocrine and metabolic disorders (CC 23)	0.020	0.024	0.028	0.023
Disorders of thyroid, cholesterol, lipids (CC 25 – 26)	-0.010	-0.011	-0.010	-0.010
Appendicitis (CC 37)	-0.024	-0.031	-0.078	-0.031
Bone/joint/muscle infections/necrosis (CC 39)	0.061	0.052	0.070	0.060
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	0.022	0.022	0.023	0.023
Disorders of the vertebrae and spinal discs (CC 41)	0.011	0.009	0.008	0.010
Osteoarthritis of hip or knee (CC 42)	0.057	0.049	0.009	0.045
Other musculoskeletal and connective tissue disorders (CC 45)	0.021	0.028	0.015	0.024
Severe hematological disorders (CC 46)	0.126	0.122	0.133	0.130
Coagulation defects and other specified hematological disorders (CC 48)	0.026	0.019	0.019	0.023

Variable	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Delirium and encephalopathy (CC 50)	0.114	0.100	0.123	0.111
Dementia or other specified brain disorders (CC 51 – 53)	0.095	0.109	0.135	0.106
Major psychiatric disorders (CC 57 – 59)	0.067	0.063	0.067	0.066
Depression/anxiety (CC 61 – 62)	0.031	0.023	0.027	0.028
Other psychiatric disorders (CC 63)	0.017	0.017	0.020	0.017
Mental retardation or developmental disability (CC 64 – 68)	0.107	0.116	0.123	0.113
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.125	0.121	0.160	0.130
Polyneuropathy; other neuropathies (CC 75, 81)	0.016	0.016	0.020	0.017
Multiple sclerosis (CC 77)	0.117	0.135	0.118	0.124
Parkinson's and Huntington's diseases (CC 78)	0.184	0.159	0.181	0.177
Seizure disorders and convulsions (CC 79)	0.068	0.069	0.054	0.066
Congestive heart failure (CC 85)	0.068	0.073	0.078	0.071
Acute coronary syndrome (CC 86 – 87)	0.017	0.011	0.007	0.015
Valvular and rheumatic heart disease (CC 91)	0.006	0.006	-0.003	0.006
Hypertension and hypertensive disease (CC 94 – 95)	0.015	0.019	0.014	0.016
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.017	0.016	0.019	0.017
Stroke (CC 99 – 100)	0.035	0.039	0.038	0.036
Vascular or circulatory disease (CC 106 – 109)	0.030	0.028	0.031	0.030
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.051	0.049	0.065	0.053
Pleural effusion/pneumothorax (CC 117)	0.004	0.008	0.042	0.010
Other respiratory disorders (CC 118)	0.007	0.005	0.005	0.007
Legally blind (CC 119)	0.107	0.117	0.152	0.116
Dialysis status (CC 134)	0.357	0.440	0.367	0.380
Renal failure (CC 135 – 140)	0.050	0.050	0.058	0.050
Urinary incontinence (CC 143)	0.040	0.040	0.035	0.040
Urinary tract infection (CC 144)	0.021	0.018	0.018	0.021
Other urinary tract disorders (CC 145)	0.002	-0.009	0.000	0.000
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.092	0.113	0.139	0.106
Cellulitis, local skin infection (CC 164)	0.032	0.019	0.024	0.028
Other dermatological disorders (CC 165)	-0.016	-0.015	-0.014	-0.014
Trauma (CC 166 – 168, 170 – 173)	0.041	0.053	0.086	0.050
Vertebral fractures without spinal cord injury (CC 169)	0.038	0.034	0.068	0.042
Other injuries (CC 174)	0.018	0.021	0.020	0.021
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02	0.025	0.025	0.024	0.027
Minor symptoms, signs, findings (CC 179)	0.009	0.010	0.015	0.009

