

2015 Condition-Specific Measures Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Readmission Measures

Acute Myocardial Infarction – Version 8.0

Heart Failure – Version 8.0

Pneumonia – Version 8.0

Chronic Obstructive Pulmonary Disease – Version 4.0

Stroke – Version 4.0

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1. HOW TO USE THIS REPORT

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

This report provides an overview of the measure methodology, methodology updates for 2015 public reporting, and the national results for 2015 public reporting. The appendices provide detailed specifications for each measure, including concise tables of the condition codes used for cohort derivation, risk adjustment and a history of annual updates.

Specifically, the report includes:

- **Section 2 - An overview of the AMI, HF, pneumonia, COPD, and stroke readmission measures:**
 - Background
 - Cohort inclusions and exclusions
 - included and excluded hospitalizations
 - how transferred patients are handled
 - differences in how the AMI, HF, pneumonia, and COPD measure scores are calculated for the Hospital Inpatient Quality Reporting program and the Hospital Readmissions Reduction Program (HRRP) (Section 3025 of the Affordable Care Act)
 - Unplanned readmission outcome
 - Risk-adjustment variables
 - Data sources
 - Readmission rate calculation
 - Categorization of hospitals' performance score
- **Section 3 - 2015 measure updates:**
 - No updates were made to the specifications of the AMI, HF, pneumonia, COPD, and stroke readmission measures for 2015.
- **Section 4 - 2015 measure results:**
 - Results from the models that are used for the Hospital Inpatient Quality Reporting program in 2015.
- **Section 5 - Glossary**

The Appendices contain detailed measure information, including

- [Appendix A](#): Statistical approach to calculating RSRRs;
- [Appendix B](#): Data quality assurance;
- [Appendix C](#): Annual updates to measures since measure development;
- [Appendix D](#): Measure specifications; and,
- [Appendix E](#): Detailed overview of the planned readmission algorithm.

For additional references, the original measure methodology reports, as well as prior updates and specifications reports, are available in the Measure Methodology and Archived Resources sections under the claims-based readmission measures page of [QualityNet](#):

- Hospital 30-Day Acute Myocardial Infarction Readmission Measure: Methodology (2008)¹
- Hospital 30-Day Heart Failure Readmission Measure: Methodology (2008)²
- Hospital 30-Day Pneumonia Readmission Measure: Methodology (2008)³
- Hospital 30-Day Chronic Obstructive Pulmonary Disease Readmission Measure: Methodology (2011)⁴
- 30-Day Readmission Following Acute Ischemic Stroke Hospitalization Measure (2010)⁵
- 2009-2013 Measure Maintenance Technical Reports: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Readmission Measures⁶⁻¹⁰
- 2013 Measure Maintenance Technical Report: Chronic Obstructive Pulmonary Disease¹¹
- 2013 Measure Maintenance Technical Report: Stroke¹²
- 2014 Measures Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Readmission Measures: Acute Myocardial Infarction, Heart Failure, Pneumonia, Chronic Obstructive Pulmonary Disease, and Stroke¹³

The AMI, HF, and pneumonia readmission measure methodologies are also described in the peer-reviewed medical literature.¹⁴⁻¹⁶

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Readmission Measures

In July 2009, CMS began publicly reporting hospital 30-day RSRRs for AMI, HF, and pneumonia for the nation's non-federal short-term acute care hospitals (including Indian Health Services hospitals) and critical access hospitals. In 2011, CMS and the Veterans Health Administration (VA) collaborated to update the readmission measures to include hospitalizations for patients admitted for AMI, HF, or pneumonia in VA hospitals.

In 2014, CMS began publicly reporting two additional readmission measures: Hospital 30-Day Chronic Obstructive Pulmonary Disease (COPD) Readmission Measure and 30-Day Readmission 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.

The readmission measures complement the 30-day mortality measures that CMS reports for AMI, HF, pneumonia, COPD, and stroke.¹⁷⁻¹⁹ Results for all five of these readmission measures are posted on *Hospital Compare*, which CMS updates annually.

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 readmission measures for 2015 public reporting through a process of measure reevaluation. The measures are reevaluated annually to improve them by responding to stakeholder input and incorporating advances in science or changes in coding.

2.2 Overview of Measure Methodology

The 2015 risk-adjusted readmission measures use specifications from the initial measure methodology reports with slight refinements to the measures, as listed in [Appendix C](#) and described in the prior measures updates and specifications reports.¹⁻¹³ The National Quality Forum (NQF) endorsed the AMI, HF, pneumonia, and COPD measures. An overview of the methodology is presented in this section.

The methodology for the Hospital Inpatient Quality Reporting measures described in this report is the same methodology that will be used to calculate excess readmissions for the AMI, HF, pneumonia, and COPD measures for HRRP, Section 3025 of the Affordable Care Act, with certain differences in the measure cohorts, as noted in [Section 2.2.1](#). These differences may make individual hospital's results for the two programs slightly different.

2.2.1 Cohort

Index Admissions Included in Measures

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

- Having a principal discharge diagnosis of AMI, HF, pneumonia, COPD, or stroke for each respective measure;
 - The COPD measure cohort also includes admissions with a principal discharge diagnosis of respiratory failure and secondary diagnosis of COPD with exacerbation
- Enrolled in Medicare fee-for-service (FFS);
- Aged 65 or over;
- Discharged alive from a non-federal acute care hospital;
- Not transferred to another acute care facility; and,
- Enrolled in Part A and Part B Medicare for the 12 months prior to the date of the admission, and enrolled in Part A during the index admission.

VA beneficiaries/hospitalizations are also included in the AMI, HF, and pneumonia readmission measures. Enrollment in Medicare FFS is not required.

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort for each measure are listed in Appendix D.

Index Admissions Excluded from the Measures

The readmission measures exclude index admissions for patients:

- Without at least 30 days post-discharge enrollment in FFS Medicare. This exclusion applies only to patients who have index admissions in non-VA hospitals; or,
- Discharged against medical advice (AMA).

An additional exclusion criterion for the AMI cohort is that patients admitted and discharged on the same day are not included as an index admission because it is unlikely these patients had clinically significant AMIs.

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 records for providers with invalid provider IDs.

Finally, admissions within 30 days of discharge from an index admission are not considered index admissions. Thus, no hospitalization will be counted as both a readmission and an index admission within the same measure. However, because the cohorts for the readmission measures are determined independently of each other, a readmission in one measure may qualify as an index admission in other CMS readmission measures.

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 consider multiple contiguous hospitalizations as a single acute episode of care. Admissions to a hospital within one day of discharge from another hospital are considered transfers whether or not the first institution indicates intent to transfer the patient in the discharge disposition code.

Readmissions for transferred patients are attributed to the hospital that ultimately discharges the patient to a non-acute care setting (e.g., to home or a skilled nursing facility). Thus, if a patient is admitted to Hospital A, transferred to Hospital B, and ultimately discharged from Hospital B to a non-acute care setting, a readmission within 30 days of discharge to any acute care hospital is attributed to Hospital B.

If a patient is readmitted to the same hospital on the same day of discharge for the same diagnosis as the index admission, the measures consider the patient to have had one single continuous admission. However, if the diagnosis of the readmission is different from the index admission, this is considered a readmission in the measures.

Hospital Readmissions Reduction Program (HRRP)

CMS uses the AMI, HF, pneumonia, and COPD readmission measures in HRRP. HRRP includes only subsection (d) hospitals and hospitals located in Maryland. Critical access hospitals, cancer hospitals, and hospitals in United States (U.S.) territories will not be included. Admissions to such hospitals will not be included as index admissions nor counted as readmissions. Because the set of hospitals among which these measures are calculated for the HRRP differs from those used in calculations for the Hospital Inpatient Quality Reporting program, hospital scores may differ.

