2014 Measures Updates and Specifications Report
Hospital-Level 30-Day Risk-Standardized Mortality Measures

Acute Myocardial Infarction – Version 8.0
Heart Failure – Version 8.0
Pneumonia – Version 8.0
Chronic Obstructive Pulmonary Disease – Version 3.0
Stroke – Version 3.0

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS) condition-specific mortality measures used in the Hospital Inpatient Quality Reporting (IQR) program and publicly reported on *Hospital Compare*, the hospital-level 30-day risk-standardized mortality rates (RSMRs) following acute myocardial infarction (AMI), heart failure (HF), pneumonia, chronic obstructive pulmonary disease (COPD), and stroke. This report provides a single source of information about these measures for a wide range of readers. Reports describing readmission outcomes for these conditions, hospital-wide readmissions, and procedure-based outcome measures (hip/knee arthroplasty) can be found on *QualityNet*.

This report provides an overview of the measure methodology, methodology updates for 2014 public reporting, and the national results for 2014 public reporting. The appendices provide detailed specifications for each measure, including tables of the condition codes used for cohort derivation and risk adjustment and a history of prior annual updates.

Specifically, the report includes

- **Section 2 - An overview of the AMI, HF, pneumonia, COPD and stroke mortality measures:**
  - Background
  - Cohort inclusions and exclusions
    - included and excluded hospitalizations
    - how transferred patients are handled
  - Outcome
  - Risk-adjustment specifications
  - Data sources
  - Mortality rate calculation
  - Categorization of hospitals' performance score

- **Section 3 - 2014 measure updates:**
  - No updates were made to the specifications of the AMI, HF, pneumonia, COPD, and stroke mortality measures for 2014.

- **Section 4 - 2014 measure results**:
  - Results from the models that are used for the Hospital IQR program in 2014.

- **Section 5 - Glossary**

The Appendices contain detailed measure information, including

- Appendix A: Statistical approach to RSMR;
- Appendix B: Data quality assurance;
- Appendix C: Annual updates to measures since measure development; and
- Appendix D: Measure specifications

For additional references, the original AMI, HF, and pneumonia measure methodology reports, as well as prior updates and specifications reports (formerly called measure maintenance reports) are available on the claims-based mortality measure page of *QualityNet*:

- Risk-Adjustment Models for AMI and HF 30-Day Mortality Methodology (Version 1.0) [1]
- Risk-Adjustment Methodology for Hospital Monitoring/Surveillance and Public Reporting Supplement #1: 30-Day Mortality Model for Pneumonia (Version 1.0)[2]
- Hospital-level 30-day Mortality Following Admission for an Acute Exacerbation of Chronic Obstructive Pulmonary Disease Measure Methodology Report (Version 1.0) [3]
- 30-Day Mortality Following Acute Ischemic Stroke Hospitalization Measure Methodology Report (Version 1.0)[4]
- 2008-2013 Measure Maintenance Technical Reports: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Mortality Measures (Version 2.0-Version 7.0)[5-10]
- 2013 Measure Updates and Specifications Report: Hospital-level 30-day Mortality Following an Admission for an Acute Exacerbation of Chronic Obstructive Pulmonary Disease (Version 2.0)[11]
- 2013 Measure Updates and Specifications Report: Hospital 30-day Mortality Following an Admission for an Acute Ischemic Stroke (Version 2.0) [12]

The AMI, HF, and pneumonia mortality measure methodologies are also described in the peer-reviewed medical literature.[13-15]

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Mortality Measures

In June 2007, CMS began publicly reporting hospital 30-day RSMRs for AMI and HF for the nation's non-federal* short-term acute care and critical access hospitals, and added the pneumonia mortality measure in August 2008. In 2011, CMS and the Veterans Health Administration (VA) collaborated to update the mortality measures to include hospitalizations for patients admitted for AMI, HF, or pneumonia in VA hospitals. These three measures complement the 30-day readmission measures CMS reports for AMI, HF, and pneumonia.[16-18] The mortality measures are posted on *Hospital Compare,* and CMS updates them annually.

This year CMS plans to report two additional mortality measures, Hospital 30-Day, All-Cause, RSMR following Chronic Obstructive Pulmonary Disease Hospitalization and 30-Day, All-Cause, Risk-Standardized Mortality Rate following Acute Ischemic Stroke Hospitalization. These two measures also include admissions to non-federal acute care hospitals and critical access hospitals. However, the COPD and stroke measures do not include admissions to VA hospitals.

CMS contracted with the Yale-New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (CORE) to update the 30-day AMI, HF, pneumonia, COPD, and stroke mortality measures for 2014 public reporting through a process of measure reevaluation. Measures are reevaluated annually to improve them by responding to stakeholder input and incorporating advances in the science or changes in coding.

2.2 Overview of Measure Methodology

The 2014 risk-adjusted mortality measures use specifications from the initial measure methodology reports[1-4] with slight refinements to the measures as listed in Appendix C and described in the prior measures updates and specifications reports.[5-12] The National Quality Forum (NQF) endorses the AMI, HF, pneumonia, and COPD measures. An overview of the methodology is presented in this section.

2.2.1 Cohort

Index Admissions Included in Measures

An index admission is the hospitalization to which the mortality outcome is attributed and includes admissions for patients:

* Includes Indian Health Services hospitals.

- Having a principal discharge diagnosis of AMI, HF, pneumonia, stroke, or COPD for each respective measure[+];
- Enrolled in Medicare fee for service (FFS) or VA beneficiaries[*];
- Aged 65 or over;
- 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 the index admission. This requirement is dropped for patients with an index admission within a VA hospital.

Index Admissions Excluded from the Measures[‡]

The mortality measures exclude index admissions for patients:

- 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 (age and gender) data;
- Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission; or
- Discharged against medical advice (AMA).

For patients with more than one admission in a given year for a given condition, only one index admission for that condition is randomly selected for inclusion in the cohort.

Additionally, for index admissions that occur during the transition between measure reporting periods, June and July of each year, the measures include admissions only if they were the first to occur in the 30 days prior to a patient's death. Additional admissions in that 30-day period are excluded. This exclusion criterion is applied after one admission per patient per year is randomly selected to avoid assigning a single death to two admissions in two separate reporting periods. For example, a patient who is admitted on June 18, 2011, readmitted on July 2, 2011, and subsequently dies on July 15, 2011: if both admissions are randomly selected for inclusion (one for the July 2010-June 2011 time period and the other for the July 2011-June 2012 time period), the

[+] The COPD measure cohort also includes admissions with a principal discharge diagnosis of respiratory failure and a secondary discharge diagnosis of COPD. For specific International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort for each condition, refer to Appendix D.
[*] VA beneficiaries are not included in the COPD or stroke mortality measures.
[†] The acute episode is included in the measure, but the death is attributed to the hospital where the patient was initially admitted rather than the hospital receiving the transferred patient.
[‡] 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, and stays for patients not listed in the Medicare enrollment file as well as records for providers with invalid provider IDs.
[§] This exclusion criterion does not apply to the COPD or stroke mortality measures.

measure will exclude the July 2, 2011, admission to avoid assigning the death to two admissions.

The number 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, Figure 4.5.1, and Figure 4.6.1 for AMI, HF, pneumonia, COPD, and stroke, respectively.

Patients Transferred Between Hospitals

The measures include patients admitted to a non-federal acute care hospital or VA hospital[**] with a diagnosis of AMI, HF, pneumonia, COPD, or stroke and who are not transferred from another acute care facility (VA or non-federal). The measures consider admission to the first hospital as the start of an acute episode of care and assigns the patient's outcome to the hospital that initially admitted him/her. For patients seen in the emergency department, who are then admitted to the hospital or transferred to another hospital, the measures assign them to the hospital that initially admits them as an inpatient.

2.2.2 Outcome

All-Cause Mortality

There are a number of reasons for counting all deaths in the CMS mortality measures. First, from a patient perspective, a death from any cause is an adverse event. In addition, making inferences about quality issues and accountability based solely on the documented cause of death is difficult. For example, a patient hospitalized for HF who develops a hospital-acquired infection may ultimately die of sepsis and multi-organ failure. Considering the patient's death to be unrelated to the care the patient received for HF during the hospitalization would be inappropriate.

30-Day Time Frame

The measures assess mortality within a 30-day period from the date of the index admission. This standard time period is necessary so that the outcome for each patient is measured uniformly. The measures use a 30-day time frame because outcomes occurring within 30 days of admission can be influenced by hospital care and the early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities in an effort to reduce mortality.[19]

2.2.3 Risk-Adjustment Variables

The measures adjust for variables (i.e. age, sex, comorbid diseases, and indicators of patient frailty) that are clinically relevant and have strong relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and provider Medicare administrative claims data extending 12 months

[**] VA hospitals are not included in the COPD or stroke mortality measures.

prior to, and including, the index admission. The risk-adjustment variables for the AMI, HF, and pneumonia measures are also obtained from VA administrative data for patients with a VA index admission.

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

The measures do not adjust for the patients' admission source or their discharge disposition (e.g., skilled nursing facility) 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 measures also do not adjust for socioeconomic status (SES) because the association between SES and health outcomes can be due, in part, to differences in the quality of health care patients with varying SES received. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important quality differences. Additionally, recent analyses have shown that hospitals caring for high proportions of low SES patients perform similarly on the measures to hospitals caring for low proportions of low SES patients.[20]

Refer to Table D.1.2, Table D.2.2, Table D.3.2, Table D.4.2, and Table D.5.2 in Appendix D of this report for the list of risk-adjustment variables for AMI, HF, pneumonia, COPD, and stroke, respectively.

2.2.4 Data Sources

The data sources for these analyses are Medicare administrative claims data for all measures; VA administrative data for the AMI, HF, and pneumonia measures; and enrollment information for patients with inpatient admissions between July 1, 2010, and June 30, 2013. The datasets also contain associated inpatient, outpatient, and provider Medicare administrative claims for the 12 months prior to the index admission for patients admitted in this time period. See the original methodology reports for further descriptions of these data sources and an explanation of the three-year measurement period.[1-4]

2.2.5 Measure Calculation

The measures estimate hospital-level 30-day all-cause RSMRs for each condition using hierarchical logistic regression models (Appendix D). In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals.[21] At the patient level, it models the log-odds of mortality within 30 days of discharge using age, sex, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the

underlying risk of mortality 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 RSMR is calculated as the ratio of the number of "predicted" deaths to the number of "expected" deaths at a given hospital, multiplied by the national observed mortality rate. For each hospital, the numerator of the ratio is the number of deaths within 30 days predicted based on the hospital's performance with its observed case mix, and the denominator is the number of deaths expected based on the nation's performance with that 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 performance given its case mix to be compared to an average hospital's performance with the same case mix. Thus, a lower ratio indicates lower-than-expected mortality rates or better quality, while a higher ratio indicates higher-than-expected mortality rates or worse quality.

The "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors (Table D.1.2, Table D.2.2, Table D.3.2, Table D.4.2, and Table D.5.2 for the AMI, HF, pneumonia, COPD and stroke measures, respectively) and the hospital-specific intercept on the risk of mortality. The estimated hospital-specific intercept is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are transformed and summed over all patients attributed to the hospital to get a value. The "expected" number of deaths (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 transformed and 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.

This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed mortality rate. The hierarchical logistic regression models are described fully in Appendix A and in the original methodology reports. [1-4]

2.2.6 Categorizing Hospital Performance

To categorize hospital performance, CMS estimates each hospital's RSMR and the corresponding 95% interval estimate. CMS assigns hospitals to a performance category by comparing each hospital's RSMR interval estimate to the national observed mortality rate. Comparative performance for hospitals with 25 or more eligible cases is classified as follows:

- "No different than U.S. national rate" if the 95% interval estimate surrounding the hospital's rate includes the national observed mortality rate.
- "Worse than U.S. national rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed mortality rate.
- "Better than U.S. national rate" if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed mortality rate.

If a hospital has fewer than 25 eligible cases for a measure, 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 mortality rates and interval estimates will not be publicly reported for the measure.

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

3. UPDATES TO MEASURES FOR 2014 PUBLIC REPORTING

3.1 Rationale for Measure Updates

Measure reevaluation ensures that the risk-standardized mortality models are continually assessed and remain valid given possible changes in the data over time and allows for model refinements. As this report describes, for 2014 public reporting, we undertook the following measures reevaluation activities[††]:

- Validated the performance of each condition-specific model and its corresponding risk-adjustment variables in three recent one-year periods (July 2010-June 2011, July 2011-June 2012, and July 2012-June 2013);
- Evaluated and validated model performance for the three years combined (July 2010-June 2013); and
- Updated the measures SAS analytic package and documentation.

3.2 Changes to SAS Analytic Package (SAS Pack)

We made minor refinements to the measure calculation SAS analytic package. The new SAS analytic packages and documentation are available upon request by emailing cmsmortalitymeasures@yale.edu. **Do *NOT* submit patient-identifiable information (e.g., date of birth, Social Security number, health insurance claim number, etc.) to this address.**

[††] The Condition Category Groups (CC) of ICD-9-CM codes were not updated this year due to the upcoming transition to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).

4. RESULTS FOR 2014 PUBLIC REPORTING

4.1 Assessment of Updated Models

The mortality measures estimate hospital-specific 30-day all-cause RSMRs using hierarchical logistic regression models. Section 2 of this report summarizes the measure methodology and model risk-adjustment variables. Refer to prior technical reports for further details.[1]

We evaluated the performance of the models and provide national results using the July 2010-June 2013 data for 2014 reporting, and fit the updated models to three single-year time periods (July 2010-June 2011, July 2011-June 2012, and July 2012-June 2013) and to the combined three-year dataset (July 2010-June 2013). We examined differences in the frequency of patient risk factors and the model variable coefficients and compared the model performance among these datasets.

For each of the five conditions, we assessed logistic regression model performance in terms of discriminant ability for each year of data and for the three-year combined period. We computed two summary statistics to assess model performance: the predictive ability and the area under the receiver operating characteristic (ROC) curve (c-statistic). The c-statistic is an indicator of the model's discriminant ability or ability to correctly classify those who have and have not died within 30 days of admission. Potential values range from 0.5, meaning no better than chance, to 1.0, meaning perfect discrimination.

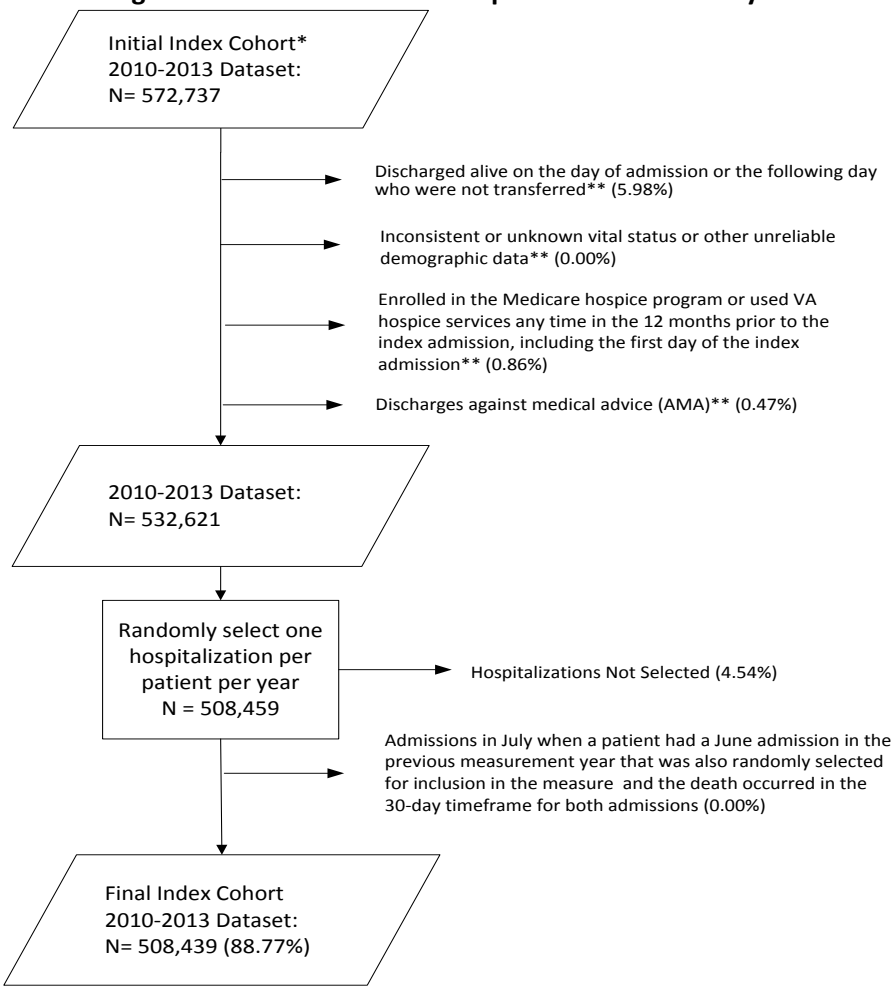
The results of these analyses for each of the five measures (AMI, HF, pneumonia, COPD, and stroke) are presented in Sections 4.2, 4.3, 4.4, 4.5, and 4.6, respectively.

4.2 AMI Mortality 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 in the July 2010-June 2013 Dataset



*The initial index cohort includes patients who meet the following inclusion criteria:
- -Having a principal discharge diagnosis of AMI;
- -Enrolled in Medicare Fee-For-Service (FFS) or VA beneficiaries;
- -Aged 65 years or over;
- -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 the index admission. This requirement is dropped for patients with an index admission within a VA hospital.

** These categories are not mutually exclusive

4.2.2 Frequency of AMI Model Variables

We examined the change in both observed mortality rates and frequency of clinical and demographic variables (Table 4.2.1). Between July 2010-June 2011 and July 2012-June 2013, the observed mortality rate decreased from 15.4% to 14.6%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service (FFS) population, but is also due, in part, to increased coding opportunities on administrative claims. In the 2012 update to the measures, we increased the number of diagnosis and procedure codes to align with version 5010 format changes Department of Health and Human Services (HHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals submitted more codes, which translated into increased frequencies for some model variables. Some notable changes include an increase from 11.9% to 16.8% for history of PTCA, from 8.9% to 12.3% for history of CABG, from 80.9% to 84.7% for coronary atherosclerosis or angina, from 28.8% to 31.7% for valvular or rheumatic heart disease, from 86.7% to 89.3% for hypertension, from 24.6% to 26.8% for renal failure, and from 45.1% to 47.0% for diabetes mellitus (DM) or DM complications except proliferative retinopathy.

4.2.3 AMI Model Parameters and Performance

Table 4.2.2 shows model variable coefficients by individual year and for the combined three-year dataset. Table 4.2.3 shows the risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the AMI mortality 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-years; the area under the ROC curve (c-statistic) remained constant at 0.72 (Table 4.2.4).

