2014 Measure Updates and Specifications Report
Hospital-Level 30-Day Risk-Standardized Payment Measure

Acute Myocardial Infarction – Version 3.0

Submitted By:

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) hospital-level 30-day risk-standardized payment (RSP) measure following acute myocardial infarction (AMI) that will be publicly reported on *Hospital Compare*. This measure is hereafter referred to as the AMI Payment measure. This report is intended to provide a single source of information about this measure for a wide range of readers. Additional references for the AMI Payment measure can be found on the claims-based payment measure page of *QualityNet*.[1,2]

Within this report we provide an overview of the measure methodology and methodology updates for 2014 public reporting. The appendices provide detailed specifications for the measure, including concise tables of the condition codes used for cohort derivation and risk adjustment as well as a history of annual updates from previous years.

Specifically, the reader can find:

- **Section 2 – Background and Overview of Measure Methodology:**
  - Background on payment methodology
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The Appendices contain detailed measure information, including:

- Appendix A: Statistical approach

- Appendix B: Annual updates
- Appendix C: Measure specifications

For additional references, the original measure methodology (v1.0) and 2013 Measure Updates and Specification (v2.0) reports are also available on the claims-based payment measure page of *QualityNet*:

- Hospital-level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 1.0)[1]
- 2013 Measure Updates and Specifications Report: Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 2.0)[2]

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on the Payment Measure

In 2012, CMS developed a measure to estimate hospital-level 30-day risk-standardized payment (RSP) following hospitalization for AMI. This measure is not intended to be interpreted in isolation but considered in the context of existing quality measures such as CMS's 30-day risk-standardized all-cause mortality and readmission measures for AMI. Starting in 2014, CMS will publicly report the AMI Payment measure results for the nation's non-federal* short-term acute care and critical access hospitals on *Hospital Compare*, which CMS updates annually.

CMS contracted with the Yale New Haven Health Services Corporation – Center for Outcomes Research & Evaluation (YNHHSC/CORE) to update the AMI Payment measure for 2014 public reporting through a process of measure reevaluation. Measure reevaluation is an annual process to improve measures by responding to stakeholder input on the measures and incorporating advances in the science or changes in coding.

2.2 Overview of Measure Methodology

The 2014 AMI Payment measure uses the methodology described in the initial measure methodology report[1] with slight refinements to the measure as listed in Appendix B and described in the prior measure updates report.[2] Below, we provide an overview of the current methodology.

2.2.1 Cohort

Index Admissions Included in Measure

An index admission is the hospitalization that begins the 30-day episode-of-care payment window. The measure includes index admissions for patients:

- Having a principal discharge diagnosis of AMI†;
- Enrolled in Medicare fee-for-service (FFS);
- Aged 65 years or older;
- Not transferred from another acute care facility‡; and
- Enrolled in Part A and Part B Medicare for the 12 months prior to the date of admission, and enrolled in Part A during the index admission.

Index Admissions Excluded from the Measure

The measure excludes index admissions for patients (See Appendix C for rationale):

* Includes Indian Health Services hospitals.

† For specific International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort, refer to Table C.1 in Appendix C.

‡ The acute episode is included in the measure but payment is attributed to the hospital where the patient was initially admitted rather than the hospital receiving the transferred patient.

- With incomplete administrative data in the 30 days following the index admission if discharged alive;
- Who were discharged alive on the day of admission or the following day who were not transferred;
- With inconsistent or unknown vital status or other unreliable demographic data (age and gender);
- Discharged against medical advice (AMA);
- Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index;
- Transferred to a federal hospital;
- That could not be matched to an admission in the AMI mortality measure; or
- With missing index diagnosis-related group (DRG) weight and provider received no payment.

Transferred Patients

The measure considers multiple contiguous hospitalizations as a single acute episode of care. Admissions to another hospital for AMI within one day of discharge are considered transfers, regardless of the discharge disposition code of the previous admission.

Payments for transferred patients are attributed to the hospital that admitted the patient for the index hospitalization. Thus, if a patient is admitted to Hospital A and transferred to Hospital B, the 30-day 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 30-day episode. This attribution is consistent with the AMI risk-standardized mortality rate (RSMR) measure.[3]

Medicare reduces payments when patients are transferred to another Inpatient Prospective Payment System (IPPS) hospital and have a length of stay at least one day less than the geometric mean length of stay for the DRG. 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.[4] We assign the per diem rate or the full DRG rate to the transferring hospital where applicable and then add it to the payment for the hospital that received the transfer patient to calculate the payment for the index admission.

2.2.2 Payment Outcome

AMI Payments

Using administrative claims data, we measure RSPs for Medicare patients for an episode of care that begins with an index admission for AMI and ends 30 days after the index admission. The AMI Payment measure captures payments for Medicare patients across multiple care settings, services, and supplies (i.e., inpatient, outpatient, skilled nursing facility, home health, hospice, physician/clinical laboratory/ambulance services, and

durable medical equipment, prosthetics/orthotics, and supplies). We remove payment adjustments unrelated to clinical care decisions.

To isolate payment variation that reflects practice patterns rather than CMS payment adjustments, we "strip" and "standardize" payments for each care setting. Stripping refers to removing geographic differences and policy adjustments in payment rates for individual services from the total payment for that service. Standardizing refers to averaging payments across geographic areas for those services where geographic differences in payment cannot be stripped. Stripping and standardizing the payment amounts allows for a fair comparison across hospitals based solely on payments for decisions related to clinical care of AMI.

30-Day Time Frame

The measure assesses payments within a 30-day period from the date of index admission. The measure uses a 30-day time frame because payments accrued within 30 days of admission can be influenced by hospital care and the transition to the outpatient setting. Also, the 30-day period provides a standardized observation period for each hospital. Lastly, the 30-day post-admission timeframe is consistent with other CMS measures endorsed by the National Quality Forum (NQF) and publicly reported by CMS, which provides stakeholders with a consistent time period for assessing health care value.

Please see the 2012 Methodology Report[1] for a full description of the calculation of patients' total 30-day payment, by health care setting.

2.2.3 Risk-Adjustment Variables

The measure adjusts for variables (i.e., age, prior percutaneous coronary intervention (PCI)/coronary artery bypass graft (CABG), and comorbidities) that are clinically relevant and have strong relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending 12 months prior to, and including, the index admission.

The measure seeks to adjust for case-mix differences among hospitals based on the patient characteristics at the time of the index admission. Accordingly, only comorbidities that convey information about the patient at that time or in the 12 months prior to – and not complications that arise during – the course of the hospitalization are included in the risk adjustment. Please refer to Table C.3 in Appendix C of this report for the list of potential complications not used for risk adjustment.

The measure does not adjust for the patients' admission source or their discharge disposition (e.g. skilled nursing facility (SNF)) because these factors are associated with the structure of the healthcare system, not solely patients' clinical comorbidities. Regional differences in the availability of post-acute care providers and practice patterns might exert an undue influence on model results.

The measure also does not adjust for socioeconomic status (SES) because the association between SES and health outcomes can be due, in part, to differences in care received by groups of patients with varying SES. The measure seeks to adjust for patient demographic and clinical characteristics while illuminating important payment differences at the hospital-level. Additionally, recent analyses have shown that hospitals caring for high proportions of low SES patients perform similarly on the measure to hospitals caring for low proportions of low SES patients.[5]

Please refer to Table C.2 in Appendix C of this report for the list of risk-adjustment variables for the AMI Payment measure.