Note: Subsection (d) hospitals encompass any acute care hospital located in one of the fifty states or the District of Columbia which does not meet any of the following exclusion criteria as defined by the Social Security Act: psychiatric, rehabilitation, children's, or long-term care hospitals, and cancer specialty centers. By definition, all other hospitals are considered subsection (d) hospitals.

More information about the HRRP can be found on [QualityNet's Hospital Readmissions Reduction Program](#) webpage and in the fiscal year (FY) 2013, FY 2014, and FY 2015 IPPS [Final Rules](#) on the CMS website.

2.2.2 Outcome

All-Cause Unplanned Readmissions

The measures count all unplanned readmissions and are designed to capture readmissions that arise from acute clinical events requiring urgent rehospitalization

within 30 days of discharge. Only an unplanned inpatient admission to a short-term acute care hospital can qualify as a readmission. Planned readmissions, which are generally not a signal of quality of care, are not counted. For more detail about how planned readmissions are defined, refer to Section 2.2.3 and Appendix E.

There are a number of reasons for counting unplanned readmissions for all causes in the CMS readmission measures. First, from a patient perspective, an unplanned readmission for any cause is an adverse event. In addition, making inferences about quality issues and accountability based solely on the documented cause of readmission is difficult. For example, a patient with HF who develops a hospital-acquired infection may ultimately be readmitted for sepsis. In this context, considering the readmission to be unrelated to the care the patient received for HF during the index admission would be inappropriate.

30-Day Time Frame

The measures assess unplanned readmissions within a 30-day period from the date of discharge from an 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 discharge 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 readmissions.²⁰

Multiple Readmissions

If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first is counted as a readmission. The measure looks for a dichotomous yes or no outcome of whether each admitted patient has an unplanned readmission within 30 days. If the first readmission after discharge is planned, any subsequent unplanned readmission is not counted as an outcome for that index admission because the unplanned readmission could be related to care provided during the intervening planned readmission rather than during the index admission.

2.2.3 Planned Readmission Algorithm (Version 3.0)

The planned readmission algorithm is a set of criteria for classifying readmissions as planned among the general Medicare population using Medicare administrative claims data. The algorithm identifies admissions that are typically planned and may occur within 30 days of discharge from the hospital.

The planned readmission algorithm has three fundamental principles:

1. A few specific, limited types of care are always considered planned (transplant surgery, maintenance chemotherapy/immunotherapy, rehabilitation);
2. Otherwise, a planned readmission is defined as a non-acute readmission for a scheduled procedure; and,
3. Admissions for acute illness or for complications of care are never planned.

The algorithm was developed in 2011 as part of the Hospital-Wide Readmission measure. In 2013, CMS applied the algorithm to its other readmission measures. The planned readmission algorithm replaced the definition of planned readmissions in the original AMI measure because the algorithm uses a more comprehensive definition. In applying the algorithm to condition- and procedure-specific measures, teams of clinical experts reviewed the algorithm in the context of each measure-specific patient cohort and, where clinically indicated, adapted the content of the algorithm to better reflect the likely clinical experience of each measure's patient cohort. For CMS's AMI, HF, pneumonia, and COPD readmission measures, CMS used the planned readmission algorithm without making any changes. The stroke readmission measure makes one modification to the planned readmission algorithm: it does not consider readmissions for patients readmitted for debridement of wound; infection or burn (Procedure Clinical Classifications Software [CCS] 169) as planned because such treatments are commonly provided for decubitus ulcers that can be complications of care following admission for a stroke.

The planned readmission algorithm uses a flowchart and four tables of specific procedure categories and discharge diagnosis categories to classify readmissions as planned (Appendix E). As illustrated in Figure PR.1, readmissions are considered planned if any of the following occurs during readmission:

1. A procedure is performed that is in one of the procedure categories that are always planned regardless of diagnosis;
2. The principal diagnosis is in one of the diagnosis categories that are always planned; or,
3. A procedure is performed that is in one of the potentially planned procedure categories and the principal diagnosis is not in the list of acute discharge diagnoses.

2.2.4 Risk-Adjustment Variables

In order to perform comparisons of performance between hospitals the measures adjust for variables (e.g., age, 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 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.

All measures except stroke do not adjust for patients' admission source. Additionally, all measures do not adjust for patients' discharge disposition (for example, skilled nursing facility). 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 groups of patients with varying SES receive. 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.²¹

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 comorbidity risk-adjustment variables and [Table D.1.3](#), [Table D.2.3](#), [Table D.3.3](#), [Table D.4.3](#), and [Table D.5.3](#) for the list of complications that are excluded from risk adjustment if occurring during the index admission, for AMI, HF, pneumonia, COPD, and stroke, respectively.

2.2.5 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 hospitalizations between July 1, 2011, and June 30, 2014. The datasets also contain associated inpatient, outpatient, and provider Medicare administrative claims for the 12 months prior to the index admission and one month subsequent 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.¹⁻⁵

2.2.6 Measure Calculation

The measures estimate hospital-level 30-day all-cause RSRRs for each condition using [hierarchical logistic regression models](#). In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals.²² At the patient level, it models the log-odds of hospital readmission within 30 days of discharge using age, selected clinical covariates, and a [hospital-specific intercept](#). At the hospital level, the approach models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of a readmission at the hospital, after accounting for patient risk. The hospital-specific intercepts are given a distribution to account for the clustering (non-independence) of patients within the same hospital.²² If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts should be identical across all hospitals.

The RSRR is calculated as the ratio of the number of "[predicted](#)" readmissions to the number of "[expected](#)" readmissions at a given hospital, multiplied by the [national observed readmission rate](#). For each hospital, the numerator of the ratio is the number

of readmissions within 30 days predicted based on the hospital's performance with its observed case mix, and the denominator is the number of readmissions 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 readmission rates or better quality, while a higher ratio indicates higher-than-expected readmission rates or worse quality.

The "predicted" number of readmissions (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 readmission. 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 a hospital to get a predicted value. The "expected" number of readmissions (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 readmission rate](#). The hierarchical logistic regression models are described fully in [Appendix A](#) and in the original methodology reports.¹⁻⁵

2.2.7 Categorizing Hospital Performance

To categorize hospital performance, CMS estimates each hospital's RSRR and the corresponding 95% [interval estimate](#). CMS assigns hospitals to a performance category by comparing each hospital's RSRR interval estimate to the national observed readmission 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 readmission rate.
- "Worse than U.S. national rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed readmission rate.
- "Better than U.S. national rate" if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed readmission 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 readmission rate 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 2015 PUBLIC REPORTING

3.1 Rationale for Measure Updates

Measure reevaluation ensures that the risk-standardized readmission models are continually assessed and remain valid, given possible changes in clinical practice and coding standards over time, while allowing for model refinements. Annual measure reevaluation is informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, and an assessment of coding trends that reveal shifts in clinical practice or billing patterns. As this report describes, for 2015 public reporting, we undertook the following measures reevaluation activities:

- Updated the Agency for Healthcare Research and Quality (AHRQ) CCS to the 2014 version;
- Validated the performance of each condition-specific model and its corresponding risk-adjustment variables in three recent one-year time periods (July 2011-June 2012, July 2012-June 2013, and July 2013-June 2014);
- Evaluated and validated model performance for the three years combined (July 2011-June 2014); and,
- Updated the measures' SAS analytic package and documentation.

No methodological changes to the measures were made for 2015 public reporting.

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).

3.2 Changes to SAS Analytic Package (SAS Pack)

We made minor refinements to the measure calculation SAS analytic package. The new SAS analytic package and documentation are available upon request by emailing cmsreadmissionmeasures@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 SAS analytic package describes the data files and data elements that feed the model software. Please be aware that CMS does not provide training and technical support for the software. CMS has made the SAS pack available to be completely transparent regarding the measure calculation methodology. However, note that even with the SAS pack it is not possible to replicate the RSRR calculation without the data files which contain longitudinal patient data from the entire national sample of acute care hospitals to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2015 PUBLIC REPORTING

4.1 Assessment of Updated Models

The readmission measures estimate hospital-specific 30-day all-cause RSRRs using hierarchical logistic regression models. See [Section 2](#) for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and technical reports for further details.¹⁻

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We evaluated the performance of the models, using the July 2011 to June 2014 data for 2015 reporting. We examined differences in the frequency of patient risk factors and the model variable coefficients.