4.2.4 Distribution of Hospital Volumes and RSMRs for AMI

Table 4.2.5 shows the distribution of hospital admission volumes and Table 4.2.6 shows the distribution of hospital RSMRs. The mean RSMR decreased over the three years, from 15.2% between July 2010 and June 2011 to 14.4% between July 2012 and June 2013. The median hospital RSMR in the combined three-year dataset was 14.5% (IQR 13.6% - 15.5%). 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 0.039 (SE: 0.003). 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 RSMRs for the combined dataset. The odds of all-cause mortality were 1.48 times higher if treated at a hospital one standard deviation above the national rate as compared with the odds of all-cause mortality if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.[21]

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

Of 4,529 hospitals in the study cohort, 58 performed "better than the U.S. national rate," 2,543 performed "no different from the U.S. national rate," and 18 performed "worse than the U.S. national rate." 1,910 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 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	171,698	167,255	169,506	508,439
Observed mortality rate	15.4	14.8	14.6	14.9
Mean age (SD)	79.3 (8.3)	79.1 (8.3)	79.0 (8.4)	79.1 (8.4)
Male	50.9	51.7	52.2	51.6
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	11.9	15.9	16.8	14.8
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	8.9	11.8	12.3	11.0
Congestive heart failure (CC 80)	31.2	31.0	30.3	30.8
Acute myocardial infarction (CC 81)	14.0	13.7	13.4	13.7
Other acute/subacute forms of ischemic heart disease (CC 82)	13.2	13.5	13.2	13.3
Anterior myocardial infarction (ICD-9 codes 410.00-410.19)	8.6	8.3	8.0	8.3
Other location of myocardial infarction (ICD-9 codes 410.20-410.69)	12.3	12.2	11.9	12.2
Coronary atherosclerosis or angina (CC 83, 84)	80.9	84.5	84.7	83.4
Cardio-respiratory failure or shock (CC 79)	9.9	10.4	10.5	10.3
Valvular or rheumatic heart disease (CC 86)	28.8	31.6	31.7	30.7
Hypertension (CC 89, 91)	86.7	88.9	89.3	88.3
Stroke (CC 95-96)	7.8	7.6	7.4	7.6
Cerebrovascular disease (CC 97-99, 103)	20.4	21.0	20.8	20.7
Renal failure (CC 131)	24.6	26.3	26.8	25.9
Chronic obstructive pulmonary disease (COPD) (CC 108)	29.7	31.0	30.8	30.5
Pneumonia (CC 111-113)	24.1	23.7	23.6	23.8
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	45.1	46.5	47.0	46.2
Protein-calorie malnutrition (CC 21)	6.2	6.6	6.6	6.5
Dementia or other specified brain disorders (CC 49, 50)	19.7	20.8	20.6	20.4
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	6.2	6.5	6.6	6.4
Vascular disease and complications (CC 104, 105)	26.8	27.8	27.6	27.4
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	3.8	4.0	3.9	3.9
Trauma in last year (CC 154-156, 158-162)	31.2	31.8	31.6	31.5
Major psychiatric disorders (CC 54-56)	7.6	8.2	8.1	8.0
Chronic liver disease (CC 25-27)	1.2	1.4	1.5	1.4

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

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	-2.567	-2.738	-2.724	-2.659
Age-65	0.055	0.059	0.057	0.057
Male	0.144	0.151	0.138	0.146
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	-0.314	-0.291	-0.289	-0.299
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	0.004	0.052	0.140	0.066
Congestive heart failure (CC 80)	0.325	0.290	0.285	0.301
Acute myocardial infarction (CC 81)	-0.023	-0.026	-0.014	-0.023
Other acute/subacute forms of ischemic heart disease (CC 82)	-0.038	-0.074	-0.074	-0.060
Anterior myocardial infarction (ICD-9 codes 410.00-410.19)	0.690	0.782	0.783	0.751
Other location of myocardial infarction (ICD-9 codes 410.20-410.69)	0.432	0.507	0.493	0.476
Coronary atherosclerosis or angina (CC 83, 84)	-0.551	-0.511	-0.517	-0.524
Cardio-respiratory failure or shock (CC 79)	0.208	0.176	0.115	0.165
Valvular or rheumatic heart disease (CC 86)	0.019	0.095	0.055	0.058
Hypertension (CC 89, 91)	-0.380	-0.344	-0.319	-0.352
Stroke (CC 95-96)	0.066	0.003	0.042	0.039
Cerebrovascular disease (CC 97-99, 103)	-0.059	-0.035	-0.058	-0.051
Renal failure (CC 131)	0.238	0.173	0.186	0.199
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.050	0.120	0.135	0.098
Pneumonia (CC 111-113)	0.402	0.427	0.422	0.417
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	0.104	0.096	0.098	0.100
Protein-calorie malnutrition (CC 21)	0.515	0.500	0.475	0.498
Dementia or other specified brain disorders (CC 49, 50)	0.360	0.354	0.394	0.367
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	0.223	0.211	0.212	0.213
Vascular disease and complications (CC 104, 105)	0.107	0.091	0.077	0.094
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	0.625	0.704	0.708	0.682
Trauma in last year (CC 154-156, 158-162)	-0.002	-0.033	0.012	-0.007
Major psychiatric disorders (CC 54-56)	0.122	0.087	0.054	0.089
Chronic liver disease (CC 25-27)	0.495	0.411	0.443	0.447

Table 4.2.3 – Adjusted OR and 95% CIs for the AMI Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Age-65	1.06 (1.05 - 1.06)	1.06 (1.06 - 1.06)	1.06 (1.06 - 1.06)	1.06 (1.06 - 1.06)
Male	1.16 (1.12 - 1.19)	1.16 (1.13 - 1.20)	1.15 (1.12 - 1.18)	1.16 (1.14 - 1.18)
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	0.73 (0.69 - 0.77)	0.75 (0.72 - 0.78)	0.75 (0.72 - 0.78)	0.74 (0.72 - 0.76)
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	1.00 (0.95 - 1.06)	1.05 (1.01 - 1.10)	1.15 (1.10 - 1.20)	1.07 (1.04 - 1.10)
Congestive heart failure (CC 80)	1.38 (1.34 - 1.43)	1.34 (1.29 - 1.38)	1.33 (1.28 - 1.38)	1.35 (1.32 - 1.38)

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Acute myocardial infarction (CC 81)	0.98 (0.94 - 1.02)	0.97 (0.93 - 1.02)	0.99 (0.94 - 1.03)	0.98 (0.95 - 1.00)
Other acute/subacute forms of ischemic heart disease (CC 82)	0.96 (0.92 - 1.01)	0.93 (0.89 - 0.97)	0.93 (0.89 - 0.97)	0.94 (0.92 - 0.97)
Anterior myocardial infarction (ICD-9 codes 410.00-410.19)	1.99 (1.91 - 2.09)	2.19 (2.09 - 2.29)	2.19 (2.08 - 2.29)	2.12 (2.06 - 2.18)
Other location of myocardial infarction (ICD-9 codes 410.20-410.69)	1.54 (1.48 - 1.61)	1.66 (1.59 - 1.74)	1.64 (1.57 - 1.71)	1.61 (1.57 - 1.65)
Coronary atherosclerosis or angina (CC 83, 84)	0.58 (0.56 - 0.60)	0.60 (0.58 - 0.62)	0.60 (0.58 - 0.62)	0.59 (0.58 - 0.60)
Cardio-respiratory failure or shock (CC 79)	1.23 (1.18 - 1.29)	1.19 (1.14 - 1.25)	1.12 (1.07 - 1.17)	1.18 (1.15 - 1.21)
Valvular or rheumatic heart disease (CC 86)	1.02 (0.99 - 1.05)	1.10 (1.07 - 1.13)	1.06 (1.02 - 1.09)	1.06 (1.04 - 1.08)
Hypertension (CC 89, 91)	0.68 (0.66 - 0.71)	0.71 (0.68 - 0.74)	0.73 (0.70 - 0.76)	0.70 (0.69 - 0.72)
Stroke (CC 95-96)	1.07 (1.02 - 1.12)	1.00 (0.95 - 1.06)	1.04 (0.99 - 1.10)	1.04 (1.01 - 1.07)
Cerebrovascular disease (CC 97-99, 103)	0.94 (0.91 - 0.98)	0.97 (0.93 - 1.00)	0.94 (0.91 - 0.98)	0.95 (0.93 - 0.97)
Renal failure (CC 131)	1.27 (1.23 - 1.31)	1.19 (1.15 - 1.23)	1.20 (1.16 - 1.25)	1.22 (1.20 - 1.24)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.05 (1.02 - 1.08)	1.13 (1.09 - 1.16)	1.14 (1.11 - 1.18)	1.10 (1.08 - 1.12)
Pneumonia (CC 111-113)	1.49 (1.45 - 1.54)	1.53 (1.48 - 1.58)	1.53 (1.48 - 1.58)	1.52 (1.49 - 1.55)
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	1.11 (1.08 - 1.14)	1.10 (1.07 - 1.13)	1.10 (1.07 - 1.14)	1.11 (1.09 - 1.12)
Protein-calorie malnutrition (CC 21)	1.67 (1.60 - 1.75)	1.65 (1.57 - 1.73)	1.61 (1.53 - 1.69)	1.65 (1.60 - 1.69)
Dementia or other specified brain disorders (CC 49, 50)	1.43 (1.39 - 1.48)	1.42 (1.38 - 1.47)	1.48 (1.43 - 1.53)	1.44 (1.42 - 1.47)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	1.25 (1.18 - 1.32)	1.23 (1.17 - 1.30)	1.24 (1.17 - 1.30)	1.24 (1.20 - 1.28)
Vascular disease and complications (CC 104, 105)	1.11 (1.08 - 1.15)	1.09 (1.06 - 1.13)	1.08 (1.05 - 1.12)	1.10 (1.08 - 1.12)
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	1.87 (1.76 - 1.98)	2.02 (1.91 - 2.14)	2.03 (1.91 - 2.15)	1.98 (1.91 - 2.05)
Trauma in last year (CC 154-156, 158-162)	1.00 (0.97 - 1.03)	0.97 (0.94 - 1.00)	1.01 (0.98 - 1.04)	0.99 (0.98 - 1.01)
Major psychiatric disorders (CC 54-56)	1.13 (1.08 - 1.18)	1.09 (1.04 - 1.14)	1.06 (1.01 - 1.11)	1.09 (1.06 - 1.12)
Chronic liver disease (CC 25-27)	1.64 (1.48 - 1.82)	1.51 (1.36 - 1.67)	1.56 (1.41 - 1.72)	1.56 (1.47 - 1.66)

Table 4.2.4 – AMI Generalized Linear Modeling (Logistic Regression) 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)	3.2 - 36.9	3.1 - 36.3	2.9 - 35.4	3.1 - 36.1
c-statistic	0.72	0.72	0.72	0.72

Table 4.2.5 – Distribution of Hospital AMI 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	4,242	4,169	4,098	4,529
Mean number of admissions (SD)	40.5 (55.0)	40.1 (54.4)	41.4 (56.0)	112.3 (160.6)
Range (min. – max.)	1 - 538	1 - 457	1 - 510	1 - 1470
25th percentile	4	4	4	9
50th percentile	17	17	18	40
75th percentile	57	57	59	159

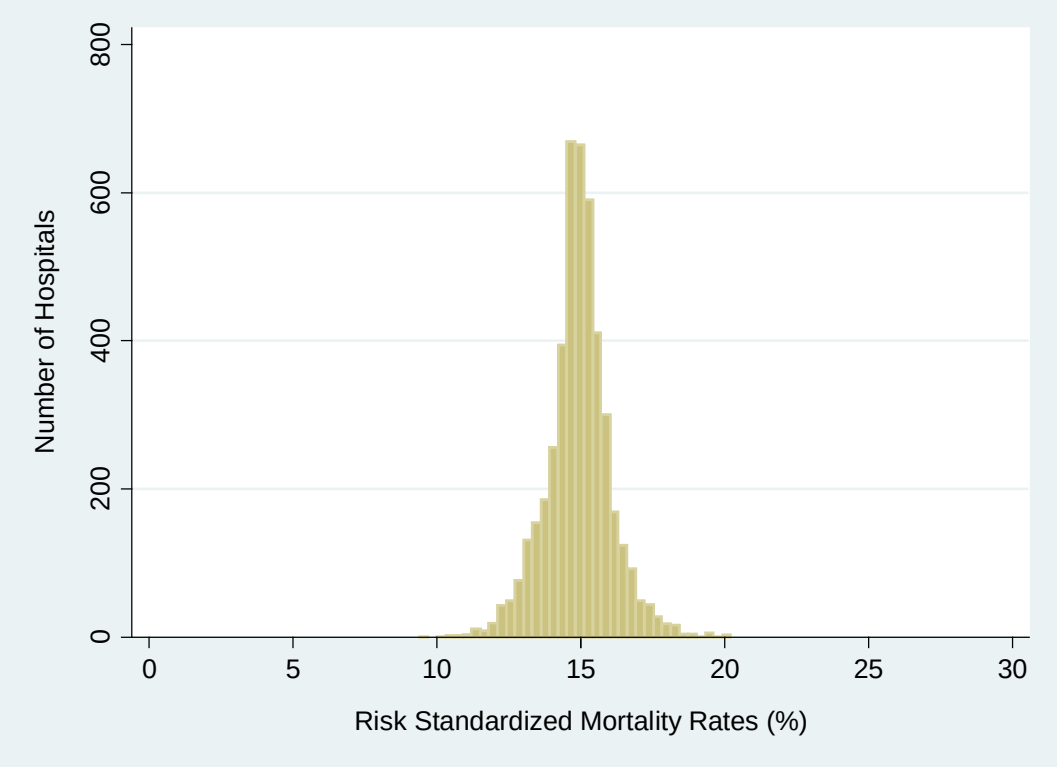
Table 4.2.6 – Distribution of Hospital AMI RSMRs over Different Time Periods (%)

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of hospitals	4,242	4,169	4,098	4,529
Mean (SD)	15.2 (1.1)	14.6 (1.2)	14.4 (1.3)	14.6 (1.4)
Range (min. – max.)	12.2 - 18.8	10.9 - 20.2	10.6 - 20.1	9.4 - 20.2
25th percentile	14.5	13.9	13.6	13.6
50th percentile	15.2	14.6	14.4	14.5
75th percentile	15.9	15.4	15.1	15.5

Table 4.2.7 – Between Hospital Variance for AMI

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between hospital variance (SE)	0.033 (0.005)	0.041 (0.005)	0.042 (0.005)	0.039 (0.003)

Figure 4.2.2 – Distribution of Hospital 30-Day AMI RSMRs between July 2010 and June 2013



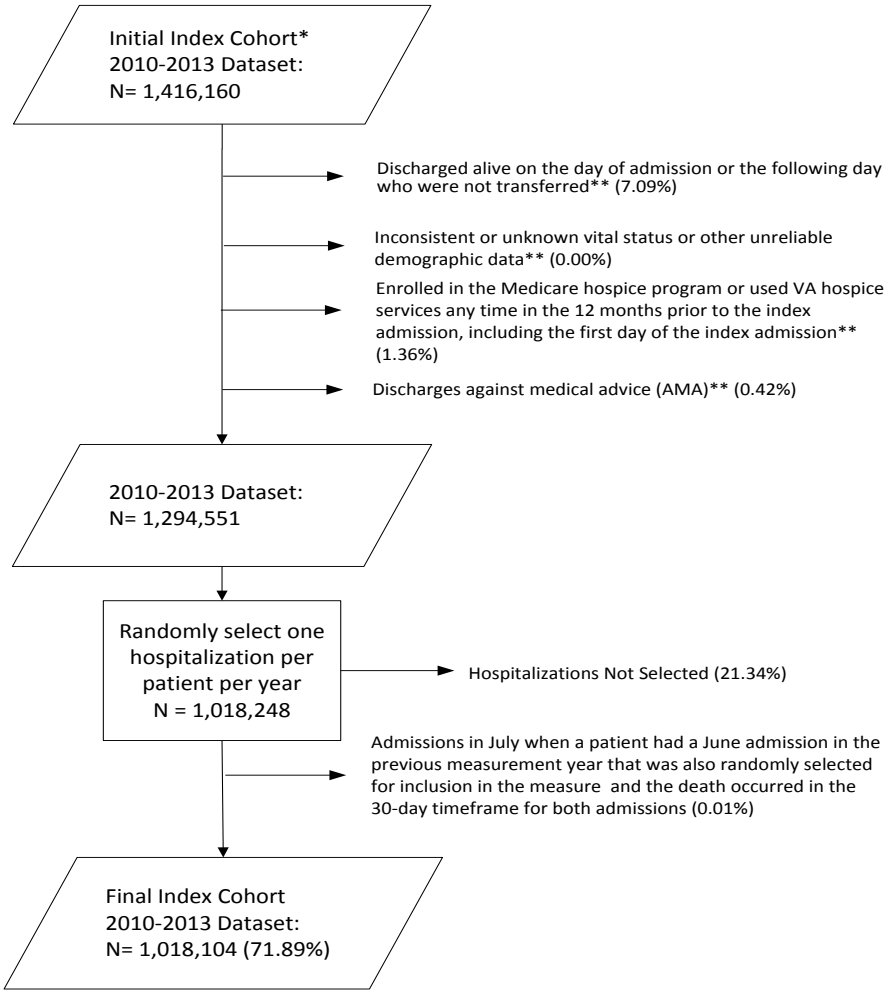
N= 4,529 hospitals

4.3 HF Mortality 2014 Model Results

4.3.1 Index Cohort Exclusions

The exclusion criteria for the measures are presented in Section 2.2.1. The percentage of HF patients meeting each exclusion criterion in the July 2010-June 2013 dataset is presented in Figure 4.3.1.

Figure 4.3.1 – Index Cohort Sample for HF in the July 2010-June 2013 Dataset



*The initial index cohort includes patients who meet the following inclusion criteria:
-Having a principal discharge diagnosis of HF;
-Enrolled in Medicare Fee-For-Service (FFS) or VA beneficiaries;
-Aged 65 years or over;
-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 the index admission. This requirement is dropped for patients with an index admission within a VA hospital.

** These categories are not mutually exclusive

4.3.2 Frequency of HF Model Variables

We examined the change in both observed mortality rates and frequency of clinical and demographic variables (Table 4.3.1). Between July 2010-June 2011 and July 2012-June 2013, the observed mortality rate increased from 11.9% to 12.1%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service (FFS) population, but is also due, in part, to increased coding opportunities on administrative claims. In the 2012 update to the measures, we increased the number of diagnosis and procedure codes to align with version 5010 format changes Department of Health and Human Services (HHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals submitted more codes, which translated into increased frequencies for some model variables. Some notable changes include an increase from 9.4% to 13.3% for history of PTCA, from 13.9% to 19.0% for history of CABG, from 23.8% to 26.6% for cardio-respiratory failure or shock, from 48.5% to 53.0% for valvular or rheumatic heart disease, from 91.5% to 93.4% for hypertension, from 46.1% to 49.9% for renal failure, from 47.1% to 48.7% for chronic obstructive pulmonary disease, from 23.5% to 25.1% for dementia or other specified brain disorders, from 7.9% to 8.7% for hemiplegia, paraplegia, paralysis, functional disability, and from 36.4% to 38.4% for vascular disease and complications.

4.3.3 HF Model Parameters and Performance

Table 4.3.2 shows model variable coefficients by individual year and for the combined three-year dataset. Table 4.3.3 shows the risk-adjusted ORs and 95% CIs for the HF mortality 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 years; the area under the ROC curve (c-statistic) remained constant at 0.68 (Table 4.3.4).