2.2.4 Data Sources

The data sources for these analyses are Medicare administrative claims data, publicly-available CMS final rule and fee schedule data, and enrollment information for patients with hospitalizations that occurred between July 1, 2010 and June 30, 2013. The datasets allow for calculation of associated payments for Medicare patients across multiple care settings, services, and supplies (i.e., inpatient, outpatient, skilled nursing facility, home health, hospice, physician/clinical laboratory/ambulance services, and durable medical equipment, prosthetics/orthotics, and supplies). Medicare administrative claims data for certain Part A and Part B services in the 12 months prior to and during the index admission are used for risk adjustment. Please see the original methodology report[1] for further descriptions of these data sources.

2.2.5 Measure Calculation

The measure estimates hospital-level 30-day RSPs using a hierarchical generalized linear model. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and across hospitals.[6] At the patient level, it uses a generalized linear model with a log link and inverse Gaussian distribution to model the total 30-day payment using age, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercept as arising from a normal distribution. The hospital-specific intercept represents the underlying 30-day payment at the hospital, after accounting for patient risk. If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts 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 30-day payment predicted on the basis of the hospital's performance with its observed case mix, and the denominator is the payment expected on the basis of the nation's performance with that hospital's case mix. It conceptually allows for a comparison of a particular hospital's performance given its case mix to an average hospital's performance with the same case mix. Thus, a lower ratio of "predicted" payment to "expected" payment indicates lower-than-expected 30-day payment, and a higher ratio indicates higher-than-expected 30-day payment.

The "predicted" 30-day payment (the numerator) is calculated using the coefficients estimated by regressing the risk factors (found in Table C.2) and the hospital-specific intercept on the payment outcome. The "estimated" hospital-specific intercept is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are then summed over all patients attributed to a hospital to get a predicted value. The "expected" 30-day payment (the denominator) is obtained in the same manner, but a common intercept using all hospitals in our sample is added in place of the hospital-specific intercept. The results are then summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period.

For each hospital, the ratio of "predicted" 30-day payment over "expected" 30-day payment is then multiplied by the national mean payment to get the RSP. This transforms the ratio of predicted over expected into a payment amount that is compared to the national mean payment. The hierarchical generalized linear regression models are described fully in Appendix A and in the original methodology report.[1]

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 is classified as follows:

- "No different than U.S. national payment" if the 95% interval estimate surrounding the hospital's RSP includes the national mean payment.
- "Higher than U.S. national payment" if the entire 95% interval estimate surrounding the hospital's RSP is higher than the national mean payment.
- "Lower than U.S. national payment" if the entire 95% interval estimate surrounding the hospital's RSP is lower than the national mean payment.

If a hospital has fewer than 25 eligible cases, CMS assigns the hospital to a separate category: "The number of cases is too small (fewer than 25) to reliably tell how well the hospital is performing." If a hospital has fewer than 25 eligible cases, the hospital's RSP and interval estimate will not be publicly reported for the measure.

3. UPDATES TO MEASURE FOR 2014 PUBLIC REPORTING

3.1 Rationale for Measure Updates

Measure reevaluation ensures that the RSP model is continually assessed, remains valid given possible changes in the data over time, and allows for model refinements. As part of measure reevaluation we:

- Validate the performance of the AMI Payment model and its corresponding risk-adjustment variables in three recent one-year datasets (July 2010-June 2011, July 2011-June 2012, and July 2012-June 2013);
- Evaluate and validate model performance in the three-year combined dataset (July 2010-June 2013); and
- Update the measure SAS analytic package and documentation.

3.2 Detailed Discussion of Measure Updates

3.2.1 Add-on Payments

The calculation of the patient-level total 30-day payment has been updated to include the following payments: "new technology add-on payment" and "blood clotting factor add-on payment."

New technology add-on payment
CMS allows inpatient settings to claim the new technology add-on payment as an addition to the standard reimbursement they receive. 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. This payment is identified in administrative claims by an inpatient value code that is specific to new technology.[7]

Blood clotting factor add-on payment
CMS allows inpatient hospitals, inpatient rehabilitation facilities, and long-term care hospitals to receive additional reimbursement for blood clotting factor for patients with hemophilia. Hospitals indicate this payment in administrative claims with the Healthcare Common Procedure Coding System (HCPCS) codes for blood clotting factors.[7]

The new technology and blood clotting factor add-on payments are related to clinical care decisions and hospital practice patterns. Since the intent of the measure is to highlight variation in payments related to these domains, we include these payment adjustments in our calculation of the outcome.

3.2.2 Winsorization of Outlier Payments

As part of the reevaluation of this measure, the patient-level total 30-day payments were Winsorized to eliminate extreme values at the upper end of the total payment distribution. This method reassigns any patient-level total 30-day payment that is greater than a particular percentile (99.9^{th}) with the value of that percentile. Winsorizing outlier data can improve model prediction. In addition, by Winsorizing the extreme

values of payments, we are able to mitigate the impact of possibly erroneous claims without attempting to make corrections or excluding patients.

3.2.3 Update to Exclusion Criteria

The exclusion criteria for the AMI Payment measure have been updated to exclude patients whose hospital claim is both missing DRG weight and indicates that the provider received no payment. During the development of this measure, patients with a missing DRG code or weight were excluded because the payment for their index admission could not be calculated. However, patients with a missing DRG weight for a readmission were not excluded, nor were patients with analogous missing information from other care settings (i.e., missing resource utilization group (RUG) weight from a SNF stay). In order to maintain consistency, we chose between two options: do not exclude patients with a missing DRG code or weight for their index admission, or exclude all patients with a missing DRG, RUG, or ambulatory payment classification (APC) weights. Because the number of patients with a missing DRG code or weight for their index admission is small and the payment could be calculated for these hospitalizations using other variables, we decided to eliminate the missing DRG exclusion criterion. In our updated approach, for patients with missing DRG (or other analogous) codes or weights in these settings, the payment is calculated by using the actual payment and removing the wage index and policy adjustments.

3.3 Changes to SAS Analytic Package (SAS Pack)

We revised the measure calculation SAS analytic package to reflect all changes to the index admission cohorts, new technology and blood clotting factor add-on payments, Winsorization, and model specifications. The new SAS pack and documentation are available upon request by emailing cmsepisodepaymentmeasures@yale.edu. **Do *NOT* submit patient-identifiable information (e.g., Date of Birth, Social Security Number, Health Insurance Claim Number, etc.) to this address.**

4. RESULTS FOR PUBLIC REPORTING

4.1 Assessment of Updated Model

The payment measure estimates hospital-specific 30-day RSPs using a hierarchical generalized linear model. Section 2 of this report summarizes the measure methodology and model risk-adjustment variables. Refer to the initial measure methodology report[1] and prior measure updates report[2] for further details.

We used data from July 2010 to June 2013 to reassess the model. We began this evaluation by separating these data into three single-year time periods: July 2010-June 2011, July 2011-June 2012, and July 2012-June 2013. We then compared: 1) differences in the frequency of patient risk factors, 2) model variable coefficients, and 3) overall model performance across these single years. We repeated these analyses for the combined three-year data from July 2010-June 2013. Before evaluation, all payments were inflation adjusted to 2013 dollars.

We assessed generalized linear model performance in terms of discriminant ability for each year of data and for the three-year combined period. We computed two summary statistics for assessing model performance: R^2 and predictive ability.

A predictive ratio is an estimator's ratio of predicted outcome to observed outcome.[8] A predictive ratio close to 1.0 indicates an accurate prediction. A ratio substantially greater than 1.0 indicates overprediction, and a ratio substantially less than 1.0 indicates underprediction.