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 been readmitted within 30 days of discharge. Potential values range from 0.5, meaning no better than chance, to 1.0, meaning perfect discrimination. A c-statistic of 1.0 indicates perfect prediction, implying patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in patients' outcomes.

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.

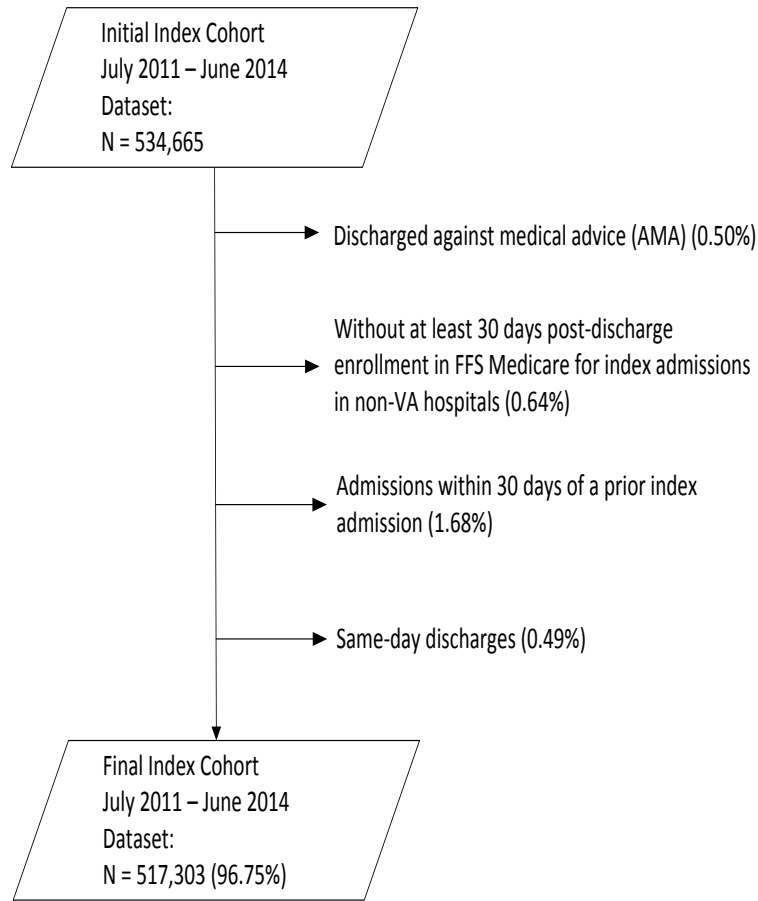
4.2 AMI Readmission 2015 Model Results

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 2011-June 2014 dataset is presented in [Figure 4.2.1](#).

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes hospitalizations for Medicare FFS patients aged 65 or over with a principal discharge diagnosis of AMI; 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; who were not transferred to another acute care facility; and were alive at discharge. VA data is only included for the AMI, HF, and pneumonia measures.

Figure 4.2.1 – AMI Cohort Exclusions in the July 2011-June 2014 Dataset



4.2.2 Frequency of AMI Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables ([Table 4.2.1](#)). Between July 2011-June 2012 and July 2013-June 2014, the observed readmission rate decreased from 17.8% to 16.0%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the 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 the version 5010 format changes the Department of Health and Human Services (DHHS) required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals have submitted more codes, which translated into increased frequencies for some model variables. Notable decreases occurred in Congestive heart failure (CC 80) (32.8% to 31.0%), Acute coronary syndrome (CC 81-82) (22.7% to 21.5%), and Valvular or rheumatic heart disease (CC 86) (32.2% to 31.7%), while notable increases occurred in History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 codes V45.82, 00.66, 36.06, and 36.07) (17.3% to 18.8%), % Males (52.1% to 53.6%), Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120) (47.1% to 47.8%), and Renal failure (CC 131) (27.4% to 28.1%). Refer to [Table 4.2.1](#) for more detail.

4.2.3 AMI Model Parameters and Performance

[Table 4.2.2](#) shows hierarchical regression 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 readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the area under the ROC curve (c-statistic) remained constant at 0.65 ([Table 4.2.4](#)).

4.2.4 Distribution of Hospital Volumes and RSRRs for AMI

[Table 4.2.5](#) shows the distribution of hospital admission volumes and [Table 4.2.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 17.8% between July 2011 and June 2012 to 16.0% between July 2013 and June 2014. The median hospital RSRR in the combined three-year dataset was 16.9% (Interquartile Range [IQR] 16.7% - 17.3%). [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 0.020 (Standard Error [SE]: 0.002). 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 RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation above the national rate were 1.33 times higher than the odds of all-cause readmission if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.²²

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

Of 4,384 hospitals in the study cohort, 30 performed “better than the U.S. national rate,” 2,273 performed “no different from the U.S. national rate,” and 23 performed “worse than the U.S. national rate.” 2,058 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	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Total N	173,601	176,684	167,018	517,303
Observed readmission rate (%)	17.8	17.1	16.0	17.0
Mean age minus 65 (SD)	13.7 (8.3)	13.6 (8.4)	13.3 (8.4)	13.6 (8.3)
Male (%)	52.1	52.6	53.6	52.7
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 codes V45.82, 00.66, 36.06, 36.07)	17.3	18.3	18.8	18.1
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 codes V45.81, 36.10-36.16)	12.0	12.3	12.0	12.1
Congestive heart failure (CC 80)	32.8	32.0	31.0	32.0
Acute coronary syndrome (CC 81-82)	22.7	22.0	21.6	22.1
Anterior myocardial infarction (ICD-9 codes 410.00-410.12)	7.2	6.9	6.8	7.0
Other location of myocardial infarction (ICD-9 codes 410.20-410.62)	11.1	10.8	10.9	11.0
Angina pectoris/old myocardial infarction (CC 83)	28.4	28.3	28.0	28.3
Coronary atherosclerosis (CC 84)	86.6	86.6	86.6	86.6
Valvular or rheumatic heart disease (CC 86)	32.2	32.2	31.7	32.1
Specified arrhythmias and other heart rhythm disorders (CC 92- 93)	35.9	35.9	35.5	35.8
History of infection (CC 1, 3-6)	27.2	27.2	26.6	27.0
Metastatic cancer or acute leukemia (CC 7)	2.1	2.0	2.0	2.1
Cancer (CC 8-12)	19.4	19.1	19.1	19.2
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	47.1	47.6	47.8	47.5
Protein-calorie malnutrition (CC 21)	6.4	6.3	6.1	6.3
Disorders of fluid/electrolyte/acid-base (CC 22-23)	29.0	28.8	28.7	28.8
Iron deficiency or other unspecified anemias and blood disease (CC 47)	48.6	48.0	47.1	47.9
Dementia or other specified brain disorders (CC 49-50)	20.1	19.9	19.2	19.7
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	6.6	6.6	6.6	6.6
Stroke (CC 95-96)	7.6	7.3	7.2	7.4
Cerebrovascular disease (CC 97-99, 103)	21.5	21.2	20.5	21.0
Vascular or circulatory disease (CC 104-106)	37.0	36.7	36.1	36.6
Chronic obstructive pulmonary disease (COPD) (CC 108)	31.5	31.0	30.3	30.9
Asthma (CC 110)	6.8	6.9	7.0	6.9
Pneumonia (CC 111-113)	23.3	23.1	21.9	22.8
End-stage renal disease or dialysis (CC 129-130)	3.2	3.4	3.4	3.3
Renal failure (CC 131)	27.4	27.8	28.1	27.8
Other urinary tract disorders (CC 136)	22.8	22.0	21.1	22.0
Decubitus ulcer or chronic skin ulcer (CC 148-149)	8.0	7.9	7.7	7.9