4.3.4 Distribution of Hospital Volumes and RSMRs for HF

Table 4.3.5 shows the distribution of hospital admission volumes and Table 4.3.6 shows the distribution of hospital RSMRs. The mean RSMR increased over the three years, from 11.8% between July 2010 and June 2011 to 12.0% between July 2012 and June 2013. The median hospital RSMR in the combined three-year dataset was 11.6% (IQR 10.6% - 12.6%). Table 4.3.7 shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.051 (SE: 0.002). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

Figure 4.3.2 shows the overall distribution of the hospital RSMRs for the combined dataset. The odds of all-cause mortality were 1.57 times higher if treated at a hospital one standard deviation above the national rate as compared with the odds of all-cause mortality if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.[21]

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

Of 4,781 hospitals in the study cohort, 170 performed "better than the U.S. national rate," 3,707 performed "no different from the U.S. national rate," and 103 performed "worse than the U.S. national rate." 801 were classified as "number of cases too small" (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.3.1 – Frequency of HF 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	352,233	333,648	332,367	1,018,104
Observed mortality rate	11.9	11.8	12.1	11.9
Mean age (SD)	81.2 (8.2)	81.2 (8.2)	81.2 (8.3)	81.2 (8.3)
Male	45.0	45.5	46.3	45.6
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	9.4	12.7	13.3	11.8
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	13.9	18.8	19.0	17.2
Congestive heart failure (CC 80)	74.5	74.9	74.0	74.5
Acute myocardial infarction (CC 81)	9.7	9.7	9.7	9.7
Other acute/subacute forms of ischemic heart disease (CC 82)	12.2	12.2	12.2	12.2
Coronary atherosclerosis or angina (CC 83, 84)	71.5	73.5	72.7	72.6
Cardio-respiratory failure or shock (CC 79)	23.8	25.6	26.6	25.3
Valvular or rheumatic heart disease (CC 86)	48.5	52.6	53.0	51.3
Hypertension (CC 89, 91)	91.5	93.3	93.4	92.8
Stroke (CC 95, 96)	9.8	9.7	9.4	9.7
Renal failure (CC 131)	46.1	49.1	49.9	48.3
Chronic obstructive pulmonary disease (COPD) (CC 108)	47.1	48.7	48.7	48.2
Pneumonia (CC 111-113)	44.4	44.9	45.4	44.9
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	52.5	53.9	53.7	53.3
Protein-calorie malnutrition (CC 21)	9.4	10.3	10.4	10.0
Dementia or other specified brain disorders (CC 49, 50)	23.5	25.5	25.1	24.7
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	7.9	8.7	8.7	8.4
Vascular disease and complications (CC 104, 105)	36.4	38.6	38.4	37.8
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	4.3	4.4	4.5	4.4
Trauma in last year (CC 154-156, 158-162)	39.5	40.4	40.4	40.1
Major psychiatric disorders (CC 54-56)	10.2	10.9	10.8	10.6
Chronic liver disease (CC 25-27)	2.5	3.0	3.2	2.9

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

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	-3.347	-3.389	-3.303	-3.347
Age-65	0.052	0.052	0.052	0.052
Male	0.272	0.279	0.247	0.267

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	-0.300	-0.323	-0.271	-0.298
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	-0.230	-0.151	-0.105	-0.158
Congestive heart failure (CC 80)	0.228	0.224	0.175	0.209
Acute myocardial infarction (CC 81)	0.261	0.206	0.256	0.240
Other acute/subacute forms of ischemic heart disease (CC 82)	-0.049	-0.032	-0.048	-0.039
Coronary atherosclerosis or angina (CC 83, 84)	-0.091	-0.038	-0.047	-0.056
Cardio-respiratory failure or shock (CC 79)	0.144	0.160	0.168	0.155
Valvular or rheumatic heart disease (CC 86)	0.018	0.072	0.063	0.050
Hypertension (CC 89, 91)	-0.388	-0.406	-0.421	-0.402
Stroke (CC 95, 96)	-0.025	-0.022	-0.047	-0.028
Renal failure (CC 131)	0.244	0.187	0.191	0.211
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.071	0.046	0.081	0.067
Pneumonia (CC 111-113)	0.320	0.294	0.266	0.294
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	-0.036	-0.017	-0.024	-0.023
Protein-calorie malnutrition (CC 21)	0.662	0.665	0.649	0.667
Dementia or other specified brain disorders (CC 49, 50)	0.283	0.297	0.315	0.300
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	0.081	0.100	0.090	0.092
Vascular disease and complications (CC 104, 105)	0.004	-0.001	0.016	0.012
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	0.604	0.579	0.550	0.582
Trauma in last year (CC 154-156, 158-162)	0.088	0.081	0.094	0.086
Major psychiatric disorders (CC 54-56)	0.107	0.115	0.111	0.112
Chronic liver disease (CC 25-27)	0.426	0.412	0.417	0.427

Table 4.3.3 – Adjusted OR and 95% CIs for the HF Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Age-65	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.06)	1.05 (1.05 - 1.05)	1.05 (1.05 - 1.05)
Male	1.31 (1.28 - 1.34)	1.32 (1.29 - 1.35)	1.28 (1.25 - 1.31)	1.31 (1.29 - 1.32)
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	0.74 (0.71 - 0.77)	0.72 (0.70 - 0.75)	0.76 (0.74 - 0.79)	0.74 (0.73 - 0.76)
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	0.79 (0.77 - 0.82)	0.86 (0.83 - 0.89)	0.90 (0.87 - 0.93)	0.85 (0.84 - 0.87)
Congestive heart failure (CC 80)	1.26 (1.22 - 1.29)	1.25 (1.21 - 1.29)	1.19 (1.16 - 1.23)	1.23 (1.21 - 1.25)
Acute myocardial infarction (CC 81)	1.30 (1.25 - 1.35)	1.23 (1.18 - 1.28)	1.29 (1.24 - 1.34)	1.27 (1.24 - 1.30)
Other acute/subacute forms of ischemic heart disease (CC 82)	0.95 (0.92 - 0.99)	0.97 (0.93 - 1.01)	0.95 (0.92 - 0.99)	0.96 (0.94 - 0.98)
Coronary atherosclerosis or angina (CC 83, 84)	0.91 (0.89 - 0.94)	0.96 (0.94 - 0.99)	0.95 (0.93 - 0.98)	0.95 (0.93 - 0.96)
Cardio-respiratory failure or shock (CC 79)	1.15 (1.13 - 1.18)	1.17 (1.14 - 1.21)	1.18 (1.15 - 1.21)	1.17 (1.15 - 1.19)
Valvular or rheumatic heart disease (CC 86)	1.02 (1.00 - 1.04)	1.07 (1.05 - 1.10)	1.06 (1.04 - 1.09)	1.05 (1.04 - 1.07)
Hypertension (CC 89, 91)	0.68 (0.65 - 0.70)	0.67 (0.64 - 0.69)	0.66 (0.63 - 0.68)	0.67 (0.65 - 0.68)
Stroke (CC 95, 96)	0.98 (0.94 - 1.01)	0.98 (0.94 - 1.01)	0.95 (0.92 - 0.99)	0.97 (0.95 - 0.99)

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Renal failure (CC 131)	1.28 (1.25 - 1.31)	1.21 (1.18 - 1.24)	1.21 (1.18 - 1.24)	1.23 (1.22 - 1.25)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.07 (1.05 - 1.10)	1.05 (1.02 - 1.07)	1.08 (1.06 - 1.11)	1.07 (1.05 - 1.08)
Pneumonia (CC 111-113)	1.38 (1.35 - 1.41)	1.34 (1.31 - 1.37)	1.30 (1.27 - 1.34)	1.34 (1.32 - 1.36)
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120)	0.96 (0.94 - 0.99)	0.98 (0.96 - 1.01)	0.98 (0.95 - 1.00)	0.98 (0.96 - 0.99)
Protein-calorie malnutrition (CC 21)	1.94 (1.88 - 2.00)	1.94 (1.89 - 2.00)	1.91 (1.86 - 1.97)	1.95 (1.91 - 1.98)
Dementia or other specified brain disorders (CC 49, 50)	1.33 (1.30 - 1.36)	1.35 (1.31 - 1.38)	1.37 (1.34 - 1.40)	1.35 (1.33 - 1.37)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	1.08 (1.04 - 1.13)	1.11 (1.06 - 1.15)	1.09 (1.05 - 1.14)	1.10 (1.07 - 1.12)
Vascular disease and complications (CC 104, 105)	1.00 (0.98 - 1.03)	1.00 (0.98 - 1.02)	1.02 (0.99 - 1.04)	1.01 (1.00 - 1.03)
Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8)	1.83 (1.75 - 1.91)	1.78 (1.71 - 1.87)	1.73 (1.66 - 1.81)	1.79 (1.74 - 1.84)
Trauma in last year (CC 154-156, 158-162)	1.09 (1.07 - 1.12)	1.08 (1.06 - 1.11)	1.10 (1.07 - 1.12)	1.09 (1.08 - 1.10)
Major psychiatric disorders (CC 54-56)	1.11 (1.08 - 1.15)	1.12 (1.09 - 1.16)	1.12 (1.08 - 1.16)	1.12 (1.10 - 1.14)
Chronic liver disease (CC 25-27)	1.53 (1.44 - 1.63)	1.51 (1.43 - 1.60)	1.52 (1.44 - 1.60)	1.53 (1.48 - 1.58)

Table 4.3.4 – HF Generalized Linear Modeling (Logistic Regression) 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)	3.1 - 26.5	3.1 - 26.1	3.3 - 26.2	3.2 - 26.2
c-statistic	0.68	0.68	0.68	0.68

Table 4.3.5 – Distribution of Hospital HF 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	4,675	4,670	4,645	4,781
Mean number of admissions (SD)	75.3 (89.4)	71.4 (85.8)	71.6 (86.6)	212.9 (258.8)
Range (min. – max.)	1 - 1008	1 - 950	1 - 962	1 - 2919
25th percentile	15	13	13	39
50th percentile	41	38	38	111
75th percentile	106	100	102	301

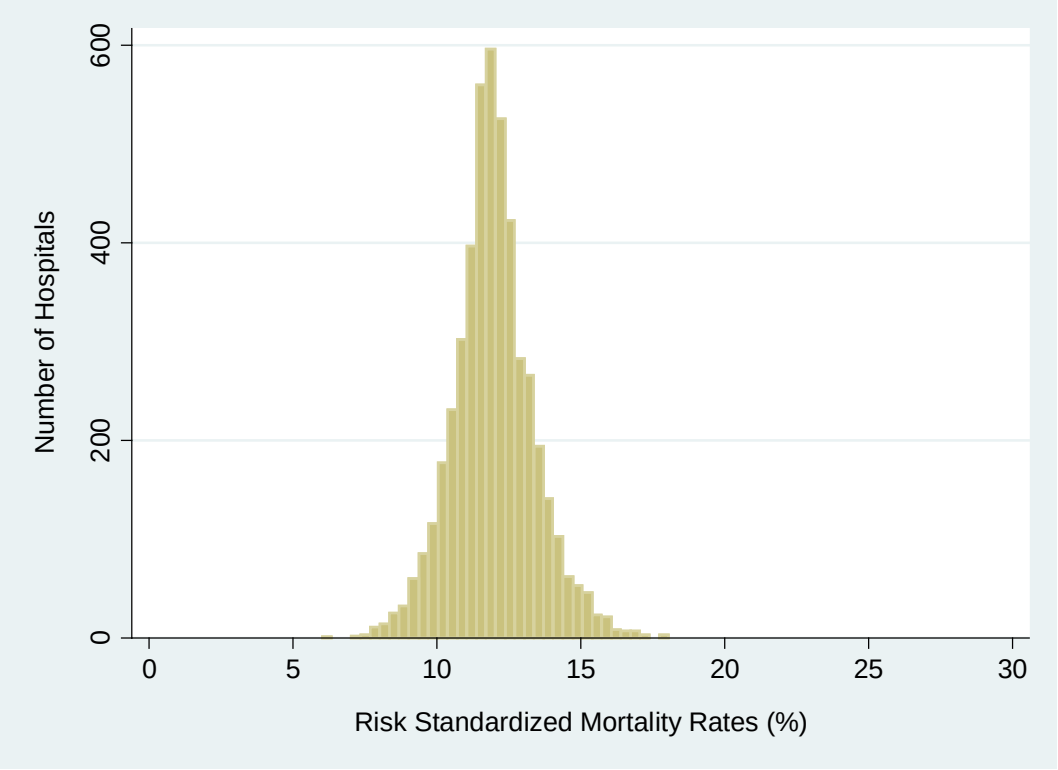
Table 4.3.6 – Distribution of Hospital HF RSMRs over Different Time Periods

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of hospitals	4,675	4,670	4,645	4,781
Mean (SD)	11.8 (1.2)	11.6 (1.3)	12.0 (1.2)	11.7 (1.6)
Range (min. – max.)	7.8 - 16.9	7.6 - 16.8	8.3 - 17.1	6.0 - 18.1
25th percentile	11.0	10.8	11.2	10.6
50th percentile	11.7	11.6	11.9	11.6
75th percentile	12.5	12.4	12.7	12.6

Table 4.3.7 – Between Hospital Variance for HF

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between hospital variance (SE)	0.044 (0.004)	0.051 (0.004)	0.041 (0.004)	0.051 (0.002)

Figure 4.3.2 – Distribution of Hospital 30-Day HF RSMRs between July 2010 and June 2013



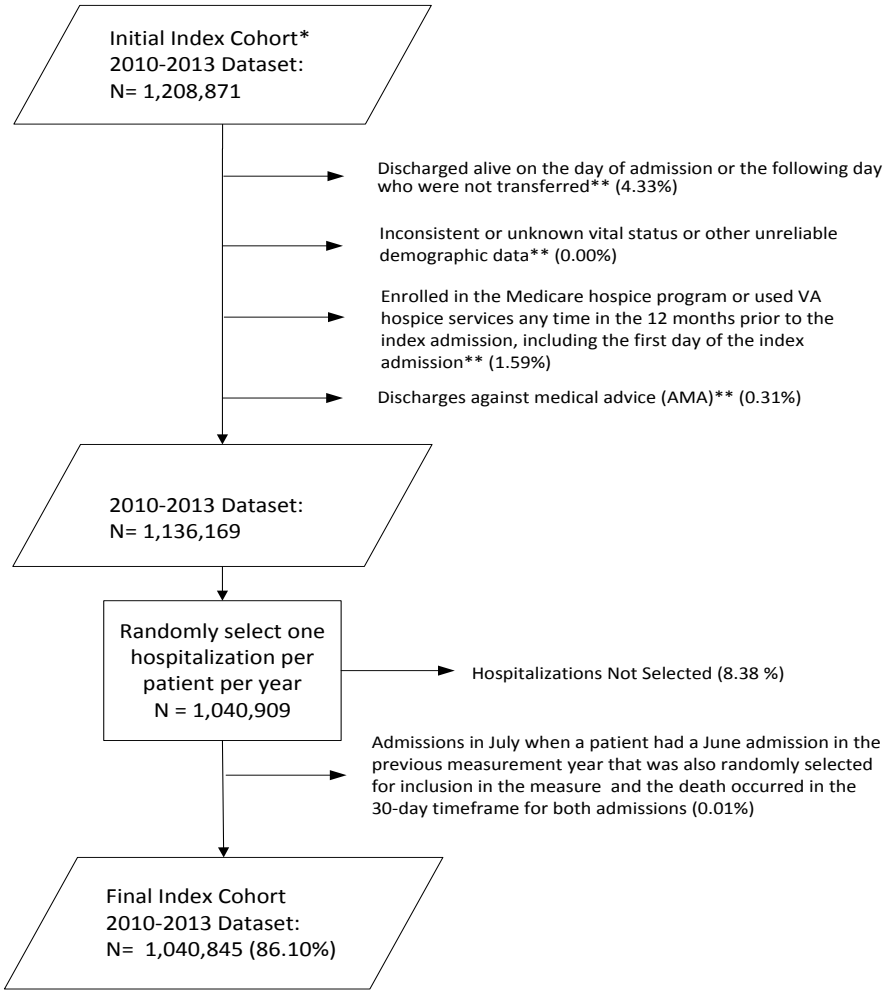
N= 4,781 hospitals

4.4 Pneumonia Mortality 2014 Model Results

4.4.1 Index Cohort Exclusions

The exclusion criteria for the measures are presented in Section 2.2.1. The percentage of pneumonia patients meeting each exclusion criterion in the July 2010-June 2013 dataset is presented in Figure 4.4.1.

Figure 4.4.1 – Index Cohort Sample for Pneumonia in the July 2010-June 2013 Dataset



*The initial index cohort includes patients who meet the following inclusion criteria:
- -Having a principal discharge diagnosis of pneumonia;
- -Enrolled in Medicare Fee-For-Service (FFS) or VA beneficiaries;
- -Aged 65 years or over;
- -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 the index admission. This requirement is dropped for patients with an index admission within a VA hospital.

** These categories are not mutually exclusive

4.4.2 Frequency of Pneumonia Model Variables

We examined the change in both observed mortality rates and frequency of clinical and demographic variables (Table 4.4.1). Between July 2010-June 2011 and July 2012-June 2013, the observed mortality rate decreased from 12.1% to 11.7%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service (FFS) population, but is also due, in part, to increased coding opportunities on administrative claims. In the 2012 update to the measures, we increased the number of diagnosis and procedure codes to align with version 5010 format changes Department of Health and Human Services (HHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals submitted more codes, which translated into increased frequencies for some model variables. Some notable changes include an increase from 5.3% to 7.4% for history of PTCA, from 7.1% to 9.2% for history of CABG, from 85.2% to 87.2% for hypertension, from 27.2% to 30.1% for renal failure, from 19.8% to 21.6% for cardio-respiratory failure and shock, from 85.2% to 87.2% for hypertension, from 27.2% to 30.1% for renal failure, from 55.0% to 57.7% for iron deficiency or other unspecified anemias and blood disease, and from 20.8% to 24.6% for depression. Additionally, notable changes included a decrease from 59.7% to 41.3% for pneumonia, from 4.5% to 2.3% for severe hematological disorders, and from 16.1% to 14.1% for fibrosis of the lung or other chronic lung disorders.

4.4.3 Pneumonia Model Parameters and Performance

Table 4.4.2 shows model variable coefficients by individual year and for the combined three-year dataset. Table 4.4.3 shows the risk-adjusted ORs and 95% CIs for the pneumonia mortality 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 years; the area under the ROC curve (c-statistic) increased slightly from 0.71 to 0.72 (Table 4.4.4).

4.4.4 Distribution of Hospital Volumes and RSMRs for Pneumonia

Table 4.4.5 shows the distribution of hospital admission volumes and Table 4.4.6 shows the distribution of hospital RSMRs. The mean RSMR decreased over the three years, from 12.0% between July 2010 and June 2011 to 11.7% between July 2012 and June 2013. The median hospital RSMR in the combined three-year dataset was 11.6% (IQR 10.4% - 12.9%). Table 4.4.7 shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.067 (SE: 0.003). 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 RSMRs for the combined dataset. The odds of all-cause mortality were 1.68 times higher if treated at a hospital one standard deviation above the national rate as compared with the odds of all-cause mortality if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0. [21]

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

Of 4,816 hospitals in the study cohort, 212 performed "better than the U.S. national rate," 4,022 performed "no different from the U.S. national rate," and 198 performed "worse than the U.S. national rate." 384 were classified as "number of cases too small" (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.4.1 – Frequency of Pneumonia 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	358,590	336,477	345,842	1,040,845
Observed mortality rate	12.1	11.9	11.7	11.9
Mean age (SD)	80.5 (8.3)	80.4 (8.3)	80.5 (8.4)	80.5 (8.3)
Male	46.0	46.3	46.1	46.1
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	5.3	7.0	7.4	6.6
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	7.1	9.2	9.2	8.5
Congestive heart failure (CC 80)	38.7	39.2	38.1	38.7
Acute myocardial infarction (CC 81)	3.8	3.9	3.9	3.9
Other acute/subacute forms of ischemic heart disease (CC 82)	5.7	5.9	5.8	5.8
Coronary atherosclerosis or angina (CC 83, 84)	48.4	50.1	49.2	49.2
Cardio-respiratory failure or shock (CC 79)	19.8	21.4	21.6	20.9
Hypertension (CC 89, 91)	85.2	87.0	87.2	86.5
Stroke (CC 95, 96)	9.7	9.3	8.9	9.3
Cerebrovascular disease (CC 97-99, 103)	21.5	22.0	21.6	21.7
Renal failure (CC 131)	27.2	29.3	30.1	28.8
Chronic obstructive pulmonary disease (COPD) (CC 108)	54.1	55.1	54.0	54.4
Pneumonia (CC 111-113)	59.7	42.1	41.3	47.9
Protein-calorie malnutrition (CC 21)	12.5	13.2	13.1	13.0
Dementia or other specified brain disorders (CC 49, 50)	30.6	31.6	31.3	31.2
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	8.5	8.9	8.9	8.8
Vascular disease and complications (CC 104, 105)	30.4	31.7	31.3	31.1
Metastatic cancer, acute leukemia, and other severe cancers (CC 7,8)	9.4	9.7	9.4	9.5
Trauma in last year (CC 154-156, 158-162)	40.1	40.8	40.6	40.5
Major psychiatric disorders (CC 54-56)	13.3	14.0	14.1	13.8
Chronic liver disease (CC 25-27)	1.8	2.0	2.1	2.0
Severe hematological disorders (CC 44)	4.5	3.6	2.3	3.5
Iron deficiency or other unspecified anemias and blood disease (CC 47)	55.0	58.9	57.7	57.2
Depression (CC 58)	20.8	24.4	24.6	23.2
Parkinson's or Huntington's diseases (CC 73)	4.2	4.1	4.0	4.1
Seizure disorders and convulsions (CC 74)	5.6	5.8	5.7	5.7
Fibrosis of lung or other chronic lung disorders (CC 109)	16.1	15.9	14.1	15.4
Asthma (CC 110)	11.0	11.4	11.4	11.3
Vertebral fractures (CC 157)	5.0	5.1	5.1	5.1