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

Variable	4/1/2018 – 3/31/2019 PR (95% CI)	4/1/2019 – 10/2/2019 PR (95% CI)	7/1/2020 – 3/31/2021 PR (95% CI)	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021 PR (95% CI)
Years over 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	0.96 (0.96 – 0.97)	0.97 (0.96 – 0.97)	0.97 (0.97 – 0.98)	0.97 (0.96 – 0.97)
History of COVID-19	-	-	1.01 (0.99 – 1.03)	0.98 (0.96 – 1.00)
Index admissions with an elective THA procedure	0.98 (0.98 – 0.98)	0.97 (0.96 – 0.97)	1.01 (1.00 – 1.01)	0.98 (0.98 – 0.98)
Procedure type (bilateral joint replacement)	1.77 (1.75 – 1.80)	1.72 (1.69 – 1.76)	1.72 (1.68 – 1.76)	1.75 (1.73 – 1.77)
Procedure type (single joint replacement)	Reference	Reference	Reference	Reference
Procedure type (staged joint replacements)	1.77 (1.73 – 1.80)	1.78 (1.73 – 1.83)	1.77 (1.69 – 1.84)	1.77 (1.74 – 1.79)
Severe infection; other infectious diseases (CC 1, 3 – 7)	1.04 (1.03 – 1.04)	1.04 (1.04 – 1.05)	1.05 (1.04 – 1.06)	1.04 (1.04 – 1.04)
Metastatic cancer and acute leukemia (CC 8)	1.07 (1.05 – 1.09)	1.08 (1.05 – 1.10)	1.10 (1.06 – 1.14)	1.08 (1.06 – 1.09)
Cancer (CC 9 – 14)	0.99 (0.99 – 0.99)	0.99 (0.99 – 1.00)	1.00 (0.99 – 1.00)	0.99 (0.99 – 1.00)
Benign neoplasms of skin, breast, eye (CC 16)	0.98 (0.98 – 0.98)	0.98 (0.97 – 0.98)	0.97 (0.97 – 0.98)	0.98 (0.98 – 0.98)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.05 (1.04 – 1.05)	1.04 (1.04 – 1.05)	1.04 (1.04 – 1.05)	1.04 (1.04 – 1.05)
Protein-calorie malnutrition (CC 21)	1.12 (1.10 – 1.14)	1.14 (1.11 – 1.17)	1.15 (1.11 – 1.20)	1.13 (1.12 – 1.15)
Morbid obesity (CC 22)	1.08 (1.08 – 1.09)	1.09 (1.09 – 1.10)	1.09 (1.08 – 1.10)	1.09 (1.08 – 1.09)
Other significant endocrine and metabolic disorders (CC 23)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.04)	1.03 (1.01 – 1.05)	1.02 (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 – 1.00)	0.99 (0.99 – 0.99)
Appendicitis (CC 37)	0.98 (0.94 – 1.02)	0.97 (0.92 – 1.02)	0.92 (0.84 – 1.02)	0.97 (0.94 – 1.00)
Bone/joint/muscle infections/necrosis (CC 39)	1.06 (1.05 – 1.07)	1.05 (1.04 – 1.07)	1.07 (1.05 – 1.09)	1.06 (1.06 – 1.07)
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	1.02 (1.02 – 1.03)	1.02 (1.02 – 1.03)	1.02 (1.01 – 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 (1.00 – 1.01)	1.01 (1.01 – 1.01)