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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Intercept	-2.417	-2.435	-2.548	-2.466
Age minus 65 (years above 65, continuous)	0.012	0.010	0.011	0.011
Male	-0.098	-0.093	-0.081	-0.092
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 codes V45.82, 00.66, 36.06, 36.07)	-0.073	-0.071	-0.079	-0.075
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 codes V45.81, 36.10-36.16)	0.029	0.029	0.016	0.024
Congestive heart failure (CC 80)	0.186	0.168	0.191	0.181
Acute coronary syndrome (CC 81-82)	0.005	-0.010	0.010	0.001
Anterior myocardial infarction (ICD-9 codes 410.00-410.12)	0.194	0.196	0.224	0.209
Other location of myocardial infarction (ICD-9 codes 410.20-410.62)	-0.080	-0.113	-0.103	-0.094
Angina pectoris/old myocardial infarction (CC 83)	0.014	0.066	0.046	0.043
Coronary atherosclerosis (CC 84)	0.035	0.025	0.029	0.032
Valvular or rheumatic heart disease (CC 86)	0.120	0.121	0.130	0.126
Specified arrhythmias and other heart rhythm disorders (CC 92- 93)	0.100	0.084	0.083	0.090
History of infection (CC 1, 3-6)	0.057	0.042	0.038	0.044
Metastatic cancer or acute leukemia (CC 7)	0.174	0.240	0.263	0.224
Cancer (CC 8-12)	0.028	0.013	0.033	0.024
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	0.179	0.174	0.186	0.177
Protein-calorie malnutrition (CC 21)	0.114	0.096	0.116	0.110
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.109	0.121	0.112	0.114
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.265	0.298	0.303	0.289
Dementia or other specified brain disorders (CC 49-50)	0.035	0.015	0.005	0.017
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.077	0.080	0.053	0.069
Stroke (CC 95-96)	0.061	-0.001	0.015	0.024
Cerebrovascular disease (CC 97-99, 103)	0.026	0.063	0.044	0.045
Vascular or circulatory disease (CC 104-106)	0.099	0.096	0.130	0.107
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.240	0.261	0.258	0.252
Asthma (CC 110)	0.047	0.002	0.003	0.017
Pneumonia (CC 111-113)	0.144	0.149	0.151	0.148
End-stage renal disease or dialysis (CC 129-130)	0.286	0.326	0.289	0.299
Renal failure (CC 131)	0.150	0.147	0.125	0.138
Other urinary tract disorders (CC 136)	0.077	0.071	0.085	0.080
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.098	0.085	0.078	0.087

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

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)	1.01 (1.01 - 1.01)
Male	0.91 (0.88 - 0.93)	0.91 (0.89 - 0.94)	0.92 (0.90 - 0.95)	0.91 (0.90 - 0.93)
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 codes V45.82, 00.66, 36.06, 36.07)	0.93 (0.90 - 0.96)	0.93 (0.90 - 0.96)	0.92 (0.89 - 0.96)	0.93 (0.91 - 0.95)
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 codes V45.81, 36.10-36.16)	1.03 (0.99 - 1.07)	1.03 (0.99 - 1.07)	1.02 (0.98 - 1.06)	1.02 (1.00 - 1.05)
Congestive heart failure (CC 80)	1.20 (1.17 - 1.24)	1.18 (1.15 - 1.22)	1.21 (1.17 - 1.25)	1.20 (1.18 - 1.22)
Acute coronary syndrome (CC 81-82)	1.01 (0.97 - 1.04)	0.99 (0.96 - 1.02)	1.01 (0.98 - 1.05)	1.00 (0.98 - 1.02)
Anterior myocardial infarction (ICD-9 codes 410.00-410.12)	1.21 (1.15 - 1.28)	1.22 (1.16 - 1.28)	1.25 (1.18 - 1.32)	1.23 (1.20 - 1.27)
Other location of myocardial infarction (ICD-9 codes 410.20-410.62)	0.92 (0.88 - 0.97)	0.89 (0.85 - 0.94)	0.90 (0.86 - 0.95)	0.91 (0.89 - 0.94)
Angina pectoris/old myocardial infarction (CC 83)	1.01 (0.98 - 1.05)	1.07 (1.04 - 1.10)	1.05 (1.01 - 1.08)	1.04 (1.03 - 1.06)
Coronary atherosclerosis (CC 84)	1.04 (1.00 - 1.08)	1.03 (0.99 - 1.07)	1.03 (0.99 - 1.07)	1.03 (1.01 - 1.06)
Valvular or rheumatic heart disease (CC 86)	1.13 (1.10 - 1.16)	1.13 (1.10 - 1.16)	1.14 (1.11 - 1.17)	1.13 (1.12 - 1.15)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.11 (1.07 - 1.14)	1.09 (1.06 - 1.12)	1.09 (1.05 - 1.12)	1.09 (1.08 - 1.11)
History of infection (CC 1, 3-6)	1.06 (1.03 - 1.09)	1.04 (1.01 - 1.07)	1.04 (1.01 - 1.07)	1.05 (1.03 - 1.06)
Metastatic cancer or acute leukemia (CC 7)	1.19 (1.09 - 1.29)	1.27 (1.17 - 1.38)	1.30 (1.19 - 1.42)	1.25 (1.19 - 1.31)
Cancer (CC 8-12)	1.03 (1.00 - 1.06)	1.01 (0.98 - 1.05)	1.03 (1.00 - 1.07)	1.02 (1.01 - 1.04)
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	1.20 (1.16 - 1.23)	1.19 (1.16 - 1.22)	1.20 (1.17 - 1.24)	1.19 (1.18 - 1.21)
Protein-calorie malnutrition (CC 21)	1.12 (1.07 - 1.18)	1.10 (1.05 - 1.16)	1.12 (1.07 - 1.18)	1.12 (1.09 - 1.15)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.12 (1.08 - 1.15)	1.13 (1.09 - 1.17)	1.12 (1.08 - 1.16)	1.12 (1.10 - 1.14)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.30 (1.27 - 1.34)	1.35 (1.31 - 1.39)	1.35 (1.31 - 1.40)	1.34 (1.31 - 1.36)
Dementia or other specified brain disorders (CC 49-50)	1.04 (1.00 - 1.07)	1.02 (0.98 - 1.05)	1.01 (0.97 - 1.04)	1.02 (1.00 - 1.04)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.08 (1.03 - 1.14)	1.08 (1.03 - 1.14)	1.05 (1.00 - 1.11)	1.07 (1.04 - 1.10)
Stroke (CC 95-96)	1.06 (1.01 - 1.12)	1.00 (0.95 - 1.05)	1.02 (0.96 - 1.07)	1.02 (1.00 - 1.05)
Cerebrovascular disease (CC 97-99, 103)	1.03 (0.99 - 1.06)	1.07 (1.03 - 1.10)	1.05 (1.01 - 1.08)	1.05 (1.03 - 1.07)
Vascular or circulatory disease (CC 104-106)	1.10 (1.07 - 1.14)	1.10 (1.07 - 1.13)	1.14 (1.11 - 1.17)	1.11 (1.09 - 1.13)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.27 (1.24 - 1.31)	1.30 (1.26 - 1.34)	1.29 (1.26 - 1.33)	1.29 (1.27 - 1.31)
Asthma (CC 110)	1.05 (1.00 - 1.10)	1.00 (0.96 - 1.05)	1.00 (0.95 - 1.06)	1.02 (0.99 - 1.05)
Pneumonia (CC 111-113)	1.16 (1.12 - 1.19)	1.16 (1.13 - 1.20)	1.16 (1.13 - 1.20)	1.16 (1.14 - 1.18)
End-stage renal disease or dialysis (CC 129-130)	1.33 (1.25 - 1.42)	1.39 (1.30 - 1.47)	1.34 (1.25 - 1.42)	1.35 (1.30 - 1.40)
Renal failure (CC 131)	1.16 (1.12 - 1.20)	1.16 (1.12 - 1.20)	1.13 (1.10 - 1.17)	1.15 (1.13 - 1.17)
Other urinary tract disorders (CC 136)	1.08 (1.05 - 1.11)	1.07 (1.04 - 1.11)	1.09 (1.05 - 1.13)	1.08 (1.06 - 1.10)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.10 (1.06 - 1.15)	1.09 (1.04 - 1.14)	1.08 (1.03 - 1.13)	1.09 (1.06 - 1.12)