Table 4.4.2 – Hierarchical Logistic Regression Model Variable Coefficients for Pneumonia over Different Time Periods

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	-3.424	-3.518	-3.597	-3.512
Age-65	0.049	0.049	0.048	0.049
Male	0.195	0.179	0.163	0.179
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	-0.310	-0.251	-0.226	-0.258
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	-0.205	-0.122	-0.108	-0.142
Congestive heart failure (CC 80)	0.230	0.196	0.216	0.215
Acute myocardial infarction (CC 81)	0.280	0.194	0.103	0.195
Other acute/subacute forms of ischemic heart disease (CC 82)	-0.113	-0.086	0.009	-0.063
Coronary atherosclerosis or angina (CC 83, 84)	-0.045	-0.014	-0.028	-0.027
Cardio-respiratory failure or shock (CC 79)	0.257	0.220	0.260	0.249
Hypertension (CC 89, 91)	-0.199	-0.156	-0.121	-0.162
Stroke (CC 95, 96)	0.056	0.077	0.040	0.059
Cerebrovascular disease (CC 97-99, 103)	-0.066	-0.096	-0.093	-0.085
Renal failure (CC 131)	0.123	0.110	0.083	0.109
Chronic obstructive pulmonary disease (COPD) (CC 108)	-0.034	0.006	0.046	0.003
Pneumonia (CC 111-113)	0.064	0.047	0.044	0.049
Protein-calorie malnutrition (CC 21)	0.759	0.768	0.769	0.776
Dementia or other specified brain disorders (CC 49, 50)	0.390	0.397	0.418	0.400
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	0.158	0.173	0.145	0.159
Vascular disease and complications (CC 104, 105)	0.016	-0.013	0.047	0.021
Metastatic cancer, acute leukemia, and other severe cancers (CC 7,8)	1.160	1.191	1.136	1.168
Trauma in last year (CC 154-156, 158-162)	0.054	0.061	0.073	0.062
Major psychiatric disorders (CC 54-56)	0.099	0.105	0.100	0.101
Chronic liver disease (CC 25-27)	0.285	0.363	0.369	0.348
Severe hematological disorders (CC 44)	0.213	0.211	0.186	0.212
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.098	0.144	0.184	0.142
Depression (CC 58)	-0.033	-0.025	-0.035	-0.032
Parkinson's or Huntington's diseases (CC 73)	0.116	0.108	0.134	0.120
Seizure disorders and convulsions (CC 74)	0.025	0.001	0.052	0.028
Fibrosis of lung or other chronic lung disorders (CC 109)	0.141	0.123	0.135	0.138
Asthma (CC 110)	-0.372	-0.359	-0.369	-0.364
Vertebral fractures (CC 157)	0.132	0.186	0.132	0.150

Table 4.4.3 – Adjusted OR and 95% CIs for the Pneumonia Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Age-65	1.05 (1.05 - 1.05)	1.05 (1.05 - 1.05)	1.05 (1.05 - 1.05)	1.05 (1.05 - 1.05)
Male	1.22 (1.19 - 1.24)	1.20 (1.17 - 1.22)	1.18 (1.15 - 1.20)	1.20 (1.18 - 1.21)

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
History of PTCA: ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	0.73 (0.69 - 0.78)	0.78 (0.74 - 0.82)	0.80 (0.76 - 0.84)	0.77 (0.75 - 0.80)
History of CABG: 36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	0.81 (0.78 - 0.85)	0.89 (0.85 - 0.92)	0.90 (0.86 - 0.93)	0.87 (0.85 - 0.89)
Congestive heart failure (CC 80)	1.26 (1.23 - 1.29)	1.22 (1.19 - 1.25)	1.24 (1.21 - 1.27)	1.24 (1.22 - 1.26)
Acute myocardial infarction (CC 81)	1.32 (1.25 - 1.40)	1.21 (1.15 - 1.29)	1.11 (1.05 - 1.17)	1.21 (1.18 - 1.26)
Other acute/subacute forms of ischemic heart disease (CC 82)	0.89 (0.85 - 0.94)	0.92 (0.87 - 0.97)	1.01 (0.96 - 1.06)	0.94 (0.91 - 0.97)
Coronary atherosclerosis or angina (CC 83, 84)	0.96 (0.93 - 0.98)	0.99 (0.96 - 1.01)	0.97 (0.95 - 1.00)	0.97 (0.96 - 0.99)
Cardio-respiratory failure or shock (CC 79)	1.29 (1.26 - 1.33)	1.25 (1.21 - 1.28)	1.30 (1.26 - 1.33)	1.28 (1.26 - 1.30)
Hypertension (CC 89, 91)	0.82 (0.80 - 0.84)	0.86 (0.83 - 0.88)	0.89 (0.86 - 0.92)	0.85 (0.83 - 0.87)
Stroke (CC 95, 96)	1.06 (1.02 - 1.10)	1.08 (1.04 - 1.12)	1.04 (1.00 - 1.08)	1.06 (1.04 - 1.08)
Cerebrovascular disease (CC 97-99, 103)	0.94 (0.91 - 0.96)	0.91 (0.88 - 0.93)	0.91 (0.89 - 0.94)	0.92 (0.90 - 0.93)
Renal failure (CC 131)	1.13 (1.10 - 1.16)	1.12 (1.09 - 1.15)	1.09 (1.06 - 1.11)	1.11 (1.10 - 1.13)
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.97 (0.94 - 0.99)	1.01 (0.98 - 1.03)	1.05 (1.02 - 1.07)	1.00 (0.99 - 1.02)
Pneumonia (CC 111-113)	1.07 (1.04 - 1.09)	1.05 (1.02 - 1.07)	1.05 (1.02 - 1.07)	1.05 (1.04 - 1.06)
Protein-calorie malnutrition (CC 21)	2.14 (2.08 - 2.19)	2.15 (2.10 - 2.21)	2.16 (2.10 - 2.22)	2.17 (2.14 - 2.21)
Dementia or other specified brain disorders (CC 49, 50)	1.48 (1.44 - 1.51)	1.49 (1.45 - 1.52)	1.52 (1.48 - 1.56)	1.49 (1.47 - 1.51)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178)	1.17 (1.13 - 1.22)	1.19 (1.14 - 1.23)	1.16 (1.11 - 1.20)	1.17 (1.15 - 1.20)
Vascular disease and complications (CC 104, 105)	1.02 (0.99 - 1.04)	0.99 (0.96 - 1.01)	1.05 (1.02 - 1.07)	1.02 (1.01 - 1.04)
Metastatic cancer, acute leukemia, and other severe cancers (CC 7,8)	3.19 (3.10 - 3.29)	3.29 (3.19 - 3.39)	3.11 (3.02 - 3.21)	3.21 (3.16 - 3.27)
Trauma in last year (CC 154-156, 158-162)	1.06 (1.03 - 1.08)	1.06 (1.04 - 1.09)	1.08 (1.05 - 1.10)	1.06 (1.05 - 1.08)
Major psychiatric disorders (CC 54-56)	1.10 (1.07 - 1.14)	1.11 (1.08 - 1.15)	1.11 (1.07 - 1.14)	1.11 (1.09 - 1.13)
Chronic liver disease (CC 25-27)	1.33 (1.24 - 1.43)	1.44 (1.34 - 1.54)	1.45 (1.35 - 1.55)	1.42 (1.36 - 1.47)
Severe hematological disorders (CC 44)	1.24 (1.18 - 1.29)	1.23 (1.17 - 1.30)	1.20 (1.13 - 1.28)	1.24 (1.20 - 1.27)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.10 (1.08 - 1.13)	1.16 (1.13 - 1.18)	1.20 (1.17 - 1.23)	1.15 (1.14 - 1.17)
Depression (CC 58)	0.97 (0.94 - 0.99)	0.98 (0.95 - 1.00)	0.97 (0.94 - 0.99)	0.97 (0.95 - 0.98)
Parkinson's or Huntington's diseases (CC 73)	1.12 (1.07 - 1.18)	1.11 (1.06 - 1.17)	1.14 (1.09 - 1.20)	1.13 (1.10 - 1.16)
Seizure disorders and convulsions (CC 74)	1.03 (0.98 - 1.07)	1.00 (0.96 - 1.05)	1.05 (1.01 - 1.10)	1.03 (1.00 - 1.06)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.15 (1.12 - 1.18)	1.13 (1.10 - 1.17)	1.14 (1.11 - 1.18)	1.15 (1.13 - 1.17)
Asthma (CC 110)	0.69 (0.66 - 0.72)	0.70 (0.67 - 0.73)	0.69 (0.66 - 0.72)	0.70 (0.68 - 0.71)
Vertebral fractures (CC 157)	1.14 (1.09 - 1.19)	1.20 (1.15 - 1.26)	1.14 (1.09 - 1.19)	1.16 (1.13 - 1.19)

Table 4.4.4 – Pneumonia Generalized Linear Modeling (Logistic Regression) 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)	2.1 - 29.1	2.2 - 28.6	2.1 - 28.6	2.1 - 28.7
c-statistic	0.71	0.72	0.72	0.72

Table 4.4.5 – Distribution of Hospital Pneumonia 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	4,746	4,728	4,712	4,816
Mean number of admissions (SD)	75.6 (72.6)	71.2 (70.0)	73.4 (74.3)	216.1 (214.2)
Range (min. – max.)	1 - 786	1 - 719	1 - 804	1 - 2309
25th percentile	25	22	22	67
50th percentile	53	49	49	148
75th percentile	103	98	100	296

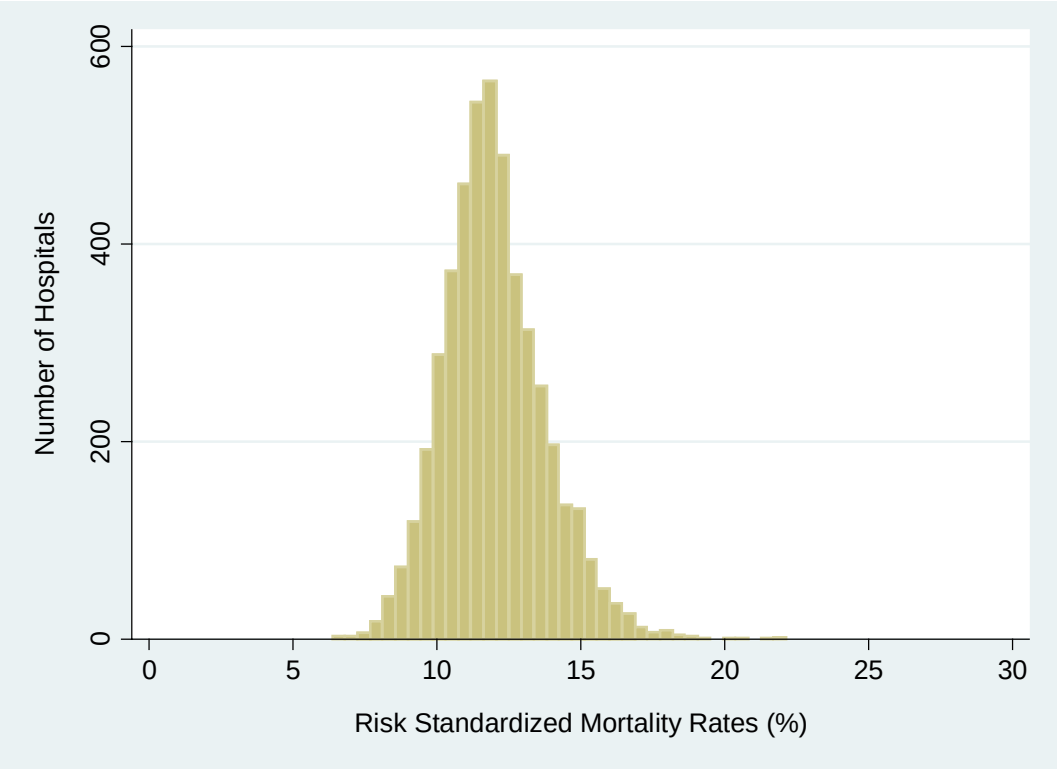
Table 4.4.6 – Distribution of Hospital Pneumonia RSMRs over Different Time Periods

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of hospitals	4,746	4,728	4,712	4,816
Mean (SD)	12.0 (1.6)	11.8 (1.6)	11.7 (1.6)	11.8 (1.9)
Range (min. – max.)	7.0 - 20.4	7.2 - 18.7	7.3 - 20.2	6.4 - 22.1
25th percentile	11.0	10.8	10.6	10.4
50th percentile	11.9	11.6	11.6	11.6
75th percentile	13.0	12.6	12.6	12.9

Table 4.4.7 – Between Hospital Variance for Pneumonia

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between hospital variance (SE)	0.066 (0.004)	0.066 (0.005)	0.068 (0.005)	0.067 (0.003)

Figure 4.4.2 – Distribution of Hospital 30-Day Pneumonia RSMRs between July 2010 and June 2013



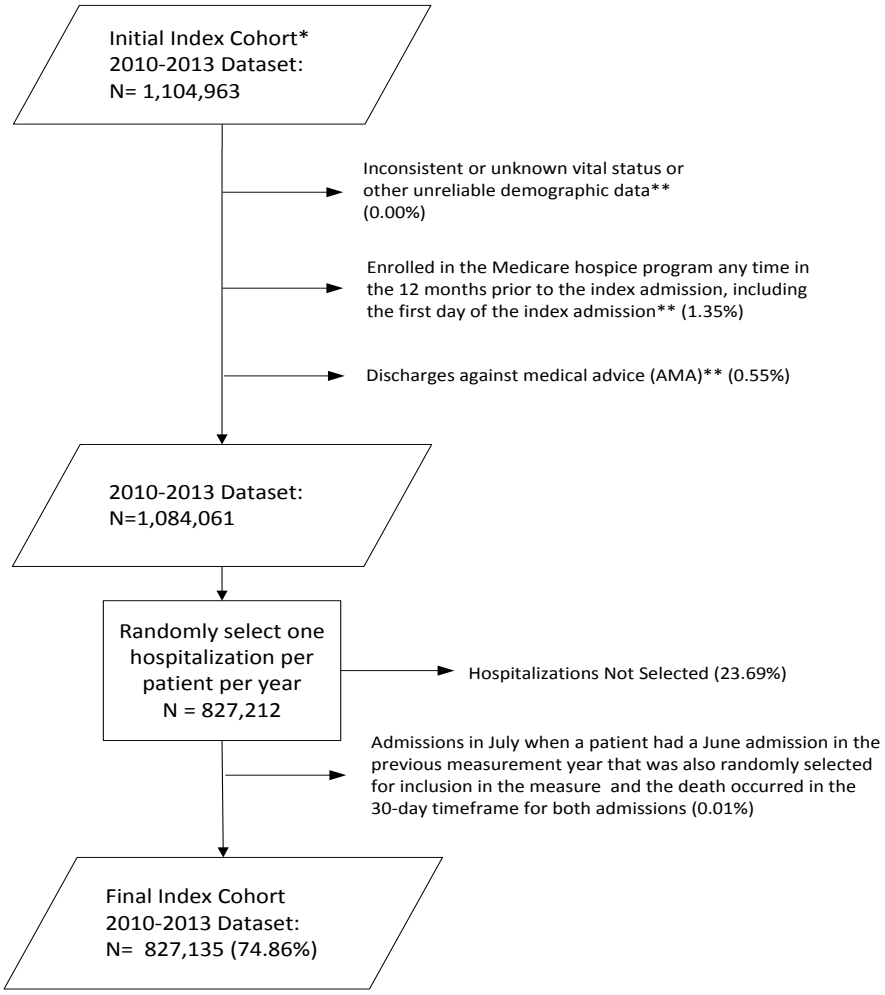
N= 4,816 hospitals

4.5 COPD Mortality 2014 Model Results

4.5.1 Index Cohort Exclusions

The exclusion criteria for the measures are presented in Section 2.2.1. The percentage of COPD patients meeting each exclusion criterion in the July 2010-June 2013 dataset is presented in Figure 4.5.1.

Figure 4.5.1– Index Cohort Sample for COPD in the July 2010-June 2013 Dataset



*The initial index cohort includes patients who meet the following inclusion criteria:
- -Having a principal discharge diagnosis of COPD or principal discharge diagnosis of respiratory failure with a secondary diagnosis of COPD;
- -Enrolled in Medicare Fee-For-Service (FFS);
- -Aged 65 years or over;
- -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 the index admission.

** These categories are not mutually exclusive

4.5.2 Frequency of COPD Model Variables

We examined the change in both observed mortality rates and frequency of clinical and demographic variables (Table 4.5.1). Between July 2010-June 2011 and July 2012-June 2013, the observed mortality rate increased slightly from 7.9% to 8.0%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service (FFS) population, but is also due, in part, to increased coding opportunities on administrative claims. In the 2012 update to the measures, we increased the number of diagnosis and procedure codes to align with version 5010 format changes Department of Health and Human Services (HHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals submitted more codes, which translated into increased frequencies for some model variables. Some notable changes include an increase from 13.8% to 17.6% for sleep apnea, from 29.9% to 32.4% for cardio-respiratory failure and shock, from 27.1% to 31.3% for drug/alcohol abuse, without dependence, from 20.0% to 28.4% for other psychiatric disorders, and from 22.8% to 25.7% for renal failure.

4.5.3 COPD Model Parameters and Performance

Table 4.5.2 shows model variable coefficients by individual year and for the combined three-year dataset. Table 4.5.3 shows the risk-adjusted ORs and 95% CIs for the COPD mortality 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 years; the area under the ROC curve (c-statistic) remained the same at 0.72 (Table 4.5.4).