Variable	4/1/2018 – 3/31/2019 PR (95% CI)	4/1/2019 – 10/2/2019 PR (95% CI)	7/1/2020 – 3/31/2021 PR (95% CI)	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021 PR (95% CI)
Osteoarthritis of hip or knee (CC 42)	1.06 (1.05 – 1.07)	1.05 (1.04 – 1.06)	1.01 (1.00 – 1.02)	1.05 (1.04 – 1.05)
Other musculoskeletal and connective tissue disorders (CC 45)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.04)	1.02 (1.01 – 1.02)	1.02 (1.02 – 1.03)
Severe hematological disorders (CC 46)	1.13 (1.11 – 1.16)	1.13 (1.09 – 1.17)	1.14 (1.09 – 1.20)	1.14 (1.12 – 1.16)
Coagulation defects and other specified hematological disorders (CC 48)	1.03 (1.02 – 1.03)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.03)	1.02 (1.02 – 1.03)
Delirium and encephalopathy (CC 50)	1.12 (1.11 – 1.14)	1.11 (1.08 – 1.13)	1.13 (1.10 – 1.16)	1.12 (1.11 – 1.13)
Dementia or other specified brain disorders (CC 51 – 53)	1.10 (1.09 – 1.11)	1.11 (1.10 – 1.13)	1.14 (1.13 – 1.16)	1.11 (1.10 – 1.12)
Major psychiatric disorders (CC 57 – 59)	1.07 (1.06 – 1.08)	1.07 (1.06 – 1.07)	1.07 (1.06 – 1.08)	1.07 (1.06 – 1.07)
Depression/anxiety (CC 61 – 62)	1.03 (1.03 – 1.04)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.04)	1.03 (1.03 – 1.03)
Other psychiatric disorders (CC 63)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.02)
Mental retardation or developmental disability (CC 64 – 68)	1.11 (1.08 – 1.14)	1.12 (1.08 – 1.17)	1.13 (1.07 – 1.19)	1.12 (1.10 – 1.14)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.13 (1.12 – 1.15)	1.13 (1.11 – 1.15)	1.17 (1.14 – 1.20)	1.14 (1.13 – 1.15)
Polyneuropathy; other neuropathies (CC 75, 81)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.02)
Multiple sclerosis (CC 77)	1.12 (1.10 – 1.15)	1.14 (1.10 – 1.19)	1.13 (1.07 – 1.18)	1.13 (1.11 – 1.15)
Parkinson's and Huntington's diseases (CC 78)	1.20 (1.18 – 1.22)	1.17 (1.15 – 1.20)	1.20 (1.17 – 1.23)	1.19 (1.18 – 1.21)
Seizure disorders and convulsions (CC 79)	1.07 (1.06 – 1.08)	1.07 (1.05 – 1.09)	1.06 (1.03 – 1.08)	1.07 (1.06 – 1.08)
Congestive heart failure (CC 85)	1.07 (1.07 – 1.08)	1.08 (1.07 – 1.08)	1.08 (1.07 – 1.09)	1.07 (1.07 – 1.08)
Acute coronary syndrome (CC 86 – 87)	1.02 (1.01 – 1.03)	1.01 (1.00 – 1.03)	1.01 (0.99 – 1.03)	1.02 (1.01 – 1.02)
Valvular and rheumatic heart disease (CC 91)	1.01 (1.00 – 1.01)	1.01 (1.00 – 1.01)	1.00 (0.99 – 1.01)	1.01 (1.00 – 1.01)
Hypertension and hypertensive disease (CC 94 – 95)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.02)	1.01 (1.01 – 1.02)	1.02 (1.01 – 1.02)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.02)
Stroke (CC 99 – 100)	1.04 (1.02 – 1.05)	1.04 (1.02 – 1.06)	1.04 (1.01 – 1.06)	1.04 (1.03 – 1.05)