Table 4.2.4 – AMI Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Predictive ability, % (lowest decile – highest decile)	6.1 – 32.0	5.8 – 31.3	5.3 – 29.7	5.7 – 30.9
c-statistic	0.65	0.65	0.65	0.65

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

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	3,985	3,953	3,809	4,384
Mean number of admissions (SD)	43.6 (64.5)	44.7 (66.1)	43.8 (62.8)	118.0 (185.8)
Range (min. – max.)	1 – 539	1 – 574	1 – 504	1 – 1582
25 th percentile	3	3	3	7
50 th percentile	14	15	16	31
75 th percentile	60	62	63	160

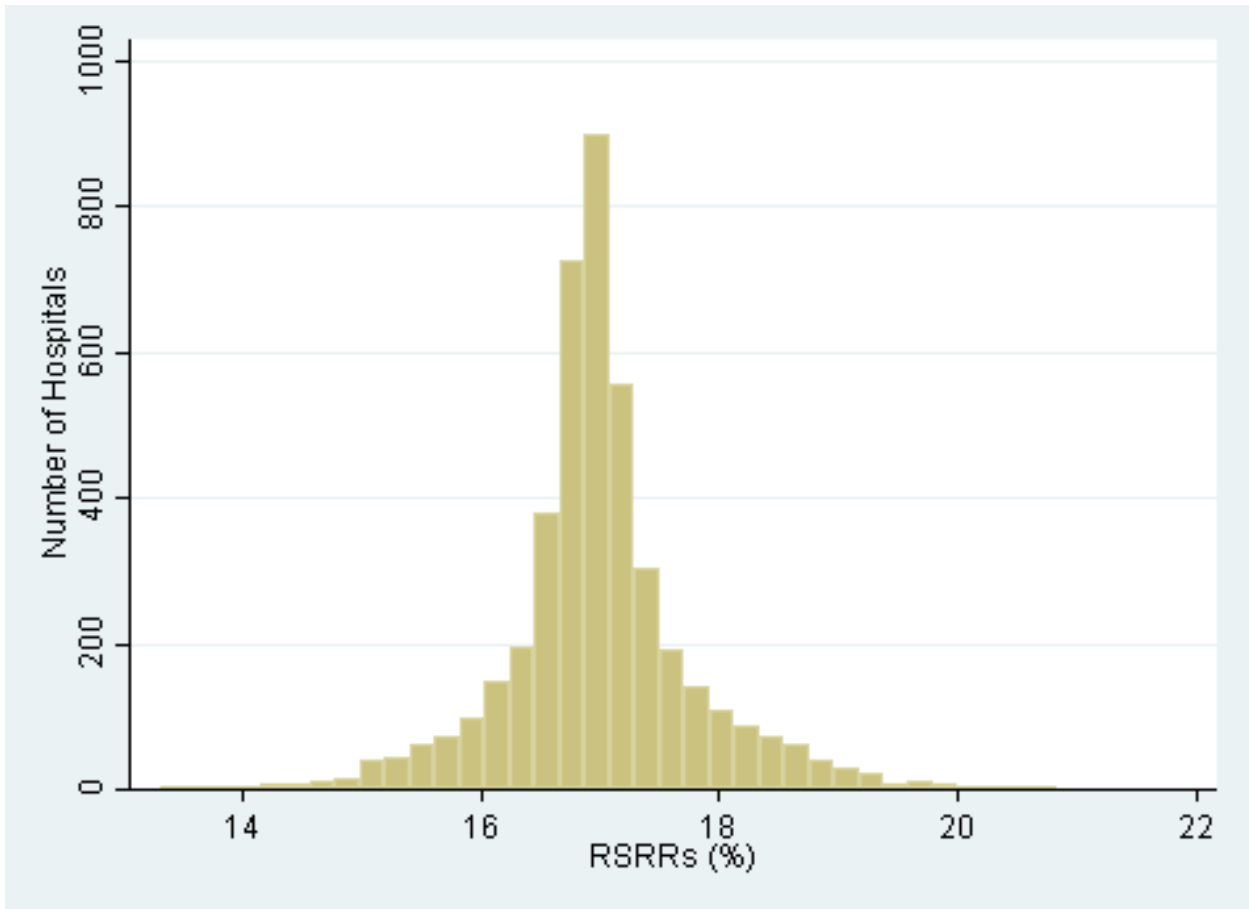
Table 4.2.6 – Distribution of Hospital AMI RSRs Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	3,985	3,953	3,809	4,384
Mean (SD)	17.8 (0.5)	17.1 (0.6)	16.0 (0.5)	17.0 (0.8)
Range (min. – max.)	14.6 – 20.7	14.1 – 20.7	13.5– 19.7	13.3– 20.8
25 th percentile	17.6	16.9	15.8	16.7
50 th percentile	17.8	17.1	16.0	16.9
75 th percentile	18.0	17.4	16.2	17.3

Table 4.2.7 – Between Hospital Variance for AMI

	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Between hospital variance (SE)	0.017 (0.003)	0.021 (0.003)	0.020 (0.003)	0.020 (0.002)

Figure 4.2.2 - Distribution of Hospital 30-Day AMI RSRRs Between July 2011 and June 2014



N= 4,384 hospitals

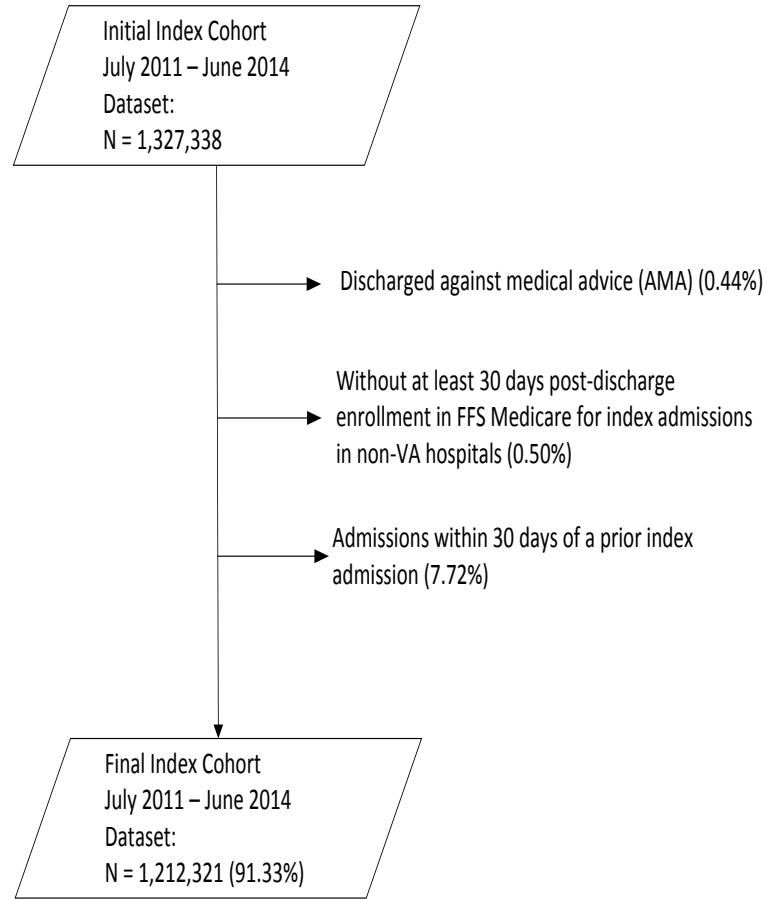
4.3 HF Readmission 2015 Model Results

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 2011-June 2014 dataset is presented in [Figure 4.3.1](#).