4.5.4 Distribution of Hospital Volumes and RSMRs for COPD

Table 4.5.5 shows the distribution of hospital admission volumes and Table 4.5.6 shows the distribution of hospital RSMRs. The mean RSMR decreased over the three years, from 7.9% between July 2010 and June 2011 to 7.6% between July 2012 and June 2013. The median hospital RSMR in the combined three-year dataset was 8.0% (IQR 7.6% -8.4%). Table 4.5.7 shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.058 (SE: 0.003). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

Figure 4.5.2 shows the overall distribution of the hospital RSMRs for the combined dataset. The odds of all-cause mortality were 1.62 times higher if treated at a hospital one standard deviation above the national rate as compared with the odds of all-cause mortality if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.[21]

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

Of 4,647 hospitals in the study cohort, 50 performed “better than the U.S. national rate,” 3,683 performed “no different from the U.S. national rate,” and 96 performed “worse than

the U.S. national rate." 818 were classified as "number of cases too small" (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.5.1 – Frequency of COPD Model Variables over Different Time Periods (%)

Description	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Total N	285,485	264,704	276,946	827,135
Observed Mortality Rate	7.9	7.6	8.0	7.8
Age-65 (SD)	12.1 (7.5)	12.1 (7.6)	12.1 (7.6)	12.1 (7.6)
Sleep apnea (ICD-9 codes: 327.20, 327.21, 327.23, 327.27, 327.29,780.51, 780.53, 780.57)	13.8	16.8	17.6	16.0
History of mechanical ventilation (ICD-9 codes: 93.90, 96.70, 96.71, 96.72)	7.3	8.1	8.1	7.8
Respirator dependence/respiratory failure (CC 77-78)	1.2	1.2	1.1.	1.2
Cardio-respiratory failure or shock (CC 79)	29.9	32.2	32.4	31.5
Congestive heart failure (CC 80)	42.3	43.1	41.7	42.4
Coronary atherosclerosis or angina (CC 83-84)	51.9	53.4	52.5	52.6
Arrhythmias (CC 92-93)	39.2	41.4	41.2	40.6
Vascular or circulatory disease (CC 104-106)	40.5	42.2	41.7	41.5
Fibrosis of lung or other chronic lung disorder (CC 109)	17.1	17.0	15.1	16.4
Asthma (CC 110)	16.9	16.8	16.5	16.7
Pneumonia (CC 111-113)	49.3	49.7	48.6	49.2
Pleural effusion/pneumothorax (CC 114)	13.3	14.0	13.6	13.6
Other lung disorders (CC 115)	53.4	52.1	49.8	51.8
Metastatic cancer and acute leukemia (CC 7)	2.8	2.8	2.8	2.8
Lung, upper digestive tract, and other severe cancers (CC 8)	6.3	6.5	6.4	6.4
Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	14.2	14.4	14.1	14.2
Other digestive and urinary neoplasms(CC 12)	6.8	6.9	6.7	6.8
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	42.1	43.2	42.8	42.7
Protein-calorie malnutrition (CC 21)	9.1	9.9	9.9	9.6
Disorders of fluid/electrolyte/acid-base (CC 22-23)	35.2	37.8	37.3	36.7
Other endocrine/metabolic/nutritional disorders (CC 24)	76.5	80.5	81.6	79.5
Other gastrointestinal disorders (CC 36)	60.4	64.1	64.0	62.8
Osteoarthritis of hip or knee (CC 40)	10.2	10.8	10.9	10.6
Other musculoskeletal and connective tissue disorders (CC 43)	67.9	70.4	70.4	69.6
Iron deficiency or other unspecified anemias and blood disease (CC 47)	46.8	50.9	50.2	49.3
Dementia or other specified brain disorders (CC 49-50)	18.5	19.5	19.1	19.0
Drug/alcohol abuse, without dependence (CC 53)	27.1	30.4	31.3	29.6
Other psychiatric disorders (CC 60)	20.0	25.5	28.4	24.6
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	5.3	5.9	5.7	5.6
Mononeuropathy, other neurological conditions/injuries (CC 76)	13.2	15.1	15.5	14.6
Hypertension and hypertensive disease (CC 90-91)	83.6	84.9	85.0	84.5

Description	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Stroke (CC 95-96)	6.5	6.5	6.2	6.4
Retinal disorders, except detachment and vascular retinopathies (CC 121)	11.6	12.2	12.4	12.1
Other eye disorders (CC 124)	19.7	20.0	20.2	19.9
Other ear, nose, throat and mouth disorders (CC 127)	36.8	37.8	37.8	37.4
Renal failure (CC 131)	22.8	25.3	25.7	24.6
Decubitus ulcer or chronic skin ulcer (CC 148-149)	8.0	8.3	8.0	8.1
Other dermatological disorders (CC 153)	30.0	31.0	31.5	30.8
Trauma (CC 154-156, 158-161)	9.8	10.2	10.3	10.1
Vertebral fractures (CC 157)	4.8	4.9	4.7	4.8
Major complications of medical care and trauma (CC 164)	5.7	5.8	5.7	5.7

Table 4.5.2 – Hierarchical Logistic Regression Model Variable Coefficients for COPD over Different Time Periods

Description	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	-2.873	-3.021	-3.053	-2.991
Age-65	0.035	0.036	0.037	0.036
Sleep apnea (ICD-9 codes: 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	-0.106	-0.098	-0.089	-0.099
History of mechanical ventilation (ICD-9 codes: 93.90, 96.70, 96.71, 96.72)	0.230	0.241	0.229	0.235
Respirator dependence/respiratory failure (CC 77-78)	-0.171	-0.171	-0.184	-0.173
Cardio-respiratory failure or shock (CC 79)	0.420	0.393	0.392	c0.401
Congestive heart failure (CC 80)	0.240	0.213	0.219	0.226
Coronary atherosclerosis or angina (CC 83-84)	-0.082	-0.049	-0.049	-0.058
Arrhythmias (CC 92-93)	0.114	0.053	0.089	0.086
Vascular or circulatory disease (CC 104-106)	0.018	0.013	0.049	0.029
Fibrosis of lung or other chronic lung disorder (CC 109)	0.129	0.123	0.122	0.125
Asthma (CC 110)	-0.365	-0.366	-0.361	-0.362
Pneumonia (CC 111-113)	0.214	0.228	0.239	0.228
Pleural effusion/pneumothorax (CC 114)	0.155	0.161	0.137	0.149
Other lung disorders (CC 115)	-0.193	-0.162	-0.180	-0.179
Metastatic cancer and acute leukemia (CC 7)	0.859	0.837	0.847	0.851
Lung, upper digestive tract, and other severe cancers (CC 8)	0.604	0.579	0.620	0.603
Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	0.039	0.051	-0.024	0.022
Other digestive and urinary neoplasms(CC 12)	-0.183	-0.198	-0.163	-0.180
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	-0.081	-0.041	-0.061	-0.059
Protein-calorie malnutrition (CC 21)	0.765	0.722	0.784	0.765
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.166	0.130	0.121	0.141
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.225	-0.192	-0.189	-0.203
Other gastrointestinal disorders (CC 36)	-0.201	-0.190	-0.142	-0.178
Osteoarthritis of hip or knee (CC 40)	-0.263	-0.353	-0.284	-0.296
Other musculoskeletal and connective tissue disorders (CC 43)	-0.167	-0.169	-0.159	-0.163
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.124	0.247	0.237	0.200

Description	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Dementia or other specified brain disorders (CC 49-50)	0.137	0.156	0.179	0.161
Drug/alcohol abuse, without dependence (CC 53)	-0.185	-0.134	-0.111	-0.146
Other psychiatric disorders (CC 60)	0.144	0.124	0.143	0.139
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.093	0.011	0.015	0.042
Mononeuropathy, other neurological conditions/injuries (CC 76)	-0.171	-0.141	-0.164	-0.159
Hypertension and hypertensive disease (CC 90-91)	-0.188	-0.179	-0.171	-0.178
Stroke (CC 95-96)	-0.023	-0.024	-0.030	-0.024
Retinal disorders, except detachment and vascular retinopathies (CC 121)	-0.04	-0.084	-0.051	-0.059
Other eye disorders (CC 124)	-0.100	-0.096	-0.104	-0.102
Other ear, nose, throat and mouth disorders (CC 127)	-0.226	-0.232	-0.234	-0.230
Renal failure (CC 131)	0.126	0.101	0.076	0.102
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.262	0.278	0.280	0.274
Other dermatological disorders (CC 153)	-0.110	-0.084	-0.087	-0.093
Trauma (CC 154-156, 158-161)	0.058	0.090	0.035	0.058
Vertebral fractures (CC 157)	0.255	0.281	0.262	0.262
Major complications of medical care and trauma (CC 164)	-0.199	-0.195	-0.169	-0.188

Table 4.5.3 – Adjusted OR and 95% CIs for the COPD Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Age-65	1.04(1.03 -1.04)	1.04(1.03 -1.04)	1.04(1.04 -1.04	1.04(1.04 -1.04)
Sleep apnea (ICD-9 codes: 327.20, 327.21, 327.23, 327.27, 327.29,780.51, 780.53, 780.57)	0.90(0.86 -0.94)	0.91(0.87 -0.95)	0.92(0.88 -0.95)	0.91(0.88 -0.93)
History of mechanical ventilation (ICD-9 codes: 93.90, 96.70, 96.71,96.72)	1.26(1.20 -1.32)	1.27(1.21 -1.34)	1.26(1.20 -1.32)	1.26(1.23 -1.30)
Respirator dependence/respiratory failure (CC 77-78)	0.84(0.75 -0.94)	0.84(0.75 -0.95)	0.83(0.74 -0.93)	0.84(0.79 -0.90)
Cardio-respiratory failure or shock (CC 79)	1.52(1.47 -1.57)	1.48(1.43 -1.54)	1.48(1.43 -1.53)	1.49(1.46 -1.52)
Congestive heart failure (CC 80)	1.27(1.23 -1.31)	1.24(1.19 -1.28)	1.25(1.20 -1.29)	1.25(1.23 -1.28)
Coronary atherosclerosis or angina (CC 83-84)	0.92(0.89 -0.95)	0.95(0.92 -0.98)	0.95(0.92 -0.98)	0.94(0.93 -0.96)
Arrhythmias (CC 92-93)	1.12(1.09 -1.16)	1.05(1.02 -1.09)	1.09(1.06 -1.13)	1.09(1.07 -1.11)
Vascular or circulatory disease (CC 104-106)	1.02(0.99 -1.05)	1.01(0.98 -1.05)	1.05(1.02 -1.08)	1.03(1.01 -1.05)
Fibrosis of lung or other chronic lung disorder (CC 109)	1.14(1.10 -1.18)	1.13(1.09 -1.17)	1.13(1.09 -1.17)	1.13(1.11 -1.16)
Asthma (CC 110)	0.69(0.66 -0.73)	0.69(0.66 -0.73)	0.70(0.67 -0.73)	0.70(0.68 -0.72)
Pneumonia (CC 111-113)	1.24(1.20 -1.28)	1.26(1.22 -1.30)	1.27(1.23 -1.31)	1.26(1.23 -1.28)
Pleural effusion/pneumothorax (CC 114)	1.17(1.12 -1.21)	1.18(1.13 -1.22)	1.15(1.10 -1.19)	1.16(1.13 -1.19)
Other lung disorders (CC 115)	0.82(0.80 -0.85)	0.85(0.82 -0.88)	0.84(0.81 -0.86)	0.84(0.82 -0.85)
Metastatic cancer and acute leukemia (CC 7)	2.36(2.21 -2.53)	2.31(2.15 -2.48)	2.33(2.18 -2.50)	2.34(2.25 -2.44)
Lung, upper digestive tract, and other severe cancers (CC 8)	1.83(1.74 -1.93)	1.78(1.69 -1.88)	1.86(1.77 -1.96)	1.83(1.77 -1.88)

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	1.04(1.00 -1.08)	1.05(1.01 -1.10)	0.98(0.94 -1.02)	1.02(1.00 -1.05)
Other digestive and urinary neoplasms (CC 12)	0.83(0.78 -0.89)	0.82(0.77 -0.87)	0.85(0.80 -0.90)	0.84(0.81 -0.87)
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	0.92(0.90 -0.95)	0.96(0.93 -0.99)	0.94(0.91 -0.97)	0.94(0.93 -0.96)
Protein-calorie malnutrition (CC 21)	2.15(2.07 -2.23)	2.06(1.98 -2.14)	2.19(2.11 -2.27)	2.15(2.10 -2.20)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.18(1.14 -1.22)	1.14(1.10 -1.18)	1.13(1.09 -1.17)	1.15(1.13 -1.17)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.80(0.77 -0.83)	0.83(0.80 -0.86)	0.83(0.80 -0.86)	0.82(0.80 -0.83)
Other gastrointestinal disorders (CC 36)	0.82(0.79 -0.84)	0.83(0.80 -0.86)	0.87(0.84 -0.90)	0.84(0.82 -0.85)
Osteoarthritis of hip or knee (CC 40)	0.77(0.73 -0.81)	0.70(0.66 -0.74)	0.75(0.71 -0.79)	0.74(0.72 -0.77)
Other musculoskeletal and connective tissue disorders (CC 43)	0.85(0.82 -0.87)	0.85(0.82 -0.88)	0.85(0.83 -0.88)	0.85(0.83 -0.87)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.13(1.10 -1.17)	1.28(1.24 -1.33)	1.27(1.23 -1.31)	1.22(1.20 -1.24)
Dementia or other specified brain disorders (CC 49-50)	1.15(1.11 -1.19)	1.17(1.13 -1.21)	1.20(1.16 -1.24)	1.17(1.15 -1.20)
Drug/alcohol abuse, without dependence (CC 53)	0.83(0.80 -0.86)	0.88(0.84 -0.91)	0.90(0.87 -0.93)	0.86(0.85 -0.88)
Other psychiatric disorders (CC 60)	1.16(1.12 -1.20)	1.13(1.09 -1.17)	1.15(1.12 -1.19)	1.15(1.13 -1.17)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.10(1.03 -1.17)	1.01(0.95 -1.08)	1.02(0.96 -1.08)	1.04(1.01 -1.08)
Mononeuropathy, other neurological conditions/injuries (CC 76)	0.84(0.81 -0.88)	0.87(0.83 -0.91)	0.85(0.81 -0.89)	0.85(0.83 -0.88)
Hypertension and hypertensive disease (CC 90-91)	0.83(0.80 -0.86)	0.84(0.80 -0.87)	0.84(0.81 -0.88)	0.84(0.82 -0.86)
Stroke (CC 95-96)	0.98(0.92 -1.04)	0.98(0.92 -1.04)	1.05(1.02 -1.08)	1.03(1.01 -1.05)
Retinal disorders, except detachment and vascular retinopathies (CC 121)	0.96(0.92 -1.00)	0.92(0.88 -0.96)	0.95(0.91 -0.99)	0.94(0.92 -0.97)
Other eye disorders (CC 124)	0.90(0.87 -0.93)	0.91(0.87 -0.94)	0.90(0.87 -0.94)	0.90(0.88 -0.92)
Other ear, nose, throat and mouth disorders (CC 127)	0.80(0.77 -0.82)	0.79(0.77 -0.82)	0.79(0.77 -0.82)	0.79(0.78 -0.81)
Renal failure (CC 131)	1.13(1.10 -1.17)	1.11(1.07 -1.15)	1.08(1.04 -1.12)	1.11(1.09 -1.13)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.30(1.24 -1.36)	1.32(1.26 -1.39)	1.32(1.26 -1.39)	1.32(1.28 -1.35)
Other dermatological disorders (CC 153)	0.90(0.87 -0.93)	0.92(0.89 -0.95)	0.92(0.89 -0.95)	0.91(0.89 -0.93)
Trauma (CC 154-156, 158-161)	1.06(1.01 -1.11)	1.10(1.05 -1.15)	1.04(0.99 -1.08)	1.06(1.03 -1.09)
Vertebral fractures (CC 157)	1.29(1.22 -1.37)	1.32(1.25 -1.41)	1.30(1.23 -1.38)	1.30(1.26 -1.34)
Major complications of medical care and trauma (CC 164)	0.82(0.77 -0.87)	0.82(0.77 -0.88)	0.84(0.80 -0.90)	0.83(0.80 -0.86)

Table 4.5.4 – COPD Generalized Linear Modeling (Logistic Regression) 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)	0.014-0.219	0.013-0.208	0.014-0.223	0.014-0.217
c-statistic	0.72	0.72	0.72	0.72

Table 4.5.5 – Distribution of Hospital COPD 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	4,540	4,537	4,511	4,647
Mean number of admissions (SD)	62.9(67.6)	58.3 (63.4)	61.4 (67.3)	178 (196.2)
Range (min. – max.)	1-795	1-732	1-793	1-2259
25th percentile	15	13	14	38
50th percentile	40	36	38	108
75th percentile	90	84	88	256

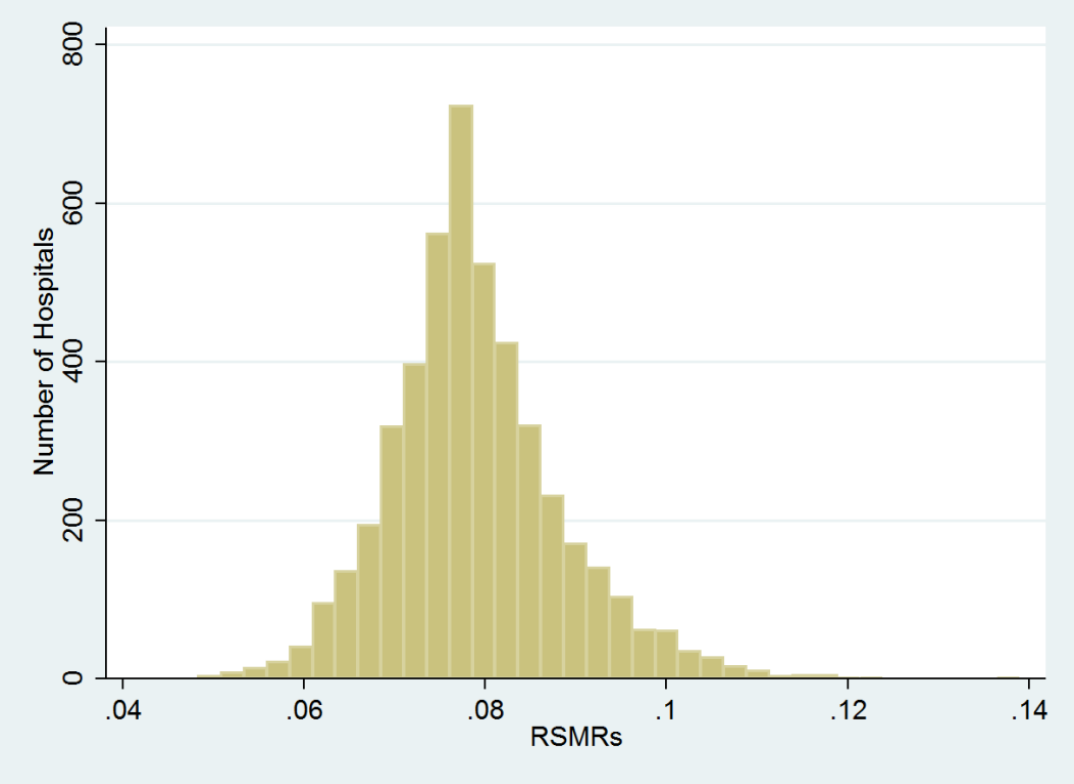
Table 4.5.6 – Distribution of Hospital COPD RSMRs over Different Time Periods

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of hospitals	4,540	4,537	4,511	4,647
Mean (SD)	7.9(0.6)	7.9(0.9)	7.6(0.6)	8.0(0.8)
Range (min. – max.)	5.1-12.03	4.8-13.9	5.7-11.1	5.5-12.1
25th percentile	7.5	7.3	7.3	7.6
50th percentile	7.8	7.8	7.6	7.9
75th percentile	8.2	8.4	7.9	8.4

Table 4.5.7 – Between Hospital Variance for COPD

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between hospital variance (SE)	0.050 (0.005)	0.054(0.006)	0.064(0.006)	0.058(0.003)

Figure 4.5.2 – Distribution of Hospital 30-Day COPD RSMRs between July 2010 and June 2013



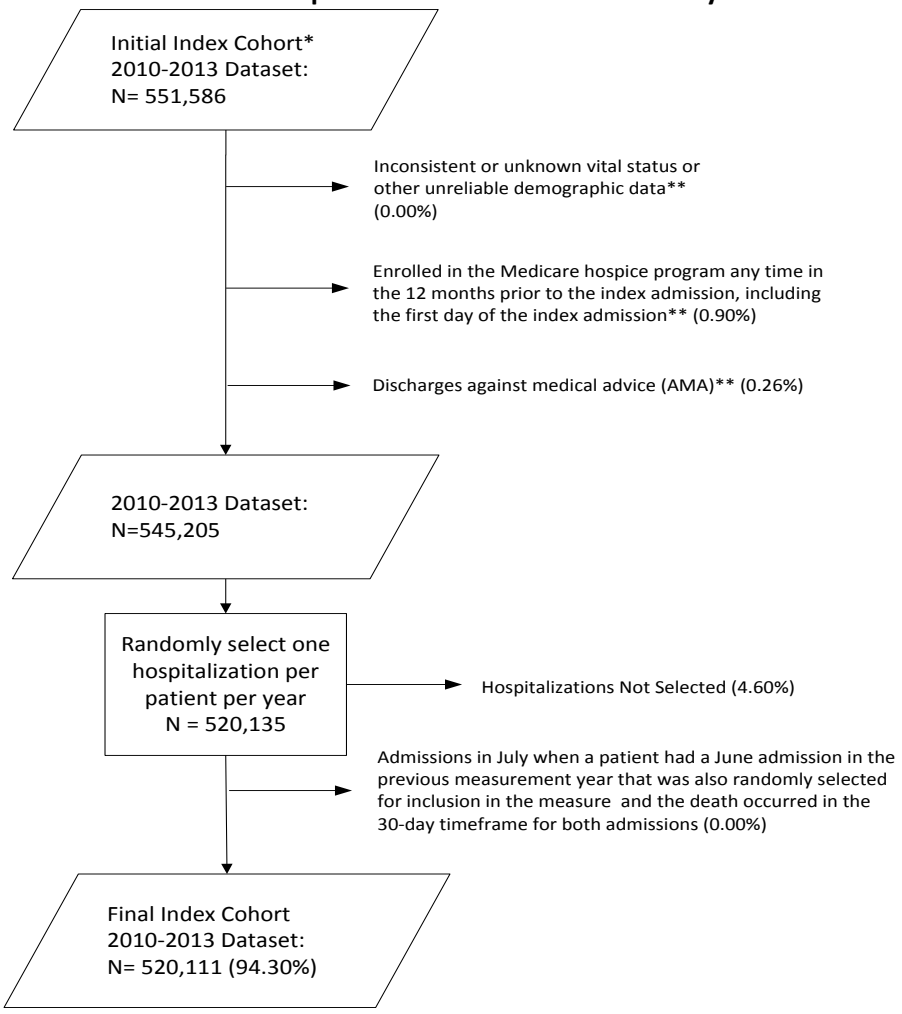
N= 4,647 hospitals

4.6 Stroke Mortality 2014 Model Results

4.6.1 Index Cohort Exclusions

The exclusion criteria for the measures are presented in Section 2.2.1. The percentage of stroke patients meeting each exclusion criterion in the July 2010-June 2013 dataset is presented in Figure 4.6.1.