Variable	4/1/2018 – 3/31/2019 PR (95% CI)	4/1/2019 – 10/2/2019 PR (95% CI)	7/1/2020 – 3/31/2021 PR (95% CI)	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021 PR (95% CI)
Vascular or circulatory disease (CC 106 – 109)	1.03 (1.03 – 1.03)	1.03 (1.02 – 1.03)	1.03 (1.02 – 1.04)	1.03 (1.03 – 1.03)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.05 (1.05 – 1.06)	1.05 (1.04 – 1.06)	1.07 (1.06 – 1.08)	1.05 (1.05 – 1.06)
Pleural effusion/pneumothorax (CC 117)	1.00 (0.99 – 1.02)	1.01 (0.99 – 1.03)	1.04 (1.01 – 1.07)	1.01 (1.00 – 1.02)
Other respiratory disorders (CC 118)	1.01 (1.00 – 1.01)	1.00 (1.00 – 1.01)	1.01 (1.00 – 1.01)	1.01 (1.01 – 1.01)
Legally blind (CC 119)	1.11 (1.07 – 1.16)	1.12 (1.07 – 1.19)	1.16 (1.07 – 1.26)	1.12 (1.09 – 1.16)
Dialysis status (CC 134)	1.43 (1.37 – 1.48)	1.55 (1.47 – 1.64)	1.44 (1.35 – 1.54)	1.46 (1.42 – 1.50)
Renal failure (CC 135 – 140)	1.05 (1.05 – 1.06)	1.05 (1.05 – 1.06)	1.06 (1.05 – 1.07)	1.05 (1.05 – 1.06)
Urinary incontinence (CC 143)	1.04 (1.04 – 1.05)	1.04 (1.03 – 1.05)	1.04 (1.02 – 1.05)	1.04 (1.04 – 1.04)
Urinary tract infection (CC 144)	1.02 (1.02 – 1.03)	1.02 (1.01 – 1.02)	1.02 (1.01 – 1.03)	1.02 (1.02 – 1.02)
Other urinary tract disorders (CC 145)	1.00 (1.00 – 1.01)	0.99 (0.98 – 1.00)	1.00 (0.99 – 1.01)	1.00 (1.00 – 1.00)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.10 (1.08 – 1.11)	1.12 (1.10 – 1.14)	1.15 (1.12 – 1.18)	1.11 (1.10 – 1.12)
Cellulitis, local skin infection (CC 164)	1.03 (1.03 – 1.04)	1.02 (1.01 – 1.03)	1.02 (1.01 – 1.04)	1.03 (1.02 – 1.03)
Other dermatological disorders (CC 165)	0.98 (0.98 – 0.99)	0.98 (0.98 – 0.99)	0.99 (0.98 – 0.99)	0.99 (0.98 – 0.99)
Trauma (CC 166 – 168, 170 – 173)	1.04 (1.03 – 1.05)	1.05 (1.04 – 1.07)	1.09 (1.07 – 1.11)	1.05 (1.05 – 1.06)
Vertebral fractures without spinal cord injury (CC 169)	1.04 (1.02 – 1.05)	1.03 (1.01 – 1.06)	1.07 (1.04 – 1.11)	1.04 (1.03 – 1.05)
Other injuries (CC 174)	1.02 (1.01 – 1.02)	1.02 (1.02 – 1.03)	1.02 (1.01 – 1.03)	1.02 (1.02 – 1.02)
Major symptoms, abnormalities (CC 178), except ICD-10-CM codes R09.01 and R09.02	1.03 (1.02 – 1.03)	1.03 (1.02 – 1.03)	1.02 (1.02 – 1.03)	1.03 (1.02 – 1.03)
Minor symptoms, signs, findings (CC 179)	1.01 (1.01 – 1.01)	1.01 (1.00 – 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	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Predictive ratios (lowest decile – highest decile)	0.98 – 0.97	0.98 – 0.98	0.97 – 0.98	0.98 – 0.98
Quasi-R^2	0.18	0.17	0.14	0.17

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

Characteristic	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Number of hospitals	3,249	3,082	2,879	3,348
Mean number of admissions (SD)	90 (137)	46 (70)	31 (63)	157 (254)
Range (min. – max.)	1 – 2,883	1 – 1,488	1 – 1,478	1 – 5,849
25^{th} percentile	13	7	4	21
50^{th} percentile	43	22	12	72
75^{th} percentile	116	58	33	196