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes hospitalizations for Medicare FFS patients aged 65 or over with a principal discharge diagnosis of HF; 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; who were not transferred to another acute care facility; and were alive at discharge. VA data is only included for the AMI, HF, and pneumonia measures.

Figure 4.3.1 – HF Cohort Exclusions in the July 2011-June 2014 Dataset



4.3.2 Frequency of HF Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables ([Table 4.3.1](#)). Between July 2011-June 2012 and July 2013-June 2014, the observed readmission rate decreased from 22.7% to 21.2%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the 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 the version 5010 format changes DHHS required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals have submitted more codes, which translated into increased frequencies for some model variables. Notable decreases occurred in Coronary atherosclerosis or angina (CC 83-84) (75.4% to 73.7%), Congestive heart failure (CC 80) (77.4% to 76.1%), and Other or unspecified heart disease (CC 94) (33.9% to 33.0%), while notable increases occurred in Cardio-respiratory failure or shock (CC 79) (27.3% to 29.6%), Specified arrhythmias and other heart rhythm disorders (CC 92-93) (68.7% to 68.9%), and Valvular or rheumatic heart disease (CC 86) (53.8% to 53.9%). Refer to [Table 4.3.1](#) for more detail.

4.3.3 HF Model Parameters and Performance

[Table 4.3.2](#) shows hierarchical regression 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 readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the area under the ROC curve (c-statistic) remained constant at 0.61 ([Table 4.3.4](#)).

4.3.4 Distribution of Hospital Volumes and RSRRs for HF

[Table 4.3.5](#) shows the distribution of hospital admission volumes and [Table 4.3.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 22.7% between July 2011 and June 2012 to 21.2% between July 2013 and June 2014. The median hospital RSRR in the combined three-year dataset was 21.9% (IQR 21.2% - 22.8%). [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 0.022 (SE: 0.001). 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 RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation above the national rate were 1.34 times higher than the odds of all-cause readmission if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.²²

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

Of 4,778 hospitals in the study cohort, 100 performed “better than the U.S. national rate,” 3,766 performed “no different from the U.S. national rate,” and 133 performed “worse than the U.S. national rate.” 779 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	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Total N	413,668	405,807	392,846	1,212,321
Observed readmission rate (%)	22.7	22.1	21.2	22.0
Mean age minus 65 (SD)	15.9 (8.2)	15.9 (8.3)	15.7 (8.4)	15.8 (8.3)
Male (%)	46.0	46.7	47.5	46.7
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	19.7	19.9	19.6	19.7
Cardio-respiratory failure or shock (CC 79)	27.3	28.2	29.6	28.4
Congestive heart failure (CC 80)	77.4	76.5	76.1	76.6
Acute coronary syndrome (CC 81-82)	17.3	17.1	16.8	17.1
Coronary atherosclerosis or angina (CC 83-84)	75.4	74.5	73.7	74.5
Valvular or rheumatic heart disease (CC 86)	53.8	54.1	53.9	53.9
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	68.7	68.9	68.9	68.8
Other or unspecified heart disease (CC 94)	33.9	33.4	33.0	33.4
Vascular or circulatory disease (CC 104-106)	54.2	53.8	53.6	53.9
Metastatic cancer or acute leukemia (CC 7)	2.2	2.3	2.3	2.3
Cancer (CC 8-12)	21.6	21.5	21.6	21.5
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	54.9	54.8	55.3	55.0
Protein-calorie malnutrition (CC 21)	9.9	10.0	9.9	9.9
Disorders of fluid/electrolyte/acid-base (CC 22-23)	50.1	50.0	50.1	50.0
Liver or biliary disease (CC 25-30)	11.2	11.3	11.3	11.3
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	15.8	15.5	15.3	15.5
Other gastrointestinal disorders (CC 36)	63.9	64.3	64.4	64.2
Severe hematological disorders (CC 44)	3.8	2.5	2.4	2.9
Iron deficiency or other unspecified anemias and blood disease (CC 47)	64.6	64.1	63.9	64.2
Dementia or other specified brain disorders (CC 49-50)	24.9	24.5	24.3	24.5
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	13.5	14.2	14.8	14.2
Major psychiatric disorders (CC 54-56)	10.9	10.8	11.1	10.9
Depression (CC 58)	21.3	21.9	22.1	21.8
Other psychiatric disorders (CC 60)	17.4	20.0	21.4	19.6
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	8.8	8.8	8.7	8.8
Stroke (CC 95-96)	9.7	9.5	9.3	9.5
Chronic obstructive pulmonary disease (COPD) (CC 108)	49.7	49.6	49.1	49.5
Fibrosis of lung or other chronic lung disorders (CC 109)	11.7	10.3	9.6	10.6
Asthma (CC 110)	9.7	9.9	10.0	9.9
Pneumonia (CC 111-113)	45.4	45.7	45.3	45.5
End-stage renal disease or dialysis (CC 129-130)	4.8	4.7	4.5	4.7
Renal failure (CC 131)	51.1	51.8	52.8	51.9

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Nephritis (CC 132)	4.2	4.2	4.4	4.3
Other urinary tract disorders (CC 136)	34.1	33.1	32.1	33.1
Decubitus ulcer or chronic skin ulcer (CC 148-149)	14.8	14.7	14.7	14.7

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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Intercept	-2.127	-2.121	-2.175	-2.140
Age minus 65 (years above 65, continuous)	0.000	-0.001	-0.003	-0.001
Male	0.005	-0.009	-0.023	-0.009
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	-0.029	-0.006	0.006	-0.009
Cardio-respiratory failure or shock (CC 79)	0.091	0.084	0.107	0.094
Congestive heart failure (CC 80)	0.124	0.132	0.138	0.130
Acute coronary syndrome (CC 81-82)	0.110	0.115	0.106	0.107
Coronary atherosclerosis or angina (CC 83-84)	0.056	0.052	0.054	0.053
Valvular or rheumatic heart disease (CC 86)	0.044	0.042	0.047	0.048
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.051	0.026	0.062	0.047
Other or unspecified heart disease (CC 94)	0.050	0.029	0.029	0.039
Vascular or circulatory disease (CC 104-106)	0.069	0.073	0.071	0.070
Metastatic cancer or acute leukemia (CC 7)	0.158	0.131	0.166	0.149
Cancer (CC 8-12)	0.016	0.030	0.018	0.021
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	0.085	0.071	0.094	0.080
Protein-calorie malnutrition (CC 21)	0.080	0.075	0.081	0.080
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.112	0.122	0.087	0.107
Liver or biliary disease (CC 25-30)	0.067	0.076	0.071	0.069
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	0.061	0.072	0.066	0.066
Other gastrointestinal disorders (CC 36)	0.065	0.056	0.064	0.062
Severe hematological disorders (CC 44)	0.143	0.153	0.190	0.166
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.126	0.144	0.132	0.134
Dementia or other specified brain disorders (CC 49-50)	0.035	0.011	0.023	0.021
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	0.105	0.075	0.105	0.094
Major psychiatric disorders (CC 54-56)	0.045	0.037	0.048	0.043
Depression (CC 58)	0.027	0.008	0.012	0.018
Other psychiatric disorders (CC 60)	0.066	0.064	0.051	0.055
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.030	0.039	0.049	0.038
Stroke (CC 95-96)	0.016	0.041	0.019	0.023
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.152	0.146	0.154	0.149