For a traditional linear model (i.e. 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 (GLMs), 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.[8] Specifically, we regressed the total payment on the payment predicted by the patient-level risk factors. This regression produced a quasi-R^2 of 0.06, suggesting that approximately six percent 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 health care payment.[9]

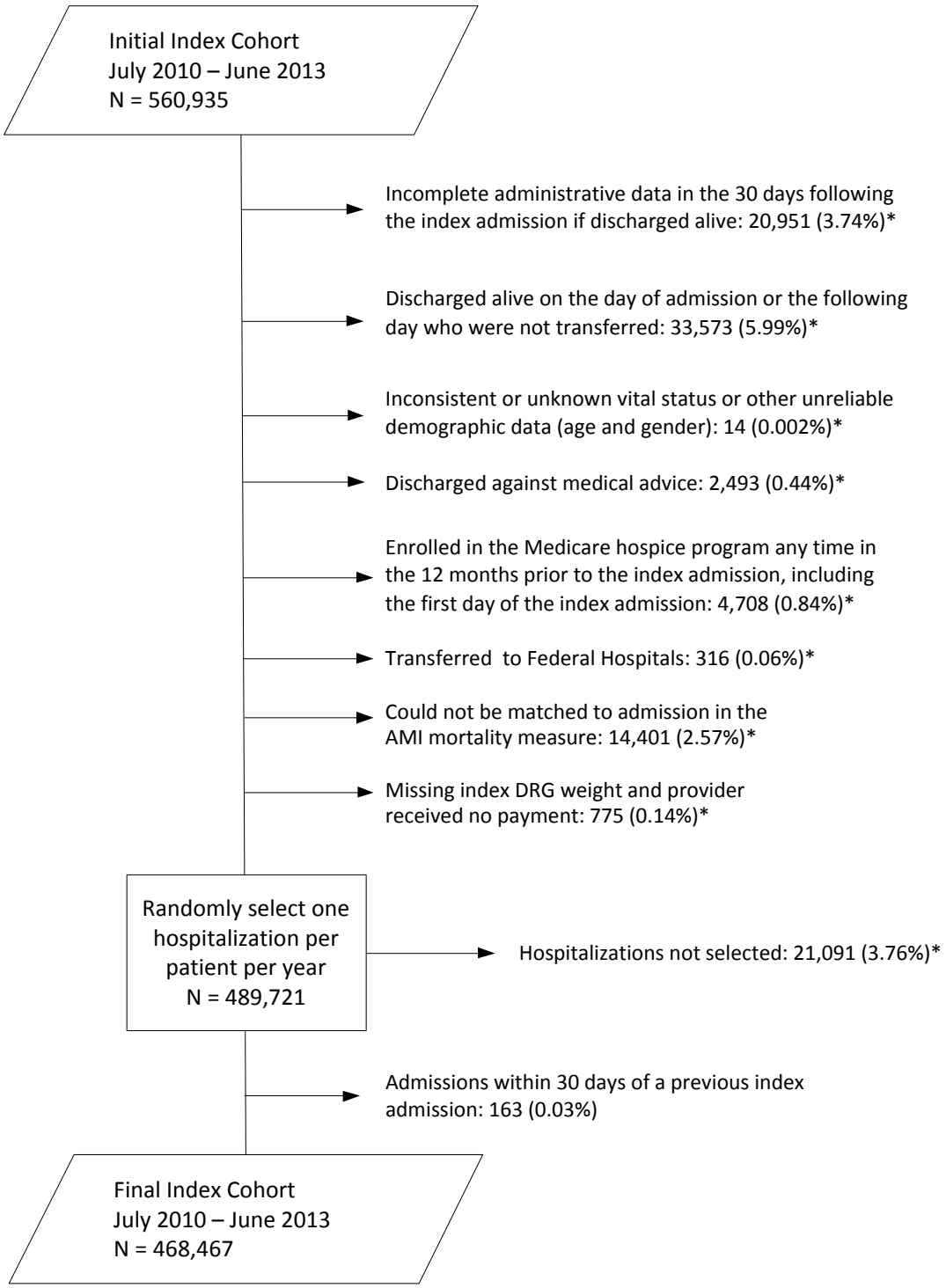
The results are presented in Section 4.2.

4.2 AMI Payment 2014 Model Results

4.2.1 Index Cohort Exclusions

The exclusion criteria for the measures are presented in Section 2.2.1. The percentage of AMI patients meeting each exclusion criterion in the July 2010-June 2013 dataset is presented in Figure 4.2.1.

Figure 4.2.1 Index Cohort Sample for AMI payment in the July 2010-June 2013 Dataset



The initial index cohort includes Medicare FFS patients aged 65 or older with a primary discharge diagnosis of AMI admitted to non-federal acute care hospitals; enrolled in Part A and Part B Medicare for the 12 months prior to the date of admission, and enrolled in Part A and B during the index admission; who were not transferred from another acute care facility.

* These categories are not mutually exclusive

4.2.2 Frequency of AMI Payment Model Variables

We examined the change in both observed payments and frequency of clinical and demographic variables (Table 4.2.1). Between July 2010- June 2011 and July 2012- June 2013, the observed average national payment decreased from $21,990 to $20,778.

The frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service population or increased coding opportunities in administrative claims from the implementation of Version 5010 format changes required by the Department of Health and Human Services (HHS). Some notable changes include an increase from 12.1% to 17.2% for History of Percutaneous Coronary Intervention (PCI), from 8.8% to 12.3% for History of Coronary Artery Bypass Grafting (CABG), from 23.5% to 26.7% for Angina Pectoris/Old Myocardial Infarction (CC 83), from 28.9% to 31.8% for Valvular and Rheumatic Heart Disease (CC 86), from 87.2% to 89.8% for Hypertension and Hypertension Complications (CC 89-91), from 45.1% to 47.0% for Diabetes and Diabetes Complications (CC 15-19, 119-120), from 80.8% to 87.1% for Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24), from 49.6% to 54.5% for Other Gastrointestinal Disorders (CC 36), from 44.0% to 47.4% for Iron Deficiency and Other Unspecified Anemias and Blood Disease (CC 47), from 11.4% to 14.2% for Drug/Alcohol Abuse/Dependence (CC 52-53), and from 12.8% to 16.5% for Depression/Anxiety (CC 58-59).

4.2.3 AMI Payment Model Parameters and Performance

Table 4.2.2 shows hierarchical generalized linear model variable coefficients by individual year and for the combined three-year dataset.
Table 4.2.3 shows the risk-adjusted payment ratios (PR) and 95% confidence intervals (CIs) for the AMI Payment model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; R^2 and predictive ratios remained similar to the model used during development (Table 4.2.4).

4.2.4 Distribution of Hospital Volumes and RSPs for AMI

Table 4.2.5 shows the distribution of hospital admission volumes and Table 4.2.6 shows the distribution of hospital RSPs. The mean RSP decreased over the three-year period, from $22,018 between July 2010 and June 2011 to $20,799 between July 2012 and June 2013. The median hospital RSP in the combined three-year dataset was $21,146 (IQR $20,455-$22,083). Table 4.2.7 shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.010 (SE 0.0004). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

Figure 4.2.2 shows the overall distribution of the hospital RSPs for the combined dataset. The expected 30-day payment if treated at a hospital one standard deviation above the national average was 1.22 times higher than the expected 30-day payment if treated at a hospital one standard deviation below the national average payment. If there were no systematic differences between hospitals, this ratio would be 1.0.[6]

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

Of the 4,372 hospitals in the study cohort, 386 had a payment "higher than the U.S. national payment," 1,905 had a payment "no different from the U.S. national payment," and 178 had a payment "lower than the U.S. national payment." 1,903 were classified as "number of cases too small" (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.2.1 Frequency of AMI Payment Model Variables over Different Time Periods