Figure 4.6.1 – Index Cohort Sample for Ischemic Stroke in the July 2010-June 2013 Dataset



*The initial index cohort includes patients who meet the following inclusion criteria:
- -Having a principal discharge diagnosis of stroke;
- -Enrolled in Medicare Fee-For-Service (FFS);
- -Aged 65 years or over;
- -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 the index admission.

** These categories are not mutually exclusive

4.6.2 Frequency of Stroke Model Variables

We examined the change in both observed mortality rates and frequency of clinical and demographic variables (Table 4.6.1). Between July 2010-June 2011 and July 2012-June 2013, the observed mortality rate decreased from 15.6% to 15.1%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the fee-for-service (FFS) population, but is also due, in part, to increased coding opportunities on administrative claims. In the 2012 update to the measures, we increased the number of diagnosis and procedure codes to align with version 5010 format changes Department of Health and Human Services (HHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals submitted more codes, which translated into increased frequencies for some model variables. Some notable changes include an increase from 82.4% to 87.0% for other significant endocrine and metabolic disorders, from 46.6% to 50.7% for other gastrointestinal disorders, from 67.0% to 69.9% for other musculoskeletal and connective tissue disorders, from 35.3% to 37.3% for iron deficiency and other/unspecified anemia and blood disease, from 11.4% to 13.3% for multiple sclerosis, from 90.4% to 92.3% for hypertension, from 18.8% to 20.9% for renal failure.

4.6.3 Stroke Model Parameters and Performance

Table 4.6.2 shows model variable coefficients by individual year and for the combined three-year dataset. Table 4.6.3 shows the risk-adjusted ORs and 95% CIs for the stroke mortality 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 years; the area under the ROC curve (c-statistic) remained stable at 0.74 (Table 4.6.4).

4.6.4 Distribution of Hospital Volumes and RSMRs for Stroke

Table 4.6.5 shows the distribution of hospital admission volumes and Table 4.6.6 shows the distribution of hospital RSMRs. The mean RSMR decreased over the three years, from 15.7% between July 2010 and June 2011 to 15.4% between July 2012 and June 2013. The median hospital RSMR in the combined three-year dataset was 15.3% (IQR 14.6% - 16.1%). Table 4.6.7 shows the between-hospital variance by individual year and for the combined three-year dataset. Between-hospital variance in the combined dataset was 0.055 (SE: 0.003). If there were no systematic differences between hospitals, the between-hospital variance would be 0.

Figure 4.6.2 shows the overall distribution of the hospital RSMRs for the combined dataset. The odds of all-cause mortality were 1.60 times higher if treated at a hospital one standard deviation above the national rate as compared with the odds of all-cause mortality if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.[21]

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

Of 4,506 hospitals in the cohort, 74 performed "better than the U.S. national rate," 2,763 performed "no different from the U.S. national rate," and 81 performed "worse than the U.S. national rate." 1,588 were classified as "number of cases too small" (fewer than 25) to reliably tell how well the hospital is performing.

Table 4.6.1 – Frequency of Stroke 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	173,364	173,813	172,934	520,111
Observed Mortality Rate	15.6	15.3	15.1	15.3
Age-65 (SD)	15.4 (8.1)	15.3 (8.2)	15.3(8.2)	15.3(8.2)
Male	40.9	41.4	41.6	41.3
Emergency department-transfer status	7.6	8.2	8.7	8.2
Congestive heart failure (CC 80)	25.3	25.3	24.5	25.1
Valvular or rheumatic heart disease (CC 86)	23.7	25.5	25.4	24.9
Congenital cardiac/circulatory defects (CC 87-88)	2.4	2.4	2.4	2.4
Hypertensive heart disease (CC 90)	5.9	5.6	5.3	5.6
Specified heart arrhythmias (CC 92)	30.8	31.2	30.9	31.0
Cerebral hemorrhage (CC 95)	1.9	1.9	2.0	1.9
Ischemic or unspecified stroke (CC 96)	24.3	23.7	22.8	23.6
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	23.2	22.9	22.6	22.9
Cerebral atherosclerosis and aneurysm (CC 98)	11.2	11.9	11.8	11.7
Hemiplegia/hemiparesis (CC 100)	5.4	5.5	5.2	5.4
History of infection (CC 1, 3-6)	27.1	27.8	27.7	27.6
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	3.7	3.8	3.8	3.7
Lymphatic, head and neck, brain, breast, colorectal and other major cancers (CC 9-13)	24.0	24.4	24.4	24.3
Protein-calorie malnutrition (CC 21)	6.5	6.8	6.5	6.6
Other significant endocrine and metabolic disorders (CC 22-24)	82.4	85.9	87.0	85.1
Other gastrointestinal disorders (CC 36)	46.6	50.2	50.7	49.2
Disorders of the vertebrae and spinal discs (CC 39)	18.6	20.2	20.2	19.7
Osteoarthritis of hip or knee (CC 40)	11.2	11.7	11.7	11.5
Other musculoskeletal and connective tissue disorders (CC 43)	67.0	69.4	69.9	68.8
Iron deficiency or other unspecified anemia and blood disease (CC 47)	35.3	37.9	37.3	36.9
Dementia or other specified brain disorders (CC 49-50)	30.3	31.6	31.6	31.2
Major psychiatric disorders (CC 54-56)	9.9	10.4	10.4	10.2
Quadriplegia, other extensive paralysis (CC 67-69)	1.4	1.5	1.5	1.5
Multiple Sclerosis (CC 72, 76)	11.4	12.7	13.3	12.5
Seizure disorders and convulsions (CC 74)	7.1	7.5	7.6	7.4
Hypertension (CC 89, 91)	90.4	91.9	92.3	91.5
Vascular disease and complications (CC 104-105)	23.9	24.4	24.1	24.1
Chronic obstructive pulmonary disease (COPD) (CC 108)	22.2	23.0	22.6	22.6
Pneumonia (CC 111-113)	16.3	16.2	16.1	16.2
Pleural effusion/pneumothorax (CC 114)	7.5	7.6	7.4	7.5
Other eye disorders (CC 124)	19.8	20.2	20.3	20.1
Other ear, nose, throat, and mouth disorders (CC 127)	27.9	28.9	28.8	28.6
Dialysis status (CC 130)	1.5	1.6	1.6	1.6
Renal failure (CC 131)	18.8	20.0	20.9	19.9

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Urinary tract infection (CC 135)	22.0	22.0	22.0	22.0
Male genital disorders (CC 140)	13.0	14.2	14.5	13.9
Decubitus ulcer of skin (CC 148)	2.6	2.7	2.7	2.7
Chronic ulcer of skin, except decubitus (CC 149)	5.6	5.5	5.2	5.4
Other dermatological disorders (CC 153)	30.7	31.7	32.1	31.5

Table 4.6.2 – Hierarchical Logistic Regression Model Variable Coefficients for Stroke over Different Time Periods

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Intercept	-2.732	-2.846	-2.884	-2.817
Age-65	0.067	0.069	0.069	0.069
Male	-0.024	-0.022	-0.025	-0.025
Emergency department-transfer status	0.369	0.390	0.384	0.355
Congestive heart failure (CC 80)	0.288	0.252	0.290	0.278
Valvular or rheumatic heart disease (CC 86)	-0.107	-0.066	-0.089	-0.086
Congenital cardiac/circulatory defects (CC 87-88)	-0.520	-0.359	-0.405	-0.430
Hypertensive heart disease (CC 90)	-0.196	-0.219	-0.200	-0.192
Specified heart arrhythmias (CC 92)	0.469	0.460	0.455	0.460
Cerebral hemorrhage (CC 95)	0.256	0.123	0.192	0.190
Ischemic or unspecified stroke (CC 96)	-0.061	-0.052	-0.095	-0.068
Precerebral arterial occlusion and transient cerebral ischemia (CC 97	-0.194	-0.243	-0.230	-0.221
Cerebral atherosclerosis and aneurysm (CC 98)	-0.222	-0.204	-0.183	-0.201
Hemiplegia/hemiparesis (CC 100)	0.194	0.186	0.218	0.202
History of infection (CC 1, 3-6)	0.091	0.081	0.093	0.094
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	0.937	0.955	0.974	0.959
Lymphatic, head and neck, brain, breast, colorectal and other major cancers (CC 9-13)	-0.018	-0.067	-0.060	-0.049
Protein-calorie malnutrition (CC 21)	0.542	0.548	0.560	0.555
Other significant endocrine and metabolic disorders (CC 22-24)	-0.332	-0.350	-0.343	-0.341
Other gastrointestinal disorders (CC 36)	-0.139	-0.104	-0.107	-0.120
Disorders of the vertebrae and spinal discs (CC 39)	-0.109	-0.109	-0.108	-0.109
Osteoarthritis of hip or knee (CC 40)	-0.191	-0.205	-0.155	-0.182
Other musculoskeletal and connective tissue disorders (CC 43)	-0.140	-0.161	-0.121	-0.143
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.104	0.161	0.166	0.145
Dementia or other specified brain disorders (CC 49-50)	0.273	0.298	0.288	0.288
Major psychiatric disorders (CC 54-56)	0.073	0.071	0.022	0.055
Quadriplegia, other extensive paralysis (CC 67-69)	0.409	0.391	0.365	0.394
Multiple Sclerosis (CC 72, 76)	-0.180	-0.153	-0.157	-0.165
Seizure disorders and convulsions (CC 74)	0.306	0.367	0.334	0.339
Hypertension (CC 89, 91)	-0.220	-0.122	-0.113	-0.156
Vascular disease and complications (CC 104-105)	0.075	0.076	0.090	0.086
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.052	0.091	0.076	0.072
Pneumonia (CC 111-113)	0.447	0.386	0.378	0.405
Pleural effusion/pneumothorax (CC 114)	0.132	0.117	0.091	0.114

Variable	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Other eye disorders (CC 124)	-0.075	-0.086	-0.100	-0.086
Other ear, nose, throat, and mouth disorders (CC 127)	-0.129	-0.090	-0.141	-0.119
Dialysis status (CC 130)	0.194	0.227	0.200	0.210
Renal failure (CC 131)	0.147	0.079	0.114	0.112
Urinary tract infection (CC 135)	0.133	0.086	0.096	0.104
Male genital disorders (CC 140)	-0.186	-0.201	-0.172	-0.184
Decubitus ulcer of skin (CC 148)	0.269	0.226	0.207	0.236
Chronic ulcer of skin, except decubitus (CC 149)	0.190	0.189	0.190	0.193
Other dermatological disorders (CC 153)	-0.089	-0.097	-0.104	-0.096

Table 4.6.3 - Adjusted OR and 95% CIs for the Stroke Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Age-65	1.07(1.07-1.07)	1.07(1.07-1.07)	1.07(1.07-1.07)	1.07(1.07-1.07)
Male	0.98(0.94-1.01)	0.98(0.94-1.01)	0.98(0.94-1.01)	0.98(0.96-1.00)
Emergency department-transfer status	1.45(1.37-1.53)	1.48(1.40-1.55)	1.47(1.40-1.54)	1.43(1.38-1.47)
Congestive heart failure (CC 80)	0.80(0.76-0.84)	0.82(0.78-0.85)	0.83(0.80-0.87)	0.82(0.80-0.84)
Valvular or rheumatic heart disease (CC 86)	0.93(0.90-0.96)	0.92(0.89-0.95)	0.91(0.87-0.94)	0.92(0.90-0.94)
Congenital cardiac/circulatory defects (CC 87-88)	1.51(1.36-1.67)	1.48(1.33-1.64)	1.44 (1.30-1.60)	1.48(1.40-1.57)
Hypertensive heart disease (CC 90)	1.16(1.12-1.20)	1.08(1.04-1.12)	1.12 (1.08-1.16)	1.12(1.10-1.14)
Specified heart arrhythmias (CC 92)	1.36(1.29-1.43)	1.44(1.38-1.52)	1.40(1.33-1.47)	1.40(1.36-1.44)
Cerebral hemorrhage (CC 95)	1.29(1.18-1.41)	1.13(1.03-1.24)	1.21(1.11-1.33)	1.21(1.15-1.27)
Ischemic or unspecified stroke (CC 96)	0.94(0.91-0.98)	0.95(0.92-0.99)	0.91(0.88-0.95)	0.93(0.92-0.96)
Precerebral arterial occlusion and transient cerebral ischemia (CC 97	1.60(1.55-1.65)	1.58(1.54-1.63)	1.58(1.53-1.63)	1.58(1.56-1.61)
Cerebral atherosclerosis and aneurysm (CC 98)	0.82(0.79-0.86)	0.79(0.76-0.82)	0.79(0.77-0.83)	0.80(0.79-0.82)
Hemiplegia/hemiparesis (CC 100)	1.21(1.14-1.29)	1.20(1.13-1.28)	1.24(1.17-1.33)	1.22(1.18-1.27)
History of infection (CC 1, 3-6)	0.90(0.87-0.93)	0.94(0.91-0.97)	0.92(0.89-0.95)	0.92(0.90-0.94)
Metastatic cancer, acute leukemia and other severe cancers (CC 7-8)	1.31(1.22-1.41)	1.25(1.17-1.35)	1.23(1.14-1.32)	1.27(1.21-1.32)
Lymphatic, head and neck, brain, breast, colorectal and other major cancers (CC 9-13)	0.98(0.95-1.02)	0.94(0.90-0.97)	0.94(0.91-0.98)	0.95(0.93-0.97)
Protein-calorie malnutrition (CC 21)	1.21(1.14-1.28)	1.21(1.14-1.28)	1.21(1.14-1.28)	1.21(1.17-1.25)
Other significant endocrine and metabolic disorders (CC 22-24)	0.83(0.79-0.87)	0.82(0.78-0.86)	0.84(0.80-0.88)	0.83(0.81-0.86)
Other gastrointestinal disorders (CC 36)	0.72(0.69-0.74)	0.71 0.68-0.73)	0.71(0.68-0.74)	0.71(0.70-0.73)
Disorders of the vertebrae and spinal discs (CC 39)	2.55(2.40-2.72)	2.60(2.44-2.77)	2.65(2.48-2.82)	2.61(2.51-2.71)
Osteoarthritis of hip or knee (CC 40)	0.87(0.84-0.90)	0.90 0.88-0.93)	0.90(0.87-0.93)	0.89(0.87-0.90)
Other musculoskeletal and connective tissue disorders (CC 43)	0.83(0.79-0.87)	0.81(0.78-0.85)	0.86(0.82-0.90)	0.83(0.81-0.86)

Variable	07/2010-06/2011 OR (95% CI)	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2010-06/2013 OR (95% CI)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.80(0.77-0.84)	0.89(0.84-0.93)	0.89(0.85-0.94)	0.86(0.83-0.88)
Dementia or other specified brain disorders (CC 49-50)	1.10(1.06-1.13)	1.08(1.05-1.12)	1.10(1.06-1.13)	1.10(1.08-1.12)
Major psychiatric disorders (CC 54-56)	0.92(0.89-0.94)	0.91(0.88-0.94)	0.90(0.87-0.93)	0.91(0.89-0.93)
Quadriplegia, other extensive paralysis (CC 67-69)	1.72(1.64-1.80)	1.73(1.65-1.81)	1.75(1.67-1.84)	1.74(1.70-1.79)
Multiple Sclerosis (CC 72, 76)	0.87(0.84-0.90)	0.85(0.82-0.88)	0.89(0.86-0.92)	0.87(0.85-0.88)
Seizure disorders and convulsions (CC 74)	0.84(0.80-0.88)	0.86(0.82-0.90)	0.86(0.82-0.89)	0.85(0.83-0.87)
Hypertension (CC 89, 91)	0.88(0.85-0.91)	0.91(0.89-0.94)	0.87(0.84-0.90)	0.89(0.87-0.90)
Vascular disease and complications (CC 104-105)	1.08(1.04-1.12)	1.08(1.04-1.12)	1.10(1.06-1.13)	1.09(1.07-1.11)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.08(1.03-1.13)	1.07(1.03-1.12)	1.02(0.98-1.07)	1.06(1.03-1.09)
Pneumonia (CC 111-113)	0.60(0.53-0.67)	0.70(0.63-0.78)	0.67(0.60-0.74)	0.65(0.61-0.69)
Pleural effusion/pneumothorax (CC 114)	1.33(1.29-1.38)	1.29(1.24-1.33)	1.34(1.29-1.38)	1.32(1.29-1.35)
Other eye disorders (CC 124)	1.21(1.09-1.35)	1.26(1.13-1.39)	1.22(1.10-1.35)	1.23(1.16-1.31)
Other ear, nose, throat, and mouth disorders (CC 127)	1.11(1.08-1.14)	1.18(1.14-1.21)	1.18(1.14-1.22)	1.16(1.14-1.18)
Dialysis status (CC 130)	1.56(1.51-1.62)	1.47(1.42-1.53)	1.46(1.41-1.52)	1.50(1.47-1.53)
Renal failure (CC 131)	1.05(1.02-1.09)	1.10(1.06-1.13)	1.08(1.04-1.12)	1.08(1.05-1.10)
Urinary tract infection (CC 135)	1.31(1.27-1.35)	1.35(1.31-1.39)	1.33(1.29-1.38)	1.33(1.31-1.36)
Male genital disorders (CC 140)	1.14(1.10-1.18)	1.09(1.05-1.13)	1.10(1.06-1.14)	1.11(1.09-1.13)
Decubitus ulcer of skin (CC 148)	1.14(1.09-1.20)	1.12(1.07-1.18)	1.10(1.04-1.15)	1.12(1.09-1.15)
Chronic ulcer of skin, except decubitus (CC 149)	0.90(0.86-0.93)	0.90(0.87-0.93)	0.90(0.87-0.93)	0.90(0.88-0.92)
Other dermatological disorders (CC 153)	0.82(0.77-0.88)	0.80(0.75-0.86)	0.82(0.77-0.87)	0.83(0.80-0.86)

Table 4.6.4 – Stroke Generalized Linear Modeling (Logistic Regression) 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)	0.024-0.398	0.028-0.396	0.0256-0.392	0.034-0.420
c-statistic	0.74	0.74	0.74	0.74

Table 4.6.5 – Distribution of Hospital Stroke 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	4,299	4,281	4,190	4,506
Mean number of admissions (SD)	40.3 (51)	40.6 (52.1)	41.3 (53.7)	115.4 (153.7)
Range (min. – max.)	1-458	1-454	1-480	1-1392
25th percentile	6	6	6	14
50th percentile	19	19	18	49
75th percentile	56	57	58	162

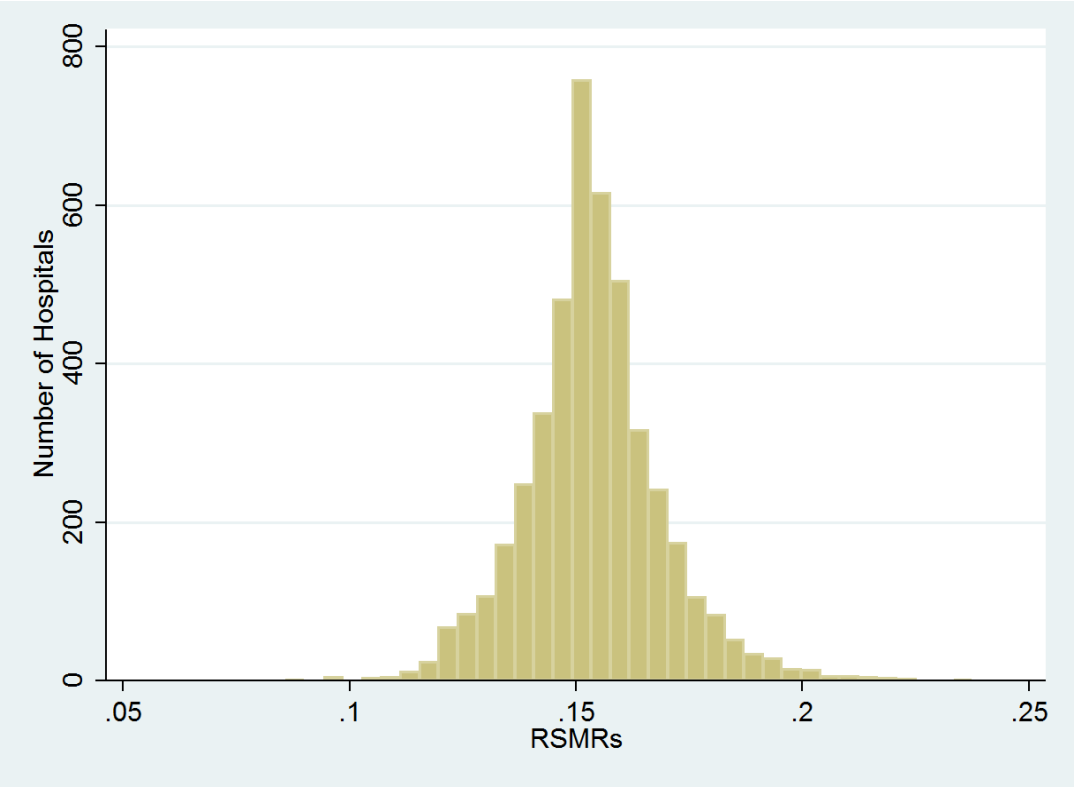
Table 4.6.6 – Distribution of Hospital Stroke RSMRs over Different Time Periods

Characteristic	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Number of hospitals	4,299	4,281	4,190	4,506
Mean (SD)	15.7 (1.1)	15.3 (1.0)	15.1 (0.9)	15.4 (1.5)
Range (min. – max.)	11.2-22.4	10.5-21.1	10.8-20.6	8.6-23.8
25th percentile	15.1	14.8	14.7	14.6
50th percentile	15.6	15.2	15.0	15.3
75th percentile	16.2	15.7	15.6	16.1

Table 4.6.7 – Between Hospital Variance for Stroke

	07/2010-06/2011	07/2011-06/2012	07/2012-06/2013	07/2010-06/2013
Between hospital variance (SE)	0.054 (0.005)	0.049 (0.005)	0.046 (0.005)	0.055 (0.003)

Figure 4.6.2 – Distribution of Hospital 30-Day Stroke RSMRs between July 2010 and June 2013



N= 4,506 hospitals

5. GLOSSARY

Cohort: The index admissions used to calculate the measure after 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 the patient had in addition to his/her 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 Condition Categories can be found at http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf.