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Fibrosis of lung or other chronic lung disorders (CC 109)	0.052	0.067	0.059	0.064
Asthma (CC 110)	-0.002	0.022	0.024	0.012
Pneumonia (CC 111-113)	0.087	0.095	0.080	0.086
End-stage renal disease or dialysis (CC 129-130)	0.139	0.077	0.126	0.112
Renal failure (CC 131)	0.179	0.162	0.178	0.172
Nephritis (CC 132)	0.071	0.128	0.059	0.085
Other urinary tract disorders (CC 136)	0.076	0.058	0.052	0.065
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.085	0.084	0.103	0.090

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

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
Male	1.01 (0.99 - 1.02)	0.99 (0.98 - 1.01)	0.98 (0.96 - 0.99)	0.99 (0.98 - 1.00)
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	0.97 (0.95 - 0.99)	0.99 (0.97 - 1.01)	1.01 (0.99 - 1.03)	0.99 (0.98 - 1.00)
Cardio-respiratory failure or shock (CC 79)	1.10 (1.08 - 1.12)	1.09 (1.07 - 1.11)	1.11 (1.09 - 1.13)	1.10 (1.09 - 1.11)
Congestive heart failure (CC 80)	1.13 (1.11 - 1.16)	1.14 (1.12 - 1.17)	1.15 (1.12 - 1.17)	1.14 (1.13 - 1.15)
Acute coronary syndrome (CC 81-82)	1.12 (1.10 - 1.14)	1.12 (1.10 - 1.14)	1.11 (1.09 - 1.13)	1.11 (1.10 - 1.13)
Coronary atherosclerosis or angina (CC 83-84)	1.06 (1.04 - 1.08)	1.05 (1.03 - 1.08)	1.06 (1.03 - 1.08)	1.05 (1.04 - 1.07)
Valvular or rheumatic heart disease (CC 86)	1.05 (1.03 - 1.06)	1.04 (1.03 - 1.06)	1.05 (1.03 - 1.07)	1.05 (1.04 - 1.06)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.05 (1.03 - 1.07)	1.03 (1.01 - 1.05)	1.06 (1.04 - 1.08)	1.05 (1.04 - 1.06)
Other or unspecified heart disease (CC 94)	1.05 (1.03 - 1.07)	1.03 (1.01 - 1.05)	1.03 (1.01 - 1.05)	1.04 (1.03 - 1.05)
Vascular or circulatory disease (CC 104-106)	1.07 (1.05 - 1.09)	1.08 (1.06 - 1.09)	1.07 (1.06 - 1.09)	1.07 (1.06 - 1.08)
Metastatic cancer or acute leukemia (CC 7)	1.17 (1.12 - 1.23)	1.14 (1.09 - 1.20)	1.18 (1.12 - 1.24)	1.16 (1.13 - 1.20)
Cancer (CC 8-12)	1.02 (1.00 - 1.04)	1.03 (1.01 - 1.05)	1.02 (1.00 - 1.04)	1.02 (1.01 - 1.03)
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	1.09 (1.07 - 1.11)	1.07 (1.06 - 1.09)	1.10 (1.08 - 1.12)	1.08 (1.07 - 1.09)
Protein-calorie malnutrition (CC 21)	1.08 (1.06 - 1.11)	1.08 (1.05 - 1.11)	1.08 (1.06 - 1.11)	1.08 (1.07 - 1.10)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.12 (1.10 - 1.14)	1.13 (1.11 - 1.15)	1.09 (1.07 - 1.11)	1.11 (1.10 - 1.13)
Liver or biliary disease (CC 25-30)	1.07 (1.05 - 1.09)	1.08 (1.06 - 1.11)	1.07 (1.05 - 1.10)	1.07 (1.06 - 1.09)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.06 (1.04 - 1.09)	1.07 (1.05 - 1.10)	1.07 (1.05 - 1.09)	1.07 (1.06 - 1.08)
Other gastrointestinal disorders (CC 36)	1.07 (1.05 - 1.09)	1.06 (1.04 - 1.08)	1.07 (1.05 - 1.09)	1.06 (1.05 - 1.08)
Severe hematological disorders (CC 44)	1.15 (1.11 - 1.20)	1.17 (1.11 - 1.22)	1.21 (1.15 - 1.27)	1.18 (1.15 - 1.21)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.13 (1.11 - 1.15)	1.16 (1.13 - 1.18)	1.14 (1.12 - 1.16)	1.14 (1.13 - 1.16)
Dementia or other specified brain disorders (CC 49-50)	1.04 (1.02 - 1.05)	1.01 (0.99 - 1.03)	1.02 (1.00 - 1.04)	1.02 (1.01 - 1.03)
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	1.11 (1.09 - 1.14)	1.08 (1.05 - 1.10)	1.11 (1.09 - 1.14)	1.10 (1.08 - 1.11)
Major psychiatric disorders (CC 54-56)	1.05 (1.02 - 1.07)	1.04 (1.01 - 1.06)	1.05 (1.02 - 1.08)	1.04 (1.03 - 1.06)
Depression (CC 58)	1.03 (1.01 - 1.05)	1.01 (0.99 - 1.03)	1.01 (0.99 - 1.03)	1.02 (1.01 - 1.03)
Other psychiatric disorders (CC 60)	1.07 (1.05 - 1.09)	1.07 (1.05 - 1.09)	1.05 (1.03 - 1.07)	1.06 (1.05 - 1.07)

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.03 (1.00 - 1.06)	1.04 (1.01 - 1.07)	1.05 (1.02 - 1.08)	1.04 (1.02 - 1.06)
Stroke (CC 95-96)	1.02 (0.99 - 1.04)	1.04 (1.02 - 1.07)	1.02 (0.99 - 1.05)	1.02 (1.01 - 1.04)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.16 (1.15 - 1.18)	1.16 (1.14 - 1.18)	1.17 (1.15 - 1.19)	1.16 (1.15 - 1.17)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.05 (1.03 - 1.08)	1.07 (1.04 - 1.10)	1.06 (1.03 - 1.09)	1.07 (1.05 - 1.08)
Asthma (CC 110)	1.00 (0.97 - 1.02)	1.02 (1.00 - 1.05)	1.03 (1.00 - 1.05)	1.01 (1.00 - 1.03)
Pneumonia (CC 111-113)	1.09 (1.07 - 1.11)	1.10 (1.08 - 1.12)	1.08 (1.06 - 1.10)	1.09 (1.08 - 1.10)
End-stage renal disease or dialysis (CC 129-130)	1.15 (1.11 - 1.19)	1.08 (1.04 - 1.12)	1.14 (1.10 - 1.18)	1.12 (1.10 - 1.14)
Renal failure (CC 131)	1.20 (1.17 - 1.22)	1.18 (1.15 - 1.20)	1.20 (1.17 - 1.22)	1.19 (1.18 - 1.20)
Nephritis (CC 132)	1.07 (1.04 - 1.11)	1.14 (1.10 - 1.18)	1.06 (1.02 - 1.10)	1.09 (1.07 - 1.11)
Other urinary tract disorders (CC 136)	1.08 (1.06 - 1.10)	1.06 (1.04 - 1.08)	1.05 (1.04 - 1.07)	1.07 (1.06 - 1.08)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.09 (1.07 - 1.11)	1.09 (1.07 - 1.11)	1.11 (1.09 - 1.13)	1.09 (1.08 - 1.11)

Table 4.3.4 – HF Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Predictive ability, % (lowest decile – highest decile)	13.1 – 36.7	13.2 – 35.4	12.2 – 34.8	12.9 – 35.6
c-statistic	0.61	0.61	0.61	0.61