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Total N	159,703	154,623	154,141	468,467
Observed mean payment ($2013)	21,990	20,998	20,778	21,264
Age (65 – 74)	32.90	33.86	34.33	33.69
Age (75 – 84)	37.98	37.59	37.08	37.56
Age (>=85)	29.12	28.55	28.59	28.76
History of PCI	12.05	16.15	17.19	15.09
History of CABG	8.82	11.83	12.26	10.94
Congestive Heart Failure (CC 80)	30.81	30.62	29.97	30.47
Angina Pectoris/Old Myocardial Infarction (CC 83)	23.50	26.58	26.68	25.56
Heart Infection/Inflammation, Except Rheumatic (CC 85)	1.88	1.90	1.90	1.89
Valvular and Rheumatic Heart Disease (CC 86)	28.90	31.65	31.79	30.76
Congenital Cardiac/Circulatory Defect (CC 87-88)	0.99	1.01	0.95	0.98
Hypertension and Hypertension Complications (CC 89-91)	87.20	89.36	89.77	88.76
Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	3.67	3.80	3.73	3.73
Diabetes and Diabetes Complications (CC 15-19, 119-120)	45.11	46.50	47.02	46.20
Protein-Calorie Malnutrition (CC 21)	5.94	6.36	6.37	6.22
Other Significant Endocrine and Metabolic Disorders (CC 22)	8.34	9.39	9.70	9.14
Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	80.81	85.90	87.13	84.57
Other Gastrointestinal Disorders (CC 36)	49.61	53.82	54.51	52.61
Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	15.98	17.32	16.74	16.67
Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	43.98	47.76	47.43	46.36
Delirium and Encephalopathy (CC 48)	4.20	4.34	4.50	4.34
Dementia (CC 49)	18.01	18.91	18.78	18.56
Drug/Alcohol Psychosis (CC 51)	0.55	0.54	0.53	0.54
Drug/Alcohol Abuse/Dependence (CC 52-53)	11.44	13.84	14.21	13.15
Severe Mental Illness (CC 54-55)	4.58	4.77	4.79	4.71
Reactive and Unspecified Psychosis (CC 56)	3.36	3.79	3.71	3.62
Depression/Anxiety (CC 58-59)	12.76	15.73	16.51	14.97
Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	15.69	16.07	15.90	15.88
Vascular Disease and Complications (CC 104-105)	26.62	27.57	27.55	27.24
Other Lung Disorders (CC 115)	26.88	27.05	25.83	26.59
Legally Blind (CC 116)	0.89	1.21	1.15	1.09

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Dialysis Status (CC 130)	2.92	3.22	3.40	3.18
Internal Injuries (CC 160)	0.97	0.98	0.96	0.97

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

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	9.881	9.740	9.735	9.791
Age (65 – 74)	0.199	0.184	0.172	0.185
Age (75 – 84)	0.175	0.160	0.164	0.167
Age (>=85) (reference group)	-	-	-	-
History of PCI	-0.082	-0.058	-0.055	-0.070
History of CABG	-0.199	-0.184	-0.185	-0.191
Congestive Heart Failure (CC 80)	-0.037	-0.051	-0.061	-0.045
Angina Pectoris/Old Myocardial Infarction (CC 83)	-0.044	-0.039	-0.030	-0.037
Heart Infection/Inflammation, Except Rheumatic (CC 85)	0.226	0.185	0.201	0.201
Valvular and Rheumatic Heart Disease (CC 86)	0.037	0.059	0.070	0.053
Congenital Cardiac/Circulatory Defect (CC 87-88)	0.080	0.114	0.110	0.101
Hypertension and Hypertension Complications (CC 89-91)	-0.052	-0.020	-0.035	-0.039
Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	-0.093	-0.097	-0.099	-0.097
Diabetes and Diabetes Complications (CC 15-19, 119-120)	0.066	0.074	0.070	0.070
Protein-Calorie Malnutrition (CC 21)	0.171	0.207	0.180	0.184
Other Significant Endocrine and Metabolic Disorders (CC 22)	0.039	0.050	0.055	0.047
Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	-0.059	-0.016	-0.009	-0.038
Other Gastrointestinal Disorders (CC 36)	-0.037	-0.027	-0.021	-0.029
Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	-0.036	-0.043	-0.048	-0.042
Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	0.130	0.183	0.194	0.164
Delirium and Encephalopathy (CC 48)	0.007	-0.017	-0.042	-0.019
Dementia (CC 49)	-0.084	-0.062	-0.070	-0.072
Drug/Alcohol Psychosis (CC 51)	0.008	-0.018	-0.031	-0.008
Drug/Alcohol Abuse/Dependence (CC 52-53)	-0.033	0.003	0.007	-0.009
Severe Mental Illness (CC 54-55)	0.027	0.023	0.026	0.023
Reactive and Unspecified Psychosis (CC 56)	-0.003	-0.002	0.013	0.004
Depression/Anxiety (CC 58-59)	-0.026	-0.021	-0.025	-0.025
Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	0.022	0.015	0.011	0.016

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Vascular Disease and Complications (CC 104-105)	0.006	-0.006	-0.004	-0.002
Other Lung Disorders (CC 115)	0.055	0.056	0.052	0.054
Legally Blind (CC 116)	-0.056	-0.009	-0.051	-0.040
Dialysis Status (CC 130)	0.120	0.110	0.113	0.114
Internal Injuries (CC 160)	0.103	0.148	0.124	0.124

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

Variable	07/2010-06/2011 PR (95% CI)	07/2011-06/2012 PR (95% CI)	07/2012-06/2013 PR (95% CI)	07/2010-06/2013 PR (95% CI)
Age (65 – 74)	1.22 (1.21-1.23)	1.20 (1.19-1.21)	1.19 (1.18-1.20)	1.20 (1.20-1.21)
Age (75 – 84)	1.19 (1.18-1.20)	1.17 (1.16-1.18)	1.18 (1.17-1.19)	1.18 (1.18-1.19)
Age (>=85) (reference group)	1.00 (--)	1.00 (--)	1.00 (--)	1.00 (--)
History of PCI	0.92 (0.91-0.93)	0.94 (0.93-0.95)	0.95 (0.94-0.96)	0.93 (0.93-0.94)
History of CABG	0.82 (0.81-0.83)	0.83 (0.82-0.84)	0.83 (0.82-0.84)	0.83 (0.82-0.83)
Congestive Heart Failure (CC 80)	0.96 (0.96-0.97)	0.95 (0.94-0.96)	0.94 (0.93-0.95)	0.96 (0.95-0.96)
Angina Pectoris/Old Myocardial Infarction (CC 83)	0.96 (0.95-0.96)	0.96 (0.95-0.97)	0.97 (0.96-0.98)	0.96 (0.96-0.97)
Heart Infection/Inflammation, Except Rheumatic (CC 85)	1.25 (1.22-1.29)	1.20 (1.17-1.24)	1.22 (1.19-1.26)	1.22 (1.20-1.24)
Valvular and Rheumatic Heart Disease (CC 86)	1.04 (1.03-1.05)	1.06 (1.05-1.07)	1.07 (1.06-1.08)	1.05 (1.05-1.06)
Congenital Cardiac/Circulatory Defect (CC 87-88)	1.08 (1.04-1.12)	1.12 (1.08-1.16)	1.12 (1.07-1.16)	1.11 (1.08-1.13)
Hypertension and Hypertension Complications (CC 89-91)	0.95 (0.94-0.96)	0.98 (0.97-0.99)	0.97 (0.95-0.98)	0.96 (0.96-0.97)
Metastatic Cancer and Acute Leukemia and Other Major Cancers (CC 7-8)	0.91 (0.90-0.93)	0.91 (0.89-0.92)	0.91 (0.89-0.92)	0.91 (0.90-0.92)
Diabetes and Diabetes Complications (CC 15-19, 119-120)	1.07 (1.06-1.08)	1.08 (1.07-1.08)	1.07 (1.07-1.08)	1.07 (1.07-1.08)
Protein-Calorie Malnutrition (CC 21)	1.19 (1.17-1.21)	1.23 (1.21-1.25)	1.20 (1.18-1.22)	1.20 (1.19-1.21)
Other Significant Endocrine and Metabolic Disorders (CC 22)	1.04 (1.02-1.06)	1.05 (1.04-1.07)	1.06 (1.04-1.07)	1.05 (1.04-1.06)
Obesity/Disorders of Thyroid, Cholesterol, Lipids (CC 24)	0.94 (0.93-0.95)	0.98 (0.97-0.99)	0.99 (0.98-1.00)	0.96 (0.96-0.97)
Other Gastrointestinal Disorders (CC 36)	0.96 (0.96-0.97)	0.97 (0.97-0.98)	0.98 (0.97-0.99)	0.97 (0.97-0.98)
Osteoporosis and Other Bone/Cartilage Disorders (CC 41)	0.96 (0.96-0.97)	0.96 (0.95-0.97)	0.95 (0.94-0.96)	0.96 (0.95-0.96)