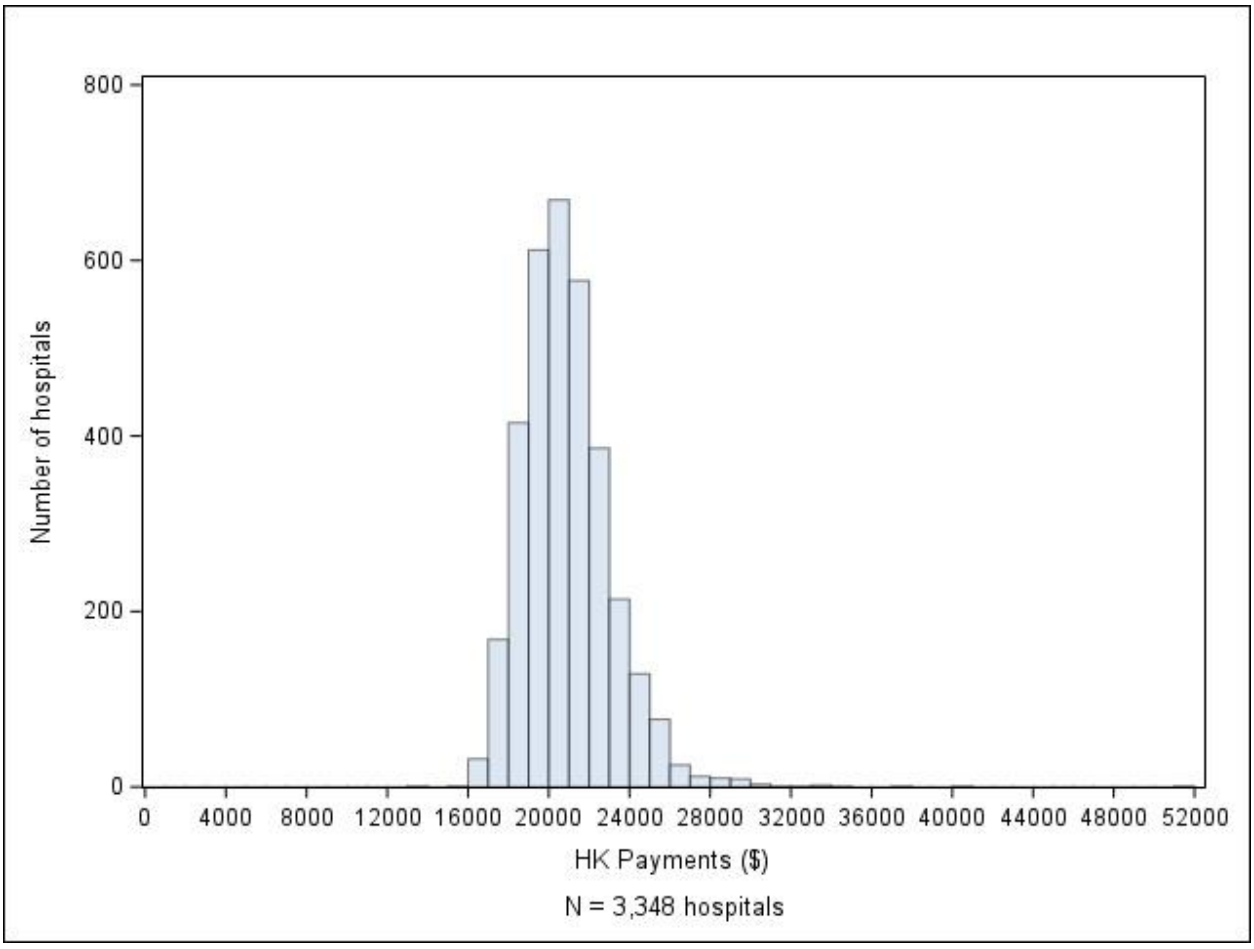
Table 4.5.6 — Distribution of Hospital THA/TKA RSPs over Different Time Periods ($2020)

Characteristic	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019 and 7/1/2020 – 3/31/2021
Number of hospitals	3,249	3,082	2,879	3,348
Mean (SD)	21,176 (2,113)	20,689 (1,765)	20,222 (1,848)	20,906 (2,269)
Range (min. – max.)	13,559 – 40,474	16,049 – 32,263	15,310 – 50,741	13,536 – 51,792
25^{th} percentile	19,770	19,566	19,160	19,407
50^{th} percentile	20,939	20,516	19,991	20,616
75^{th} percentile	22,332	21,708	21,111	22,062

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

Characteristic	4/1/2018 – 3/31/2019	4/1/2019 – 10/2/2019	7/1/2020 – 3/31/2021	4/1/2018 – 10/2/2019, 7/1/2020 – 3/31/2021
Between-hospital variance (SE)	0.013 (0.0005)	0.012 (0.0005)	0.015 (0.0008)	0.014 (0.0005)