Expected mortality: The number of deaths expected based on average hospital performance with a given hospital's case mix.

Hierarchical model: A widely accepted statistical method that enables fair evaluation of relative hospital performance by accounting for patient risk factors and 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 mortality rates 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 contribution to mortality risk.

Hospital-specific intercept: A measure of the hospital quality of care calculated based on the hospital's actual mortality rate, considering how many patients it served, its patients' risk factors, and how many died. The hospital-specific intercept will be negative for a better-than-average hospital, positive for a worse-than-average hospital, and close to zero for an average hospital. The hospital-specific intercept is used in the numerator to calculate "predicted" mortality.

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

Interval estimate: Similar to a CI, the interval estimate is a range of probable values for the estimate that characterizes the amount of associated uncertainty. For example, a 95% interval estimate for a mortality rate indicates that CMS is 95% confident that the true value of the rate lies between the lower and the upper limit of the interval.

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

National observed mortality rate: All included hospitalizations with the outcome divided by all included hospitalizations.

Outcome: The result of a broad set of healthcare activities that affect patients' well-being. For the mortality measures, the outcome is mortality within 30 days of admission.

Predicted mortality: The number of deaths within 30 days predicted based on the hospital's performance with its observed case mix, also referred to as "adjusted actual" mortality.

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

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7. APPENDICES

Appendix A. Statistical Approach to Risk-Standardized Mortality Rates for AMI, HF, Pneumonia, COPD, and Stroke Measures

We estimate the hospital-specific risk-standardized mortality rates using hierarchical generalized linear models, a strategy that accounts for within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes. We model the probability of mortality as a function of patient age, sex, clinically relevant comorbidities, and history of PCI and/or CABG with an intercept for the hospital-specific random effect.

We calculated the hospital-specific mortality rates as the ratio of a hospital's "predicted" to "expected" mortality multiplied by the national observed mortality rate. The expected mortality for each hospital is estimated using its patient-mix and the average hospital-specific intercept (i.e., the average intercept among all hospitals in the sample). The predicted mortality for each hospital is estimated given the same patient-mix but an estimated hospital-specific intercept. Operationally, the expected mortality for each hospital is obtained by summing the expected probabilities of mortality for all patients in the hospital. The expected probability of mortality for each patient is calculated via the hierarchical model, which applies the estimated regression coefficients to the observed patient characteristics and adds the average of the hospital-specific intercept. The predicted mortality for each hospital is calculated by summing the predicted probabilities for all patients in the hospital. The predicted probability for each patient is calculated through the hierarchical model, which applies the estimated regression coefficients to the patient characteristics observed, and adds the hospital-specific intercept.

More specifically, we use a hierarchical generalized linear model, in this case, a hierarchical logistic regression, to account for the natural clustering of observations within hospitals. The model employs a logit link function to link the risk factors to the outcome with a hospital-specific random effect:

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

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

Where h(.) is a logit link, Y_{ij} is whether the j^{th} patient in the i^{th} hospital died (1: death, 0 otherwise); α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \ldots, Z_{pij})$ the patient-specific covariates, μ is the average hospital intercept across all hospitals in the sample, and τ^2 is the between-hospital variance component[22]. This model separates within-hospital variation from between-hospital variation. The hierarchical generalized linear models are estimated using the SAS software system (SAS 9.3 GLIMMIX).

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, $\hat{\mu}$, $\{\hat{\alpha}_i, \hat{\alpha}_2, \ldots, \hat{\alpha}_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$ where i is the total number of hospitals. We calculate a standardized outcome measure, RSMR, for each hospital by computing the ratio of the predicted mortality to the expected mortality, multiplied by the national observed mortality rate, $\overline{y}$. Specifically, we calculate

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

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

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

n_i is the number of index hospitalizations for the i^{th} hospital.

If the "predicted" mortality is higher (or lower) than the "expected" mortality for a given hospital, its $\widehat{RSMR}$ will be higher (or lower) than the national observed mortality rate. For each hospital, we compute an interval estimate of $RSMR_i$ to characterize the level of uncertainty around the point estimate using bootstrapping simulations as described in the next section. The point estimate and interval estimate are used to characterize and compare hospital performance (e.g., higher than expected, as expected, or lower than expected).

Creating Interval Estimates

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

Algorithm:

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

1. Sample *I* hospitals with replacement.
2. Fit the hierarchical generalized linear model using all patients within each sampled hospital. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have *I* random effects to estimate the variance components. At the conclusion of Step 2, we have:
    a. $\hat{\beta}^{(b)}$ (the estimated regression coefficients of the risk factors).
    b. The parameters governing the random effects, hospital adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$.
    c. The set of hospital-specific intercepts and corresponding variances,

$$\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1,2,\ldots,I\}$$

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

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

Ninety-five percent interval estimates (or alternative interval estimates) for the hospital-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of the B estimates (or the percentiles corresponding to the alternative desired intervals).[23]

Appendix B. Data Quality Assurance (QA)

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

This section represents QA for the subset of the work conducted by CORE to maintain and report these mortality measures. It does not describe the QA to process data and create the input files, nor does it include the QA for the final processing of production data for public reporting because another contractor conducts that work. The task of creating the input files for these measures was transitioned to a different contractor this year, which had some impact on the QA approach. In prior years, data was compared to previous years' data files; however, this year, since the final data was obtained from a different source, we compared these data to data from our original source using a similar time period.

Phase I

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

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

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

Phase II

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

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

Figure B.1 – CORE QA Phase I

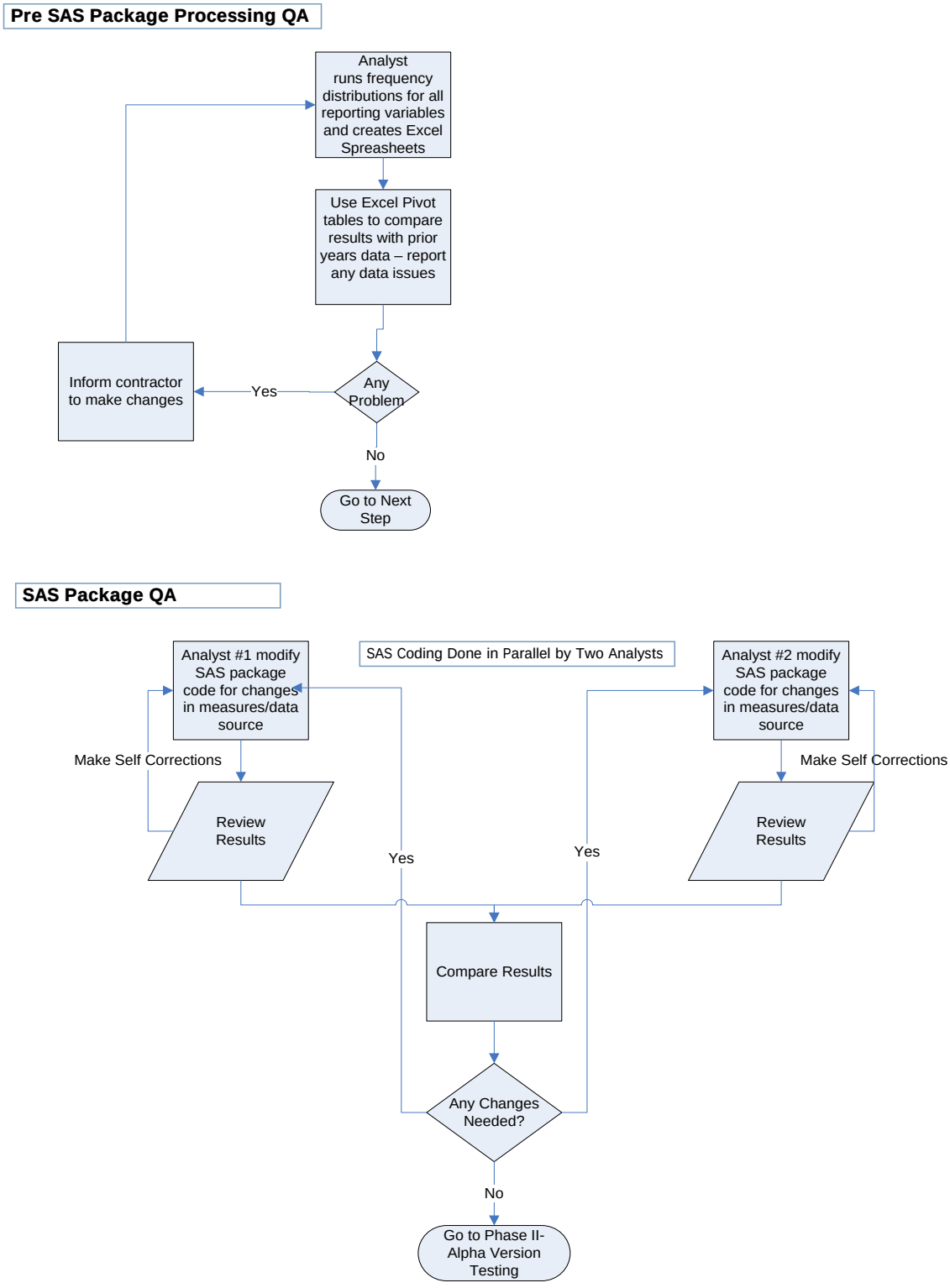
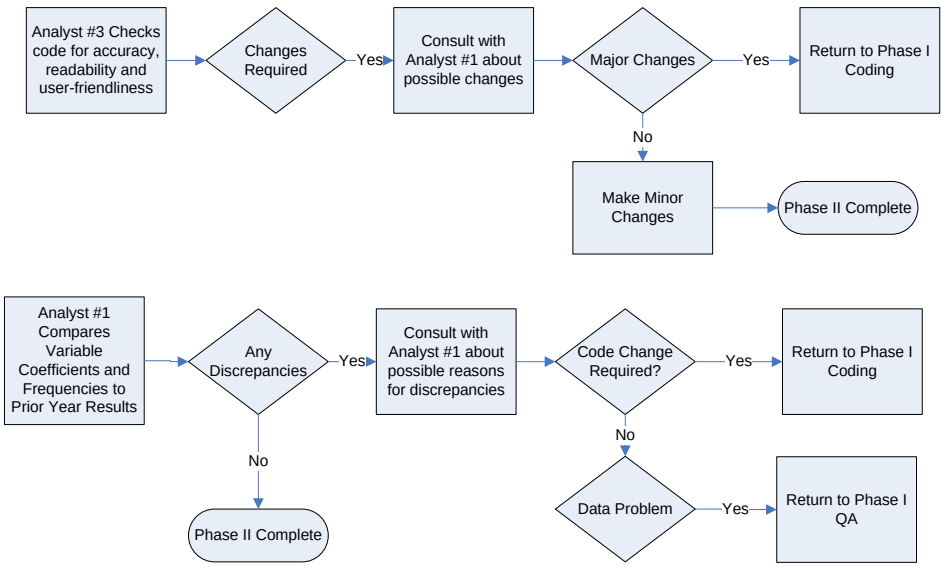


Figure B.2 – CORE QA Phase II

Results Testing – Alpha Version



Appendix C. Annual Updates

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

2014

2014 Measures Updates and Specifications Report (Version 8.0- AMI, HF, and Pneumonia and Version 3.0-COPD and Stroke)

No updates were made to the specifications of the AMI, HF, pneumonia, COPD, and stroke mortality measures for 2014 public reporting.

2013

2013 Measures Updates and Specifications Report AMI, HF, Pneumonia (Version 7.0)

1. Updated CC map.
   - Rationale: The ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.[‡‡]

2013 Measure Updates and Specifications Report COPD (Version 2.0)

1. Updated CC map.
   - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2013 Measures Updates and Specifications Report Stroke (Version 2.0)

1. Updated CC map.
   - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.
2. Incorporating Risk Adjustment for Emergency Department-transfer Patients
   - Rationale: ED-transfer patients may be at higher risk of mortality.
3. Removed ICD-9-CM code 436 from measure cohort
   - Rationale: ICD-9-CM code 436 is not commonly used to define acute ischemic stroke.

2012

2012 Measures Maintenance Report AMI, HF, Pneumonia (Version 6.0)

1. Included VA one-day stays.
   - Rationale: Stays of less than 24 hours that result in death, discharge against medical advice, or transfer (or that follow a transfer) are not likely to be observation stays because the time frame of the admissions was determined not by clinical necessity but by other factors such as death or transfer. These stays had been previously excluded from the measure.
2. Excluded patients based on enrollment in VA and CMS hospice

[‡‡] The Condition Category Groups (CC) of ICD-9-CM codes were not updated this year due to the upcoming transition to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).

- Rationale: VA patients who have a history of VA hospice care in the 12 months prior to the index admission are now excluded.

3. Incorporated Version 5010 format.
   - Rationale: Version 5010 increased the number of diagnoses and procedures hospitals could code on Medicare claims. The inclusion of 15 additional codes for diagnoses and 19 additional codes for procedures allows us to identify additional comorbidities, thereby increasing the accuracy of risk adjustment.
4. Updated CC map.
   - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2011

2011 Measures Maintenance Report AMI, HF, Pneumonia (Version 5.0)

1. Added two pneumonia codes (482.42 and 488.11).
   - Rationale: CMS updated ICD-9 cohort codes to distinguish between Methicillin susceptible and resistant Staphylococcus aureus pneumonia (482.41 and 482.42), and added a new code for viral pneumonia cases (488.11) to reflect the emergence of H1N1 influenza virus.
2. Included VA hospitals.
   - Rationale: Creates a more inclusive perspective of the relative quality of US hospitals.
3. Updated CC map.
   - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2010

2010 Measures Maintenance Report AMI, HF, Pneumonia (Version 4.0)

1. Revised period for collecting comorbidities from claims codes.
   - Rationale: The revised models use comorbidities coded within 365 days of admission rather than 365 days of discharge. This revision includes more clinical covariates for risk adjustment.
2. Updated CC map.
   - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2009

2009 Measures Maintenance Report AMI, HF, Pneumonia (Version 3.0)

1. Randomly selected one AMI admission per patient per year for inclusion in the cohort
   - Rationale: Three-year data increased the number of multiple AMI admissions, which would be statistically correlated. Randomly selecting one AMI admission per year aligned the measure with HF and PN.
2. Used three years of claims and enrollment data for public reporting.
   - Rationale: Three years of data increased the precision of the hospital RSMR estimates by increasing the number of admissions used to calculate the rates. CMS developed the measures using one year of data.
3. Excluded patients discharged AMA.
   - Rationale: Providers are unable to deliver full care and prepare the patient for discharge when patients leave AMA.

4. Updated CC map.
    - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2008

2008 Measures Maintenance Report (Version 2.0)

1. Added three viral pneumonia codes (480.0, 480.1, and 480.2)
    - Rationale: Viral pneumonias are common causes of pneumonia in the elderly.
2. Excluded patients with a history of Medicare hospice enrollment in the 12 months prior to or on the index admission date
    - Rationale: These patients are likely continuing to seek comfort measures only; thus mortality is not necessarily an adverse outcome or signal of poor quality care.
3. Added checks for cases with unreliable mortality, vital status, age, and gender data and excluded such cases
    - Additional checks include patients over 115 years of age; date of discharge is before the date of admission; unknown gender; two hospitals have conflicting death information for the same patient.
4. Modified list of complications
    - Rationale: The models do not adjust for risk factors present on an index admission if the conditions may represent complications of care.
5. Discontinued use of hierarchical component of the HCC system
    - Rationale: The hierarchical logic is meant to predict expenditures, not to estimate prevalence of comorbidities. Dropping the hierarchy allowed the risk factor coefficients to better reflect the true disease burden.
6. Updated CC map
    - Rationale: The ICD-9-CM CC map is updated annually to capture all relevant comorbidities coded in patient administrative claims data.

Appendix D. Measure Specifications

Appendix D.1 AMI

Cohort

Inclusion Criteria for AMI Measure

1. **Principal discharge diagnosis of AMI**
   Rationale: AMI is the condition targeted for measurement (Table D.1.1).
2. **Enrolled in Medicare FFS or VA beneficiaries**
   Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
3. **Aged 65 years or older**
   Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
4. **Not transferred from another acute care facility**
   Rationale: Death is attributed to the hospital where the patient was initially admitted. Transferred patients are still included in the measure cohort, but the "transfer-in" hospitalization is excluded as an index admission.
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-month prior enrollment 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 Measure

1. **Discharged alive on the day of admission or the following day who were not transferred**
   Rationale: It is unlikely that these patients had clinically significant AMI.
2. **Inconsistent or unknown vital status or other unreliable demographic data**
   Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
3. **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
   Rationale: These patients are likely continuing to seek comfort measures only, so mortality is not necessarily an adverse outcome or signal of poor quality care.
4. **Discharged against medical advice (AMA)**
   Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

   After exclusions #1-4 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. Similarly, for the three year combined data, when index admissions occur during

the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning a single death to two admissions.