Variable	07/2010-06/2011 PR (95% CI)	07/2011-06/2012 PR (95% CI)	07/2012-06/2013 PR (95% CI)	07/2010-06/2013 PR (95% CI)
Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47)	1.14 (1.13-1.15)	1.20 (1.19-1.21)	1.21 (1.21-1.22)	1.18 (1.17-1.18)
Delirium and Encephalopathy (CC 48)	1.01 (0.99-1.03)	0.98 (0.97-1.00)	0.96 (0.94-0.98)	0.98 (0.97-0.99)
Dementia (CC 49)	0.92 (0.91-0.93)	0.94 (0.93-0.95)	0.93 (0.92-0.94)	0.93 (0.93-0.94)
Drug/Alcohol Psychosis (CC 51)	1.01 (0.96-1.06)	0.98 (0.94-1.03)	0.97 (0.92-1.02)	0.99 (0.97-1.02)
Drug/Alcohol Abuse/Dependence (CC 52-53)	0.97 (0.96-0.98)	1.00 (0.99-1.01)	1.01 (1.00-1.02)	0.99 (0.98-1.00)
Severe Mental Illness (CC 54-55)	1.03 (1.01-1.05)	1.02 (1.01-1.04)	1.03 (1.01-1.04)	1.02 (1.01-1.03)
Reactive and Unspecified Psychosis (CC 56)	1.00 (0.98-1.02)	1.00 (0.98-1.02)	1.01 (0.99-1.03)	1.00 (0.99-1.01)
Depression/Anxiety (CC 58-59)	0.97 (0.96-0.98)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.98)
Precerebral Arterial Occlusion and Transient Cerebral Ischemia (CC 97)	1.02 (1.01-1.03)	1.02 (1.01-1.03)	1.01 (1.00-1.02)	1.02 (1.01-1.02)
Vascular Disease and Complications (CC 104-105)	1.01 (1.00-1.01)	0.99 (0.99-1.00)	1.00 (0.99-1.00)	1.00 (0.99-1.00)
Other Lung Disorders (CC 115)	1.06 (1.05-1.06)	1.06 (1.05-1.07)	1.05 (1.04-1.06)	1.06 (1.05-1.06)
Legally Blind (CC 116)	0.95 (0.91-0.98)	0.99 (0.96-1.02)	0.95 (0.92-0.98)	0.96 (0.94-0.98)
Dialysis Status (CC 130)	1.13 (1.10-1.16)	1.12 (1.09-1.15)	1.12 (1.09-1.15)	1.12 (1.10-1.14)
Internal Injuries (CC 160)	1.11 (1.07-1.15)	1.16 (1.12-1.20)	1.13 (1.09-1.18)	1.13 (1.11-1.16)

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

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Predictive ability (lowest decile – highest decile)	(0.98-0.95)	(0.96-0.93)	(0.95-0.93)	(0.96-0.94)
R^2	0.05	0.07	0.07	0.06

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

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of Hospitals	4,080	3,994	3,932	4,372
Mean Number of Admissions (SD)	39 (53)	39 (53)	39 (53)	107 (154)
Range (min. – max.)	1-514	1-437	1-483	1-1,397
25^{th} percentile	4	4	4	8
50^{th} percentile	16	16	16	37
75^{th} percentile	56	56	57	152

Table 4.2.6 Distribution of Hospital AMI RSPs over Different Time Periods ($2013)

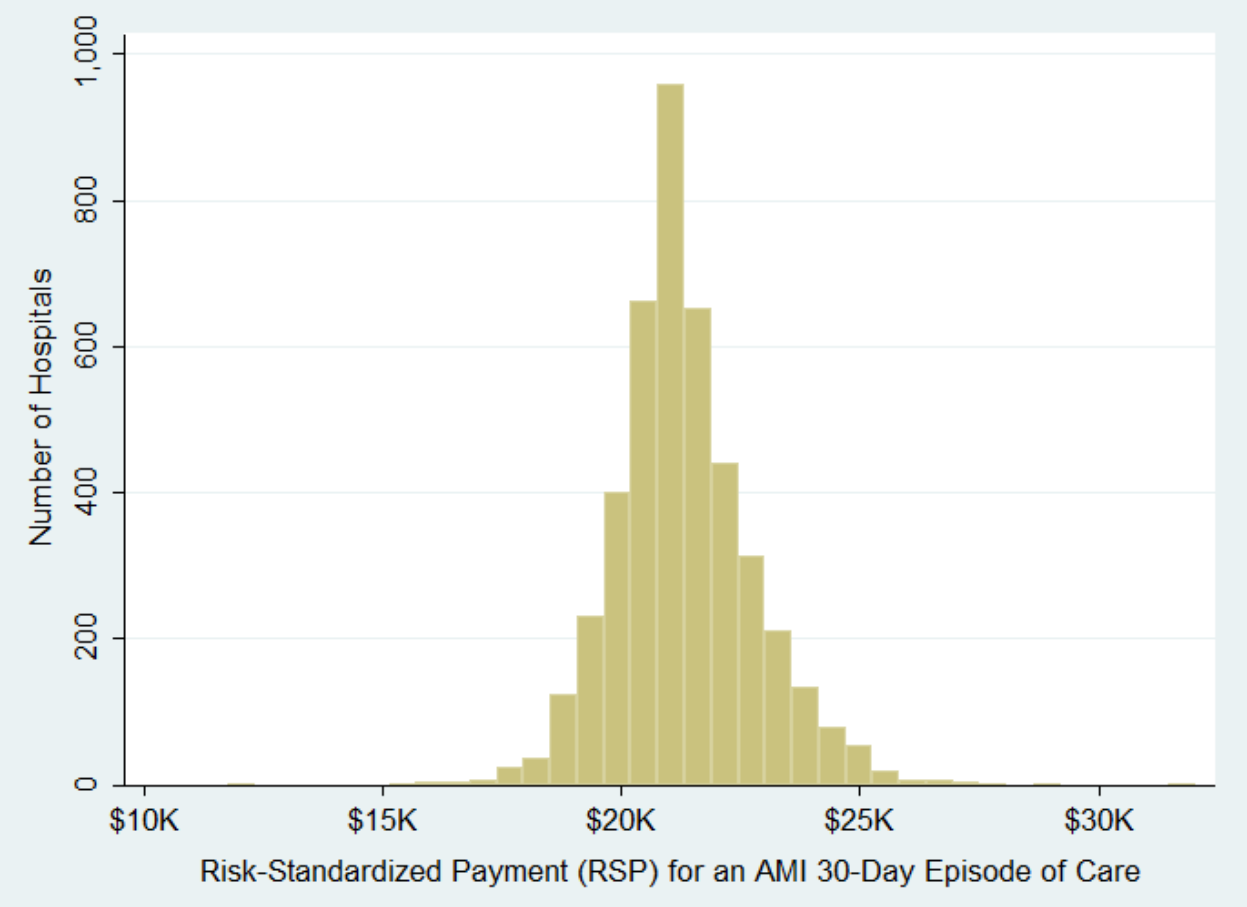
Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of Hospitals	4,080	3,994	3,932	4,372
Mean (SD)	22,018 (1,117)	21,017 (902)	20,799 (949)	21,312 (1,450)

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Range (min. – max.)	16,616-28,890	17,014-26,876	13,510-26,294	11,767-32,014
25th percentile	21,406	20,540	20,309	20,455
50th percentile	21,874	20,899	20,673	21,146
75th percentile	22,505	21,423	21,192	22,083

Table 4.2.7 Between Hospital Variance for AMI Payment

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between Hospital Variance (SE)	0.009 (0.0005)	0.007 (0.0005)	0.007 (0.0005)	0.010 (0.0004)

Figure 4.2.2 Distribution of Hospital AMI Episode-of-Care RSPs between July 2010 and June 2013 ($2013)



N= 4,372 hospitals

5. GLOSSARY

Cohort: The index admissions included in the measure after the inclusion and exclusion criteria have been applied.