Figure 4.5.2 — Distribution of Hospital THA/TKA 90-Day Episode-of-Care RSPs between April 1, 2018 and March 31, 2021, excluding October 3, 2019 through June 30, 2020 ($2020)



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 more 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 SD 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-10-CM diagnosis codes into clinically relevant categories, from the HCC system.[11,12] CMS uses modified groupings, but not the hierarchical logic of the system, to create risk factor variables. Mappings which show the assignment of 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:

- how much variation in hospital payment overall is accounted for by patients' individual risk factors (such as age and other medical conditions); and
- 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. A hospital-specific effect less than the average hospital-specific effect indicates the hospital's payments on the measure were lower than the average hospital with the same case mix, a hospital-specific effect greater than the average hospital-specific effect indicates the hospital's payments were higher than average, and a hospital-specific effect near the average hospital-specific effect indicates about average payments. 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. Patients in managed care (Medicare Advantage) are excluded from 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.[10] A predictive ratio close to 1.0 indicates an accurate prediction. A ratio substantially greater than 1.0 indicates over-prediction, and a ratio substantially less than 1.0 indicates under-prediction.

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

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7. APPENDICES

Appendix A. Statistical Approach 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:

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

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

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,…, I; j=1,…,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.[13]

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 calculate 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 calculate an RSP, $\widehat{RSP}_i$ for each hospital, using the national mean payment, denoted by $\bar{y}$. Specifically, we calculate:

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

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, $\left\{\hat{\alpha}_i^{(b)}, v\hat{a}r\left(\alpha_i^{(b)}\right); i = 1,2,\ldots,I\right\}$.
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 $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, v\hat{a}r\left(\alpha_i^{(b)}\right))$ 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).[14]

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.

This section represents QA for the subset of the work YNHHSC/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.

To assure the quality of measure output, we utilize a multi-phase approach to QA of the payment measures.

Phase I

As the first step in the QA process, we 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 includes updates to the HCC clinical category maps.

In general, we use 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 update 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.

2022

2022 Measures Updates and Specifications Report (Version 11.0 — AMI) (Version 9.0 — HF and Pneumonia) (Version 8.0 — THA/TKA)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2021 public reporting (namely, April 1, 2020; August 1, 2020; October 1, 2020 [FY 2021]; and January 1, 2021) into the cohort definitions the risk models, and the complication definitions used by the THA/TKA payment measure;
  - applied a modified version of the FY 2021 V24 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 3.1.
    - 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.
- Adjusted specifications and methodologies for the measures in response to the COVID-19 PHE — Specifically, we:
  - removed COVID-19 index admissions from the cohorts;
  - rendered COVID-19 claims ineligible for the payment outcome and excluded them;
  - added a new 'History of COVID-19' risk variable to the risk-adjustment models;
  - shortened the measurement period for 2022 public reporting to approximately 29 months (or 27 months, for THA/TKA), from the typical three-year measurement period, similar to 2021 public reporting; and
  - reduced the look-back period for use of claims data in risk adjustment to less than 12 months (from the typical 12 months) for those patients whose 12-month period included any portion of the January 1, 2020 – June 30, 2020 claims exclusion time frame. This reduced look-back period also applies to the identification of patients with a procedure code for LVAD implantation or heart transplantation prior to the index admission (an exclusion for the HF payment measure cohort).
    - Rationale: The COVID-19 PHE continues to have significant and enduring effects on the provision of medical care in the country and around the world. Adjustments to measure specifications and methodologies for 2022 help to ensure the intent of the measures is maintained. The measurement period and look-back period reductions (in certain cases) are in response to CMS's decision to exclude claims data for January 1, 2020 – June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Added a POA algorithm to the risk-adjustment methodology used to pull CC-defined risk-adjustment variables from the index admission claim.
  - Rationale: POA coding is a logical reflection of comorbidities. POA indicators more accurately distinguish complications of care from conditions already present at admission, in comparison to the previous methodology that utilized only the potential complications list.[9] Additionally, use of POA indicators helps particularly in cases where a patient has not been hospitalized or had

provider visits in the last year or where a comorbid condition present at the time of admission is relatively new.