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

ICD-9-CM Codes	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 D.1.2 – Risk Variables for AMI Measure

Variable	Description
n/a	Age-65 (years above 65, continuous)
n/a	Male
ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	History of PTCA
36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	History of CABG

Variable	Description
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of ischemic heart disease
ICD-9-CM 410.00-410.19	Anterior myocardial infarction
ICD-9-CM 410.20-410.69	Other location of myocardial infarction
CC 83, 84	Coronary atherosclerosis or angina
CC 79	Cardio-respiratory failure or shock
CC 86	Valvular or rheumatic heart disease
CC 89, 91	Hypertension
CC 95, 96	Stroke
CC 97-99, 103	Cerebrovascular disease
CC 131	Renal failure
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 111-113	Pneumonia
CC 15-20, 120	Diabetes mellitus (DM) or DM complications except proliferative retinopathy
CC 21	Protein-calorie malnutrition
CC 49, 50	Dementia or other specified brain disorders
CC 67-69, 100-102, 177, 178	Hemiplegia, paraplegia, paralysis, functional disability
CC 104, 105	Vascular disease and complications
CC 7, 8	Metastatic cancer, acute leukemia and other severe cancers
CC 154-156, 158-162	Trauma in last year
CC 54-56	Major psychiatric disorders
CC 25-27	Chronic liver disease

Table D.1.3 – 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 46	Coagulation defects and other specified hematological disorders
CC 48	Delirium and encephalopathy
CC 75	Coma, brain compression/anoxic damage

Variable	Description
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
CC 174	Major organ transplant status
CC 175	Other organ transplant/replacement
CC 176	Artificial openings for feeding or elimination

Variable	Description
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb
CC 179	Post-surgical states/aftercare/elective

Outcome

Outcome Criteria for AMI Measure

1. **30-day time frame**
   Rationale: Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality.
2. **All-cause mortality**
   Rationale: From a patient perspective, death is the most critical outcome regardless of cause.

Appendix D.2 Heart Failure

Cohort

Inclusion Criteria for HF Measure

1. **Principal discharge diagnosis of HF**
   Rationale: HF is the condition targeted for measurement (Table D.2.1).
2. **Enrolled in Medicare FFS or VA beneficiaries**
   Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
3. **Aged 65 years or older**
   Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
4. **Not transferred from another acute care facility**
   Rationale: Death is attributed to the hospital where the patient was initially admitted. Transferred patients are still included in the measure cohort, but the "transfer-in" hospitalization is excluded as an index admission.
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-month prior enrollment 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 HF Measure

1. **Discharged alive on the day of admission or the following day who were not transferred**
   Rationale: It is unlikely that these patients had clinically significant HF.
2. **Inconsistent or unknown vital status or other unreliable data**
   Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
3. **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
   Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care.
4. **Discharged against medical advice (AMA)**
   Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

   After exclusions #1-4 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are

randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.

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

ICD-9-CM Codes	Description
402.01	Malignant hypertensive heart disease with congestive heart failure (CHF)
402.11	Benign hypertensive heart disease with CHF
402.91	Hypertensive heart disease with CHF
404.01	Malignant hypertensive heart and renal disease with CHF
404.03	Malignant hypertensive heart and renal disease with CHF & renal failure (RF)
404.11	Benign hypertensive heart and renal disease with CHF
404.13	Benign hypertensive heart and renal disease with CHF & RF
404.91	Unspecified hypertensive heart and renal disease with CHF
404.93	Hypertension and non-specified heart and renal disease with CHF & RF
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Systolic heart failure, acute
428.22	Systolic heart failure, chronic
428.23	Systolic heart failure, acute or chronic
428.30	Diastolic heart failure, unspecified
428.31	Diastolic heart failure, acute
428.32	Diastolic heart failure, chronic
428.33	Diastolic heart failure, acute or chronic
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Combined systolic and diastolic heart failure, acute
428.42	Combined systolic and diastolic heart failure, chronic
428.43	Combined systolic and diastolic heart failure, acute or chronic
428.9	Heart failure, unspecified

Risk Adjustment

Table D.2.2 – Risk Variables for HF Measure

Variable	Description
n/a	Age-65 (years above 65, continuous)
n/a	Male
ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index	History of PTCA

Variable	Description
procedure codes); V4582 (index secondary diagnosis code)	
36.10 to 36.16 (pre-index procedure codes); V4581 (index secondary diagnosis code)	History of CABG
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of ischemic heart disease
CC 83, 84	Coronary atherosclerosis or angina
CC 79	Cardio-respiratory failure or shock
CC 86	Valvular or rheumatic heart disease
CC 89, 91	Hypertension
CC 95, 96	Stroke
CC 131	Renal failure
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 111-113	Pneumonia
CC 15-20, 120	Diabetes mellitus (DM) or DM complications except proliferative retinopathy
CC 21	Protein-calorie malnutrition
CC 49, 50	Dementia or other specified brain disorders
CC 67-69, 100-102, 177, 178	Hemiplegia, paraplegia, paralysis, functional disability
CC 104, 105	Vascular disease and complications
CC 7, 8	Metastatic cancer, acute leukemia and other severe cancers
CC 154-156, 158-162	Trauma in last year
CC 54-56	Major psychiatric disorders
CC 25-27	Chronic liver disease

Table D.2.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of HF 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 46	Coagulation defects and other specified hematological disorders

Variable	Description
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
CC 174	Major organ transplant status

Variable	Description
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

Outcome Criteria for HF Measure

1. **30-day time frame**
   Rationale: Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality.
2. **All-cause mortality**
   Rationale: From a patient perspective, death is the most critical outcome regardless of cause.

Appendix D.3 Pneumonia

Cohort

Inclusion Criteria for Pneumonia Measure

1. **Principal discharge diagnosis of condition**
   Rationale: Pneumonia is the condition targeted for measurement (Table D.3.1).
2. **Enrolled in Medicare FFS or VA beneficiaries**
   Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
3. **Aged 65 years or older**
   Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
4. **Not transferred from another acute care facility**
   Rationale: Death is attributed to the hospital where the patient was initially admitted. Transferred patients are still included in the measure cohort, but the "transfer-in" hospitalization is excluded as an index admission.
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-month prior enrollment 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 Pneumonia Measure

1. **Discharged alive on the day of admission or the following day who were not transferred**
   Rationale: It is unlikely that these patients had clinically significant pneumonia.
2. **Inconsistent or unknown vital status or other unreliable data**
   Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database or where the date of death occurs before the date of discharge but the patient was discharged alive.
3. **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
   Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care for these patients.
4. **Discharged against medical advice (AMA)**
   Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

   After exclusions #1-4 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are

randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.

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

ICD-9-CM Codes	Description
480.0	Pneumonia due to adenovirus
480.1	Pneumonia due to respiratory syncytial virus
480.2	Pneumonia due to parainfluenza virus
480.3	Pneumonia due to SARS-associated coronavirus
480.8	Viral pneumonia: pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia unspecified
481	Pneumococcal pneumonia (streptococcus pneumoniae pneumonia)
482.0	Pneumonia due to klebsiella pneumoniae
482.1	Pneumonia due to pseudomonas
482.2	Pneumonia due to hemophilus influenzae (h. influenzae)
482.30	Pneumonia due to streptococcus unspecified
482.31	Pneumonia due to streptococcus group a
482.32	Pneumonia due to streptococcus group b
482.39	Pneumonia due to other streptococcus
482.40	Pneumonia due to staphylococcus unspecified
482.41	Pneumonia due to staphylococcus aureus
482.42	Methicillin resistant pneumonia due to Staphylococcus aureus
482.49	Other staphylococcus pneumonia
482.81	Pneumonia due to anaerobes
482.82	Pneumonia due to escherichia coli (e.coli)
482.83	Pneumonia due to other gram-negative bacteria
482.84	Pneumonia due to legionnaires' disease
482.89	Pneumonia due to other specified bacteria
482.9	Bacterial pneumonia unspecified
483.0	Pneumonia due to mycoplasma pneumoniae
483.1	Pneumonia due to chlamydia
483.8	Pneumonia due to other specified organism
485	Bronchopneumonia organism unspecified
486	Pneumonia organism unspecified
487.0	Influenza with pneumonia
488.11	Influenza due to identified novel H1N1 influenza virus with pneumonia

Risk Adjustment

Table D.3.2 – Risk Variables for Pneumonia Measure

Variable	Description
n/a	Age-65 (years above 65, continuous)
n/a	Male
ICD-9-CM 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 (pre-index procedure codes); V4582 (index secondary diagnosis code)	History of PTCA
ICD-9-CM 36.10 to 36.16 (pre-index procedure codes); V45.81 (index secondary diagnosis code)	History of CABG
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of ischemic heart disease
CC 83, 84	Coronary atherosclerosis or angina
CC 79	Cardio-respiratory failure or shock
CC 89, 91	Hypertension
CC 95, 96	Stroke
CC 97-99, 103	Cerebrovascular disease
CC 131	Renal failure
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 111-113	Pneumonia
CC 21	Protein-calorie malnutrition
CC 49, 50	Dementia or other specified brain disorders
CC 67-69, 100-102, 177, 178	Hemiplegia, paraplegia, paralysis, functional disability
CC 104, 105	Vascular disease and complications
CC 7,8	Metastatic cancer, acute leukemia and other severe cancers
CC 154-156, 158-162	Trauma in last year
CC 54-56	Major psychiatric disorders
CC 25-27	Chronic liver disease
CC 44	Severe hematological disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 58	Depression
CC 73	Parkinson's or Huntington's diseases
CC 74	Seizure disorders and convulsions

Variable	Description
CC 109	Fibrosis of lung or other chronic lung disorders
CC 110	Asthma
CC 157	Vertebral fractures

Table D.3.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of Pneumonia 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 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
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

Outcome Criteria for Pneumonia Measure

1. **30-day time frame**
   Rationale: Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality.
2. **All-cause mortality**
   Rationale: From a patient perspective, death is the most critical outcome regardless of cause.

Appendix D.4 COPD

Cohort

Inclusion Criteria for COPD Measure

1. **Principal discharge diagnosis of COPD or principal discharge diagnosis of respiratory failure with a secondary diagnosis of COPD**
   Rationale: COPD is the condition targeted for measurement. Respiratory failure patients with a secondary diagnosis of COPD are also included in order to capture the full spectrum of severity among patients hospitalized with exacerbations of COPD (Table D.4.1).
2. **Enrolled in Medicare FFS beneficiaries**
   Rationale: Claims data are consistently available for Medicare FFS beneficiaries.
3. **Aged 65 years or older**
   Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
4. **Not transferred from another acute care facility**
   Rationale: Death is attributed to the hospital where the patient was initially admitted. Transferred patients are still included in the measure cohort, but the "transfer-in" hospitalization is excluded as an index admission.
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-month prior enrollment 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 COPD Measure

1. **Inconsistent or unknown vital status or other unreliable 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.
2. **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: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care.
3. **Discharged against medical advice (AMA)**
   Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

   After exclusions #1-3 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. Similarly, for the three year combined data, when index admissions occur during

the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.

Table D.4.1 – ICD-9-CM Codes for COPD Cohort

ICD-9-CM Codes	Description
491.21	Obstructive chronic bronchitis; with (acute) exacerbation; acute exacerbation of COPD, decompensated COPD, decompensated COPD with exacerbation.
491.22	Obstructive chronic bronchitis; with acute bronchitis
491.8	Other chronic bronchitis. Chronic: tracheitis, tracheobronchitis.
491.9	Unspecified chronic bronchitis
492.8	Other emphysema; emphysema (lung or pulmonary): NOS, centriacinar, centrilobular, obstructive, panacinar, panlobular, unilateral, vesicular. MacLeod's syndrome; Swyer-James syndrome; unilateral hyperlucent lung
493.20	Chronic obstructive asthma; asthma with COPD, chronic asthmatic bronchitis, unspecified
493.21	Chronic obstructive asthma; asthma with COPD, chronic asthmatic bronchitis, with status asthmaticus
493.22	Chronic obstructive asthma; asthma with COPD, chronic asthmatic bronchitis, with (acute) exacerbation
496	Chronic: nonspecific lung disease, obstructive lung disease, obstructive pulmonary disease (COPD) NOS. NOTE: This code is not to be used with any code from categories 491-493.
518.81[§§]	Other diseases of lung; acute respiratory failure; respiratory failure NOS
518.82[***]	Other diseases of lung; acute respiratory failure; other pulmonary insufficiency, acute respiratory distress
518.84[†††]	Other diseases of lung; acute respiratory failure; acute and chronic respiratory failure
799.1[‡‡‡]	Other ill-defined and unknown causes of morbidity and mortality; respiratory arrest, cardiorespiratory failure

[§§] Principal diagnosis when combined with a secondary diagnosis of COPD (491.21, 491.22, 493.21, or 493.22)
[***] Principal diagnosis when combined with a secondary diagnosis of COPD (491.21, 491.22, 493.21, or 493.22)
[†††] Principal diagnosis when combined with a secondary diagnosis of COPD (491.21, 491.22, 493.21, or 493.22)
[‡‡‡] Principal diagnosis when combined with a secondary diagnosis of COPD (491.21, 491.22, 493.21, or 493.22)

Risk Adjustment

Table D.4.2 – Risk Variables for COPD Measure

Variable	Description
N/A	Age-65 (years above 65, continuous)
ICD-9-CM codes: 93.90, 96.70, 96.71, 96.72	History of mechanical ventilation
ICD-9-CM codes: 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57	Sleep apnea
CC 77-78	Respirator dependence/respiratory failure
CC 79	Cardio-respiratory failure or shock
CC 80	Congestive heart failure
CC 83-84	Coronary atherosclerosis or angina
CC 92-93	Arrhythmias
CC 104-106	Vascular or circulatory disease
CC 109	Fibrosis of lung or other chronic lung disorder
CC 110	Asthma
CC 111-113	Pneumonia
CC 114	Pleural effusion/pneumothorax
CC 115	Other lung disorders
CC 7	Metastatic cancer and acute leukemia
CC 8	Lung, upper digestive tract, and other severe cancers
CC 9-11	Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms
CC 12	Other digestive and urinary neoplasms
CC 15-20, 119-120	Diabetes mellitus (DM) or DM complications
CC 21	Protein-calorie malnutrition
CC 22-23	Disorders of fluid/electrolyte/acid-base
CC 24	Other endocrine/metabolic/nutritional disorders
CC 36	Other gastrointestinal disorders
CC 40	Osteoarthritis of hip or knee
CC 43	Other musculoskeletal and connective tissue disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49-50	Dementia or other specified brain disorders
CC 53	Drug/alcohol abuse, without dependence
CC 60	Other psychiatric disorders
CC 67-69, 100-102, 177-178	Hemiplegia, paraplegia, paralysis, functional disability
CC 76	Mononeuropathy, other neurological conditions/injuries

Variable	Description
CC 90-91	Hypertension and hypertensive disease
CC 95-96	Stroke
CC 121	Retinal disorders, except detachment and vascular retinopathies
CC 124	Other eye disorders
CC 127	Other ear, nose, throat and mouth disorders
CC 131	Renal failure
CC 148-149	Decubitus ulcer or chronic skin ulcer
CC 153	Other dermatological disorders
CC 154-156, 158-161	Trauma
CC 157	Vertebral fractures
CC 164	Major complications of medical care and trauma

Table D.4.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of COPD 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 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
CC 92	Specified heart arrhythmias
CC 93	Other heart rhythm and conduction disorders
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	Cerebral palsy and other paralytic syndromes

Variable	Description
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 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
CC 174	Major organ transplant status
CC 175	Other organ transplant/replacement
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for COPD Measure

1. **30-day time frame**
   Rationale: Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality.
2. **All-cause mortality**
   Rationale: From a patient perspective, death is the most critical outcome regardless of cause.

Appendix D.5 Stroke

Cohort

Inclusion Criteria for Stroke Measure

1. **Principal discharge diagnosis of ischemic stroke**
   Rationale: Ischemic stroke is the condition targeted for measurement (Table D.5.1).
2. **Enrolled in Medicare FFS beneficiaries**
   Rationale: Claims data are consistently available for Medicare FFS beneficiaries.
3. **Aged 65 years or older**
   Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
4. **Not transferred from another acute care facility**
   Rationale: Death is attributed to the hospital where the patient was initially admitted. Transferred patients are still included in the measure cohort, but the "transfer-in" hospitalization is excluded as an index admission.
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-month prior enrollment ensures a full year of administrative data for risk adjustment. Part A is required during the index admission to ensure no that Medicare Advantage patients are included in the measures.

Exclusion Criteria for Stroke Measure

1. **Inconsistent or unknown vital status or other unreliable 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.
2. **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: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care for these patients.
3. **Discharged against medical advice (AMA)**
   Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

After exclusions #1-3 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. Similarly, for the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded from the measure to avoid assigning a single death to two admissions.

Table D.5.1 – ICD-9-CM Codes for Stroke Cohort

ICD-9-CM Codes	Description
433.01	Occlusion and stenosis of precerebral arteries, basilar artery with cerebral infarction
433.11	Occlusion and stenosis of precerebral arteries, carotid artery with cerebral infarction
433.21	Occlusion and stenosis of precerebral arteries, vertebral artery with cerebral infarction
433.31	Occlusion and stenosis of precerebral arteries, multiple and bilateral with cerebral infarction
433.81	Occlusion and stenosis of precerebral arteries, other specified precerebral artery with cerebral infarction
433.91	Occlusion and stenosis of precerebral arteries, unspecified precerebral artery with cerebral infarction, precerebral artery NOS
434.01	Occlusion of cerebral arteries, cerebral thrombosis with cerebral infarction, thrombosis of cerebral arteries
434.11	Occlusion of cerebral arteries, cerebral embolism with cerebral infarction
434.91	Occlusion of cerebral arteries, cerebral artery occlusion, unspecified, with cerebral infarction

Risk Adjustment

Table D.5.2 – Risk Variables for Stroke Measure

Variable	Description
n/a	Age-65 (years above 65, continuous)
n/a	Male
n/a	Emergency department-transfer status
CC 80	Congestive heart failure
CC 86	Valvular or rheumatic heart disease
CC 87-88	Congenital cardiac/circulatory defects
CC 90	Hypertensive heart disease
CC 92	Specified heart arrhythmias
CC 95	Cerebral hemorrhage
CC 96	Ischemic or unspecified stroke
CC 97	Precerebral arterial occlusion and transient cerebral ischemia
CC 98	Cerebral atherosclerosis and aneurysm
CC 100	Hemiplegia/hemiparesis
CC 1, 3-6	History of infection
CC 7, 8	Metastatic cancer, acute leukemia and other severe cancers
CC 9-13	Lymphatic, head and neck, brain, breast, colorectal and other major cancers
CC 21	Protein-calorie malnutrition
CC 22-24	Other significant endocrine and metabolic disorders

Variable	Description
CC 36	Other gastrointestinal disorders
CC 39	Disorders of the vertebrae and spinal discs
CC 40	Osteoarthritis of hip or knee
CC 43	Other musculoskeletal and connective tissue disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49, 50	Dementia or other specified brain disorders
CC 54-56	Major psychiatric disorders
CC 67-69	Quadriplegia, other extensive paralysis
CC 72, 76	Multiple sclerosis
CC 74	Seizure disorders and convulsions
CC 89, 91	Hypertension
CC 104-105	Vascular disease and complications
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 111-113	Pneumonia
CC 114	Pleural effusion/pneumothorax
CC 124	Other eye disorders
CC 127	Other ear, nose, throat, and mouth disorders
CC 130	Dialysis status
CC 131	Renal failure
CC 135	Urinary tract infection
CC 140	Male genital disorders
CC 148	Decubitus ulcer of skin
CC 149	Chronic ulcer of skin, except decubitus
CC 153	Other dermatological disorders

Table D.5.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of Stroke 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 balance
CC 28	Acute liver failure/disease
CC 31	Intestinal obstruction/perforation
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
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

Variable	Description
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 95	Cerebral hemorrhage
CC 96	Ischemic or unspecified stroke
CC 97	Precerebral arterial occlusion and transient cerebral ischemia
CC 100	Hemiplegia/hemiparesis
CC 101	Cerebral palsy and other paralytic syndromes
CC 102	Speech, language, cognitive, perceptual deficits
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, empyema, lung abscess
CC 114	Pleural effusion/pneumothorax
CC 124	Other eye disorders
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
CC154	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
CC 166	Major symptoms, abnormalities
CC 174	Major organ transplant status
CC 175	Other organ transplant/replacement
CC 177	Amputation status, lower limb/amputation complications
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for Stroke Measure

1. **30-day time frame**
   Rationale: Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the outpatient setting. The use of the 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality.
2. **All-cause mortality**
   Rationale: From a patient perspective, death is the most critical outcome regardless of cause.