Complications: Medical conditions that likely occurred as a consequence of care rendered, rather than as an expected outcome of the patient's condition or a condition that the patient had upon presentation to the hospital.

Comorbidities: Medical conditions that the patient had in addition to their primary disease.

Condition Categories (CCs): Groupings of ICD-9-CM diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system. CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Description of the CCs can be found at http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf.

Expected payment: The total payment expected on the basis of an average hospital's performance with a specific hospital's case mix.

Hierarchical model: A widely accepted statistical method that enables fair evaluation of relative hospital performance by taking into account patient risk factors as well as the number of patients that a hospital treats. This statistical model accounts for the structure of the data (patients clustered within hospitals) and calculates: (1) how much variation in hospital payment overall is accounted for by patients' individual risk factors (such as age and other medical conditions); and (2) how much variation is accounted for by hospital-specific performance.

Hospital-specific intercept: It is calculated based on the hospital's payment, considering how many patients it served, its patients' risk factors, and its patients' total payments. The hospital-specific intercept will be negative for a lower-than-average payment hospital, positive for a greater-than-average payment hospital, and close to zero for an average payment hospital. The hospital-specific intercept is used in the numerator to calculate the "predicted" payment.

Index admission: Any admission included in the measure calculation that begins the 30-day AMI episode of care.

Interval estimate: Similar to a confidence interval. The interval estimate is a range of probable values for the measure that characterizes the amount of uncertainty associated with the estimate. For example, a 95% interval estimate for the estimated payment ratio indicates that there is 95% statistical confidence that the true value of the payment ratio lies between the lower limit and the upper limit of the interval.

Medicare fee-for-service (FFS): Original Medicare plan. Only beneficiaries in Medicare FFS, not in managed care (Medicare Advantage), are included in the measure.

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

Outcome: The result of a broad set of healthcare activities that affect patients' well-being. For the payment measure, the outcome is the sum of payments accrued within 30 days of index admission.

Predicted payment: The total payment within 30 days predicted on the basis of the specific hospital with its observed case mix, also referred to as "adjusted actual" payment.

Risk-adjustment variables: Patient demographics, comorbidities, and relevant prior procedures that are used to adjust for differences in case mix across hospitals.

6. REFERENCES

1. Kim N, Ott LS, Spivack S, et al. *Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 1.0) 2012 Methodology Report.* 2012. Available at: https://www.qualitynet.org/dcs/ContentServer?cid=1228773321331&pagename=QnetPublic%2FPage%2FQnetTier4&c=Page.
2. Kim N, Ott LS, Spivack S, et al. *2013 Measure Updates and Specifications Report: Hospital-Level, Risk-Standardized Payment Associated with a 30-Day Episode of Care for AMI (Version 2.0).* 2013. Available at: https://www.qualitynet.org/dcs/ContentServer?cid=1228773321331&pagename=QnetPublic%2FPage%2FQnetTier4&c=Page.
3. Krumholz H, Normand S-L, Galusha D, et al. Risk-Adjustment Models for AMI and HF 30-Day Mortality: Report prepared for the Centers for Medicare & Medicaid Services.2005. Available at: https://www.qualitynet.org/dcs/ContentServer?cid=1163010421830&pagename=QnetPublic%2FPage%2FQnetTier4&c=Page
4. Medicare Payment Advisory Commission (MedPAC). *Report to the Congress: Medicare and the Health Care Delivery System.* 2011. Available at: http://www.medpac.gov/payment_basics.cfm.
5. Spivack S, Ott LS, Kim N, et al. Socioeconomic Status and Hospital Variation in 30-Day AMI Episode of Care Payments. AcademyHealth Conference. 2013.
6. Normand S-L, Shahian DM. Statistical and clinical aspects of hospital outcomes profiling. *Stat Sci.* 2007;22(2):206-226.
7. Centers for Medicare and Medicaid Services. Medicare Claims Processing Manual. 2013. Available at: http://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Internet-Only-Manuals-IOMs-Items/CMS018912.html.
8. Jones AM. Models for Health Care. Health, Econometrics and Data Group (HEDG) Working Papers. 2010.
9. Pope GC, Kautter J, Ingber MJ, Freeman S, Sekar R, and Newhart C. *Evaluation of the CMS-HCC risk adjustment model (Final Report).* RTI International. 2011.
10. Gatsonia C. Hierarchical Generalized Linear Models in the Analysis of Variations in Health Care Utilization. *Journal of the American Statistical Association.* 1999;94(445):29-42.
11. Normand S-L, Wang Y, and Krumholz H. Assessing surrogacy of data sources for institutional comparisons. *Health Services and Outcomes Research Methodology.* 2007;7(1):79-96.

7. APPENDICES

Appendix A. Statistical Approach

To calculate a hospital-specific RSP, we estimate a hierarchical generalized linear model using three years of data. This strategy accounts for within-hospital correlation of the observed outcomes and accommodates the assumption that underlying differences in care across hospitals leads to systematic differences in payments. We model the total payment as a function of patient age, select comorbidities, and history of PCI and/or CABG with a hospital-specific random effect.

We use the following strategy to calculate the hospital-specific RSPs. We calculate these payments as the ratio of "predicted" AMI payment to "expected" AMI payment, and multiply by the national mean payment. The predicted AMI payment for each hospital is estimated using its case mix and an estimated hospital-specific intercept. The expected AMI payment for each hospital is estimated given the same case mix but the average intercept among all hospitals in the sample.

Operationally, the expected AMI payment for each hospital is obtained by summing the expected AMI payments for all patients in the hospital. The expected AMI payment for each patient is calculated via the hierarchical model by applying the estimated regression coefficients to the observed patient characteristics and adding the average intercept. The predicted AMI payment for each hospital is calculated by summing the predicted AMI payments for all patients in the hospital. The predicted AMI payment for each patient is calculated through the hierarchical model by applying the estimated regression coefficients to the patient characteristics observed and adding the hospital-specific intercept.

More specifically, we use a hierarchical generalized linear model to account for the clustering of observations within hospitals and adjust for the selected risk factors. The model employs a log link and an inverse Gaussian error distribution with a hospital-specific random effect as follows:

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

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

where *i* indexes hospitals, *j* indexes patients within hospitals, α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij}$ is defined as the set of risk factors, μ is the average intercept across all hospitals in the sample, and τ^2 is the between-hospital variance component.[10] This model separates within-hospital variation from between-hospital variation. The hierarchical generalized linear models are estimated using the SAS software system (SAS 9.3 GLIMMIX procedure).