2021

2021 Measures Updates and Specifications Report (Version 10.0 — AMI) (Version 8.0 — HF and Pneumonia) (Version 7.0 — THA/TKA)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - incorporated the code changes that occurred in the FY 2020 version of the ICD-10-CM/PCS (effective with October 1, 2019+ 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 2020 V24 CMS-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.
    - 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.
- Shortened the measurement period for 2021 public reporting to approximately 29 months/30 months (from the typical three-year measurement period)
  - Rationale: The measurement period reduction is in response to the COVID-19 PHE and CMS's decision to exclude claims data for January 1, 2020 – June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Removed International Classification of Diseases, Ninth Revision (ICD-9) code-based specifications from the measures and SAS packs
  - Rationale: The Medicare claims for the measurement period of July 1, 2017 – December 1, 2019 (or April 1, 2017 – October 2, 2019, in the case of THA/TKA measure) are completely ICD-10 code-based. 2020 public reporting was the last year that warranted any ICD-9 code specifications.

2020

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

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - 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 other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
    - 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)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - 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-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.
- 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)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - 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)

- 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* — Specifically:
  - 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.
- Revised the measure specifications to accommodate the implementation of ICD-10 coding — Specifically, we:
    - 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)

- 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.[15] 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.
- 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)

- 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.

- 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)

- 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.
- 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.
- 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.
- 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 nor 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)

- 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.
- 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

- **Principal discharge diagnosis of AMI**
  - Rationale: AMI is the condition targeted for measurement.
- **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: The 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission. Medicare Part B is required to ensure coverage across all care settings.
- **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.
- **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

- **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.
- **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.
- **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.
- **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.

- **Discharged against medical advice**
  - Rationale: Providers had limited opportunity to implement high quality care.
- **Transferred to a federal hospital**
  - Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.
- **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.
- **Missing index DRG weight where provider received no payment**
  - Rationale: With neither DRG weight nor 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.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
  - Rationale: COVID-19 patients are removed from the AMI cohort in response to the COVID-19 PHE.

After the above exclusions are applied, the measure randomly selects one index admission per patient per time period for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that time period are excluded.

For the 29-month combined data, if a randomly selected July 2019 admission falls within 30 days of a randomly selected June 2019 index admission (the transition period between the first and second time periods), the measure includes only the June 2019 admission. The July 2019 admission is excluded to avoid assigning payments for the same claims to two admissions. For example, if a patient has a randomly selected admission on June 18, 2019 and then again on July 2, 2019, and then has an ED visit on July 15, 2019, the measure will exclude the July 2, 2019 admission from the cohort, and the payment for the ED visit (in addition to the payment for the July 2, 2019 admission) will count towards the payment outcome for the June 18, 2019 admission.

The ICD-10-CM codes used to define the AMI cohort are outlined in the 2022 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 — with the exception of COVID-19 claims (described in Section 2.2.2 above). 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

- **Principal discharge diagnosis of HF**
  - Rationale: HF is the condition targeted for measurement.
- **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: The 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission. Medicare Part B is required to ensure coverage across all care settings.
- **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.
- **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

- **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.
- **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.
- **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.
- **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.
- **Discharged against medical advice**
  - Rationale: Providers had limited opportunity to implement high quality care.

- **Transferred to a federal hospital**
  - Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.
- **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.
- **Missing index DRG weight where provider received no payment**
  - Rationale: With neither DRG weight nor 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
- **With a procedure code for LVAD implantation or heart transplantation either during the index admission or up to 12 months prior to the index admission**
  - Rationale: These patients represent a clinically distinct group.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
  - Rationale: COVID-19 patients are removed from the HF cohort in response to the COVID-19 PHE.

After the above exclusions are applied, the measure randomly selects one index admission per patient per time period for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that time period are excluded.