Hospital Performance Reporting

Using the selected set of risk factors, we fit the hierarchical generalized linear model defined by Equations (1) - (2) and estimate the parameters, $\hat{\mu}$, $\{\alpha_1, \alpha_2, \ldots, \alpha_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$. We calculate a standardized outcome measure, RSP_i, for each hospital by computing the ratio of the predicted

AMI payment to the expected AMI payment, and multiplying by the national mean payment, $\bar{y}$. Specifically, we calculate

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

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

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

Again, i indexes hospitals, j indexes patients within hospitals, and n_i is the number of patients within hospital i. If "predicted" total payment is higher (or lower) than "expected" total payment for a given hospital, then its $\widehat{RSP}_i$ will be higher (or lower) than the national mean payment. For each hospital, we can compute an interval estimate of *RSP*$_i$ to characterize the level of uncertainty around the point estimate using bootstrapping simulations. The point estimate and interval estimate can be used to characterize and compare hospital performance (e.g., higher than expected, as expected, or lower than expected). See Figure A.1 for our overall analysis steps.

Creating Interval Estimates

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

Algorithm:

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

1. Sample *I* hospitals with replacement.

2. Fit the hierarchical generalized linear model using all patients within each sampled hospital. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have *I* random effects to estimate the variance components. At the conclusion of Step 2, we have:
   a. $\hat{\beta}^{(b)}$ (estimated regression coefficients of the risk factors)

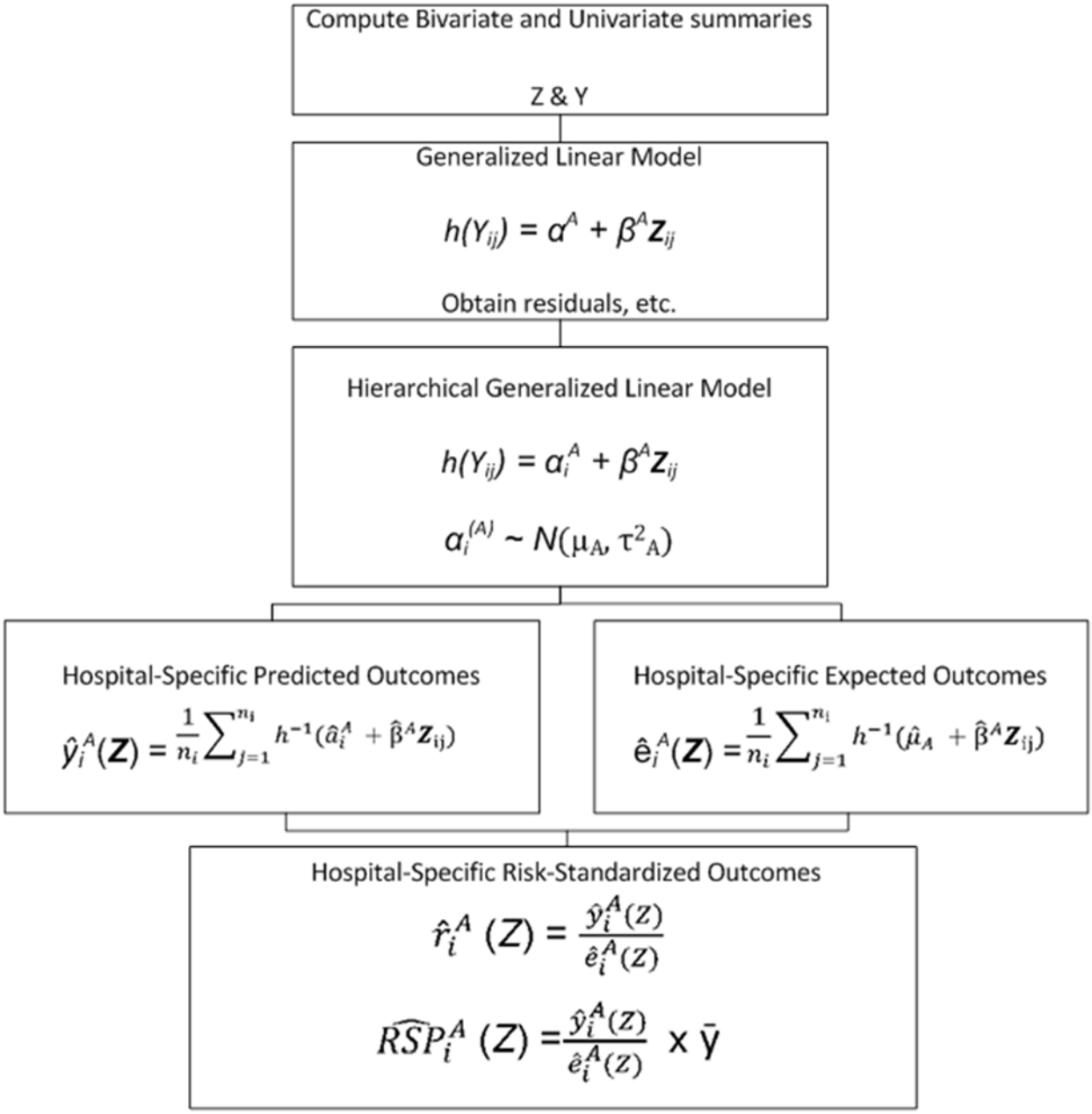
   b. The parameters governing the random effects, hospital adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$
   c. The set of hospital-specific intercepts and corresponding variances, $\{\hat{a}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1,2,\dots,I\}$

3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw $\alpha_i^{(b*)} \sim N(\hat{a}_i^{(b)}, \widehat{var}(\hat{a}_i^{(b)}))$ for the unique set of hospitals sampled in Step 1.

4. Within each unique hospital *i* sampled in Step 1, and for each patient *j* in that hospital, we calculate $\hat{y}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\widehat{RSP}_i(Z)^{(b)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\hat{\alpha}_i^{(b*)}$ is obtained from Step 3.

Ninety-five percent interval estimates (or alternative interval estimates) for the hospital-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of the B estimates (or the percentiles corresponding to the alternative desired intervals).[11]

Figure A.1 Analysis Steps



Appendix B. Annual Updates

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

2014

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

1. Updated payment calculation to include a new technology add-on payment.
   - Rationale: New technology payments are meant to ensure that Medicare beneficiaries have access to new technologies that have not been accounted for by the DRG reimbursement rate.
2. Updated payment calculation to include a blood clotting add-on payment.
   - Rationale: Blood clotting add-on payments ensure that inpatient hospitals, inpatient rehabilitation facilities, and long-term care hospitals receive additional reimbursement for blood clotting factor for patients with hemophilia.
3. Updated the payment calculation to include Winsorization of outlier payments.
   - Rationale: Winsorization eliminates extreme values at the upper end of the total payment distribution to improve model prediction and mitigate the impact of possibly erroneous claims without attempting to make corrections or excluding patients.
4. Excluded patients with a missing DRG weight during the index admission if there is there is also no payment on the claim for the provider.
   - Rationale: Without either DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive.

2013

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

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

AMI Payment Measure Specifications

Cohort

Inclusion Criteria for AMI Payment Measure

1. **Principal discharge diagnosis of AMI**
   Rationale: AMI is the condition targeted for measurement.
2. **Enrolled in Medicare FFS**
   Rationale: FFS is the traditional model for Medicare Payment. The calculation of patient-level total payment relies on FFS claims.
3. **Aged 65 or older**
   Rationale: Medicare patients younger than 65 are not included in the measure because they are considered to be clinically different from patients 65 and over as they often qualify for Medicare at a younger age because of disabilities.
4. **Not transferred from another acute care facility**
   Rationale: The acute episode is included in the measure but episode-of-care payments are assigned to the hospital where the patient was initially admitted rather than the hospital receiving the transferred patient.
5. **Enrolled in Part A and Part B Medicare for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: The 12 months prior enrollment in Part A and Part B Medicare ensures a full year of administrative data for risk adjustment. Part A is required during the index admission to ensure that no Medicare Advantage patients are included in the measures.

Exclusion Criteria for AMI Payment Measure

1. **Incomplete administrative data in the 30 days following the index admission if discharged alive**
   Rationale: This is necessary in order to identify the outcome (payments) in the sample over our analytic period.
2. **Discharged alive on the day of admission or the following day who were not transferred**
   Rationale: These patients likely did not suffer a clinically significant AMI.
3. **Inconsistent or unknown patient vital status, or other unreliable demographic data (age and gender)**
   Rationale: We exclude stays for patients that include inconsistent data (e.g., date of death precedes date of admission, age is greater than 115 or gender is discordant on the index admission claim and the denominator file).
4. **Admissions where patients are discharged against medical advice (AMA)**
   Rationale: Hospitals had limited opportunity to care for the patient.
5. **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 RSMR measure: these patients are likely continuing to seek comfort measures only, so payment may reflect patient preferences rather than hospital practice patterns.
6. **Transferred to Federal Hospitals**
   Rationale: We do not have claims data for these hospitals; therefore, including these patients would systematically underestimate payments.

7. **Could not be matched to admission in the AMI mortality measure**
   Rationale: As part of the current data processing, we match our index AMI admissions to the AMI mortality cohort to obtain the risk-adjustment variables. Patients are excluded if they cannot be matched between the AMI payment and AMI mortality cohorts.
8. **Missing index DRG weight and provider received no payment**
   Rationale: Without either DRG weight or payment data, we cannot calculate a payment for the patient's index admission; this would make the entire episode of care appear significantly less expensive

Table C.1 ICD-9-CM Codes for AMI Payment Cohort

ICD-9-CM Code	Description
410.00	AMI (anterolateral wall) – episode-of-care unspecified
410.01	AMI (anterolateral wall) – initial episode-of-care
410.10	AMI (other anterior wall) – episode-of-care unspecified
410.11	AMI (other anterior wall) – initial episode-of-care
410.20	AMI (inferolateral wall) – episode-of-care unspecified
410.21	AMI (inferolateral wall) – initial episode-of-care
410.30	AMI (inferoposterior wall) – episode-of-care unspecified
410.31	AMI (inferoposterior wall) – initial episode-of-care
410.40	AMI (other inferior wall) – episode-of-care unspecified
410.41	AMI (other inferior wall) – initial episode-of-care
410.50	AMI (other lateral wall) – episode-of-care unspecified
410.51	AMI (other lateral wall) – initial episode-of-care
410.60	AMI (true posterior wall) – episode-of-care unspecified
410.61	AMI (true posterior wall) – initial episode-of-care
410.70	AMI (subendocardial) – episode-of-care unspecified
410.71	AMI (subendocardial) – initial episode-of-care
410.80	AMI (other specified site) – episode-of-care unspecified
410.81	AMI (other specified site) – initial episode-of-care
410.90	AMI (unspecified site) – episode-of-care unspecified
410.91	AMI (unspecified site) – initial episode-of-care

Risk Adjustment

Table C.2 Risk-Adjustment Variables for AMI Payment Measure

Code	Description
	Age (65 – 74)
	Age (75 – 84)
	Age (>=85)
	History of PCI
	History of CABG

Code	Description
CC[§] 80	Congestive Heart Failure
CC 83	Angina Pectoris/Old Myocardial Infarction
CC 85	Heart Infection/Inflammation, Except Rheumatic
CC 86	Valvular and Rheumatic Heart Disease
CC 87-88	Congenital cardiac/circulatory defect
CC 89-91	Hypertension and Hypertension Complications
CC 7-8	Metastatic Cancer and Acute Leukemia and Other Major Cancers
CC 15-19, 119-120	Diabetes and Diabetes Complications
CC 21	Protein-Calorie Malnutrition
CC 22	Other Significant Endocrine and Metabolic Disorders
CC 24	Obesity/Disorders of Thyroid, Cholesterol, Lipids
CC 36	Other Gastrointestinal Disorders
CC 41	Osteoporosis and Other Bone/Cartilage Disorders
CC 47	Iron Deficiency and Other/Unspecified Anemias and Blood Disease
CC 48	Delirium and Encephalopathy
CC 49	Dementia
CC 51	Drug/Alcohol Psychosis
CC 52-53	Drug/Alcohol Abuse/Dependence
CC 54-55	Severe Mental Illness
CC 56	Reactive and Unspecified Psychosis
CC 58-59	Depression/Anxiety
CC 97	Precerebral Arterial Occlusion and Transient Cerebral Ischemia
CC 104-105	Vascular Disease and Complications
CC 115	Other Lung Disorders
CC 116	Legally Blind
CC 130	Dialysis Status
CC 160	Internal Injuries

Table C.3 Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of AMI Measure

Variable	Description
CC 2	Septicemia/Shock
CC 6	Other infectious diseases
CC 17	Diabetes with acute complications
CC 23	Disorders of fluid/electrolyte/acid-base
CC 28	Acute liver failure/disease
CC 31	Intestinal obstruction/perforation
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders

[§] CC = Condition Category, groupings of ICD-9-CM diagnosis codes developed by CMS.

Variable	Description
CC 46	Coagulation defects and other specified hematological disorders
CC 48	Delirium and encephalopathy
CC 75	Coma, brain compression/anoxic damage
CC 77	Respirator dependence/tracheostomy status
CC 78	Respiratory arrest
CC 79	Cardio-respiratory failure or shock
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Unstable angina and other acute ischemic heart disease
CC 92	Specified heart arrhythmias
CC 93	Other heart rhythm and conduction disorders
CC 94	Other and unspecified heart disesae
CC 95	Cerebral hemorrhage
CC 96	Ischemic or unspecified stroke
CC 97	Precerebral arterial occlusion and transient cerebral ischemia
CC 100	Hemiplegia/hemiparesis
CC 101	Diplegia (upper), monoplegia, and other paralytic syndromes
CC 102	Speech, language, cognitive, perceptual
CC 104	Vascular disease with complications
CC 105	Vascular disease
CC 106	Other circulatory disease
CC 111	Aspiration and specified bacterial pneumonias
CC 112	Pneumococcal pneumonia, emphysema, lung abscess
CC 114	Pleural effusion/pneumothorax
CC 129	End stage renal disease
CC 130	Dialysis status
CC 131	Renal failure
CC 132	Nephritis
CC 133	Urinary obstruction and retention
CC 135	Urinary tract infection
CC 148	Decubitus ulcer of skin
CC 152	Cellulitis, local skin infection
CC 154	Severe head injury
CC 155	Major head injury
CC 156	Concussion or unspecified head injury
CC 158	Hip fracture/dislocation
CC 159	Major fracture, except of skull, vertebrae, or hip
CC 163	Poisonings and allergic reactions
CC 164	Major complications of medical care and trauma
CC 165	Other complications of medical care

Variable	Description
CC 174	Major organ transplant status
CC 175	Other organ transplant/replacement
CC 176	Artificial openings for feeding or elimination
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb
CC 179	Post-surgical states/aftercare/elective

Outcome

1. **All Payments**
   Rationale: The specific goal of this task is to sum payments for Medicare patients including index admission as well as 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. This work will be used to better understand differences in the patterns of post-discharge care and associated payments made for Medicare patients across a continuum of care beginning with a hospitalization for AMI and following patients 30 days after hospital admission.

2. **30-day time frame**
   Rationale: First, decisions made at the admitting hospital affect not only hospitalization payments, but payments for care in the immediate post-discharge period. Second, assessing payments for a continuous episode of care may reveal practice variations in the full care of the illness that triggered an index admission. Third, a 30-day preset window provides a standard observation period by which to compare all hospitals. Lastly, when pairing payment measures with quality measures, their measurement periods should be aligned as much as possible. Most publicly reported mortality measures are reported for a 30-day period after admission.