For the 29-month combined data, if a randomly selected July 2019 admission falls within 30 days of a randomly selected June 2019 index admission (the transition period between the first and second time periods), the measure includes only the June 2019 admission. The July 2019 admission is excluded to avoid assigning payments for the same claims to two admissions. For example, if a patient has a randomly selected admission on June 18, 2019 and then again on July 2, 2019, and then has an ED visit on July 15, 2019, the measure will exclude the July 2, 2019 admission from the cohort, and the payment for the ED visit (in addition to the payment for the July 2, 2019 admission) will count towards the payment outcome for the June 18, 2019 admission.

The ICD-10 codes used to define the HF cohort inclusions and exclusions are outlined in the 2022 HF Payment Measure Code Specifications supplemental file 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 — with the exception of COVID-19 claims (described in Section 2.2.2 above). 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

- **Diagnosis coding that met one of the two following requirements:**
  1. **Principal discharge diagnosis of pneumonia; or**
  2. **a. Principal discharge diagnosis of sepsis (that is not severe); and**
     b. A secondary diagnosis of pneumonia coded as POA; and
     c. No secondary diagnosis of sepsis that is both severe and 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 patients being treated for pneumonia.
- **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: The 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission. Medicare Part B is required to ensure coverage across all care settings.
- **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.
- **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

- **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.
- **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.
- **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.

- **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.
- **Discharged against medical advice**
    - Rationale: Providers had limited opportunity to implement high quality care.
- **Transferred to a federal hospital**
    - Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.
- **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.
- **Missing index DRG weight where provider received no payment**
    - Rationale: With neither DRG weight nor 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.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
    - Rationale: COVID-19 patients are removed from the pneumonia cohort in response to the COVID-19 PHE.

After the above exclusions are applied, the measure randomly selects one index admission per patient per time period for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that time period are excluded.

For the 29-month combined data, if a randomly selected July 2019 admission falls within 30 days of a randomly selected June 2019 index admission (the transition period between the first and second time periods), the measure includes only the June 2019 admission. The July 2019 admission is excluded to avoid assigning payments for the same claims to two admissions. For example, if a patient has a randomly selected admission on June 18, 2019 and then again on July 2, 2019, and then has an ED visit on July 15, 2019, the measure will exclude the July 2, 2019 admission from the cohort, and the payment for the ED visit (in addition to the payment for the July 2, 2019 admission) will count towards the payment outcome for the June 18, 2019 admission.

The ICD-10-CM codes used to define the pneumonia cohort are outlined in the 2022 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 — with the exception of COVID-19 claims (described in Section 2.2.2 above). 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

- **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* 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.
- **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: The 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission. Medicare Part B is required to ensure coverage across all care settings.
- **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.

- **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

- **Discharged against medical advice**
  - Rationale: Providers had limited opportunity to implement high quality care.
- **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.
- **Transferred to a federal hospital**
  - Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.
- **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.
- **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.
- **Missing index DRG weight where provider received no payment**
  - Rationale: With neither DRG weight nor 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.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
  - Rationale: COVID-19 patients are removed from the THA/TKA cohort in response to the COVID-19 PHE.

After the above exclusions are applied, the measure randomly selects one index admission per patient per time period for inclusion in the cohort so that each episode of care is mutually independent. Additional admissions within that time period are excluded.

For the 27-month combined data, if a randomly selected admission for the second time period (April 1, 2019 – October 2, 2019) falls within 90 days of a randomly selected index admission for the first time period (April 1, 2018 – March 31, 2019), the measure includes only the admission from the first time period. The second admission is excluded to avoid assigning payments for the same claims to two admissions. For example, if a patient has a randomly selected admission on February 1, 2019 and then again on April 2, 2019, and then receives outpatient rehabilitation on April 20, 2019, the measure will exclude the April 2, 2019 admission from the cohort, and the payment for the

outpatient rehabilitation (in addition to the payment for the April 2, 2019 admission) will count towards the payment outcome for the February 1, 2019 admission.

The ICD-10 codes used to define the THA/TKA cohort are outlined in the 2022 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 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 — with the exception of COVID-19 claims (described in Section 2.2.2 above). 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 2022 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)