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

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,680	4,655	4,604	4,778
Mean number of admissions (SD)	88.4 (107.8)	87.2 (106.6)	85.3 (105.5)	253.7 (316.1)
Range (min. – max.)	1 - 1163	1 - 1138	1 - 1188	1 - 3489
25 th percentile	15	15	14	41
50 th percentile	46	45	43	125
75 th percentile	125	124	122	362

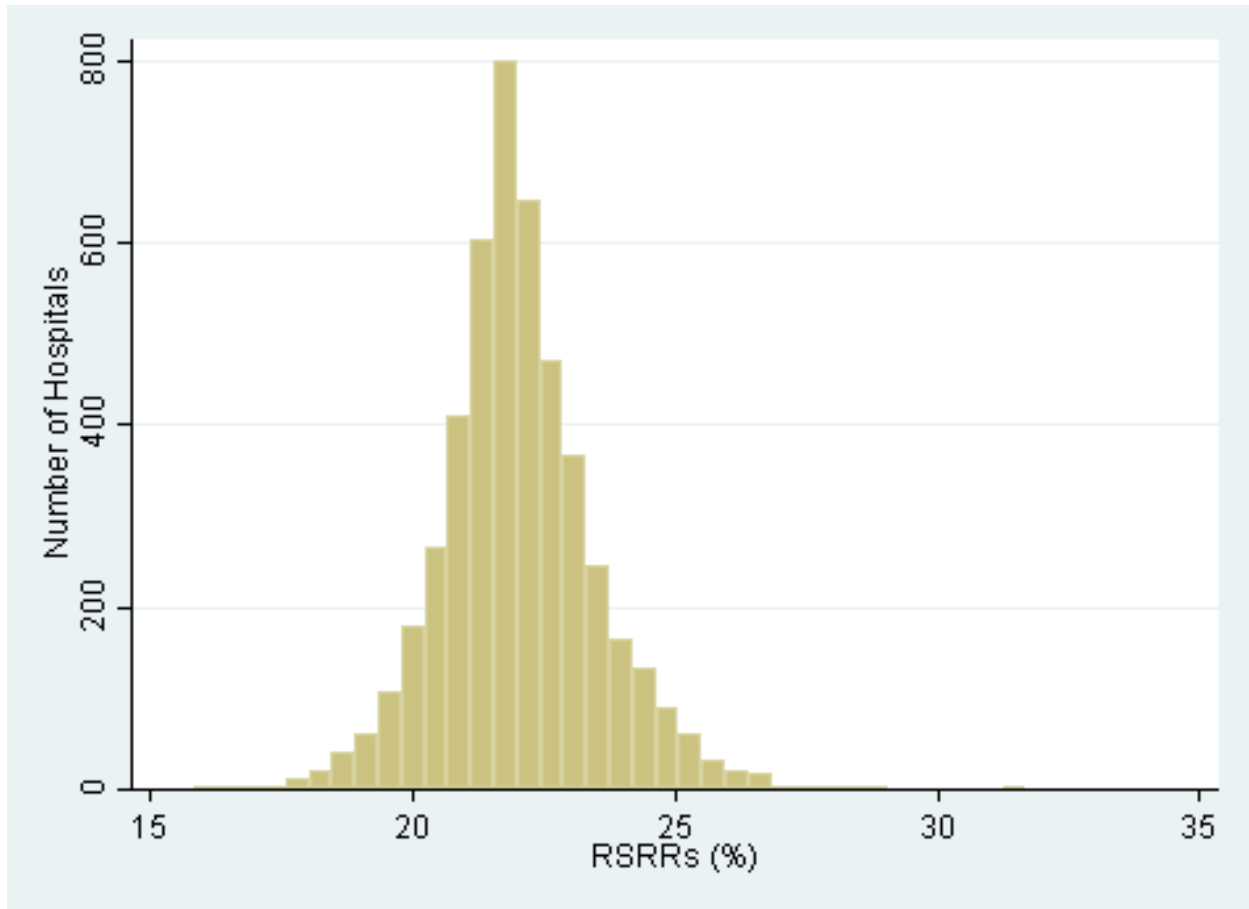
Table 4.3.6 – Distribution of Hospital HF RSRRs Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,680	4,655	4,604	4,778
Mean (SD)	22.7 (1.2)	22.1 (1.0)	21.2 (0.9)	22.0 (1.5)
Range (min. – max.)	17.6 – 29.3	17.1 - 28.1	16.9 – 26.4	15.8 - 31.7
25 th percentile	22.1	21.5	20.8	21.2
50 th percentile	22.7	22.0	21.2	21.9
75 th percentile	23.3	22.5	21.6	22.8

Table 4.3.7 – Between Hospital Variance for HF

	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Between hospital variance (SE)	0.024 (0.002)	0.020 (0.002)	0.019 (0.002)	0.022 (0.001)

Figure 4.3.2 - Distribution of Hospital 30-Day HF RSRRs Between July 2011 and June 2014



N= 4,778 hospitals

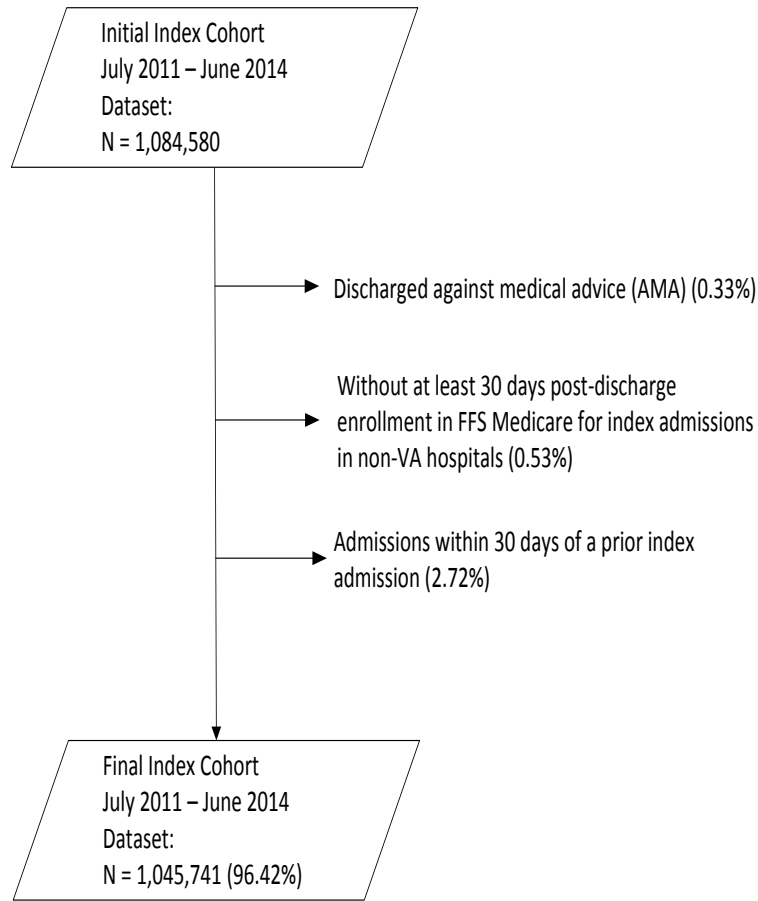
4.4 Pneumonia Readmission 2015 Model Results

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 2011-June 2014 dataset is presented in [Figure 4.4.1](#).

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes hospitalizations for Medicare FFS patients aged 65 or over with a principal discharge diagnosis of pneumonia; 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; who were not transferred to another acute care facility; and were alive at discharge. VA data is only included for the AMI, HF, and pneumonia measures.

Figure 4.4.1 – Pneumonia Cohort Exclusions in the July 2011-June 2014 Dataset



4.4.2 Frequency of Pneumonia Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables ([Table 4.4.1](#)). Between July 2011-June 2012 and July 2013-June 2014, the observed readmission rate decreased from 17.5% to 16.6%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the 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 the version 5010 format changes DHHS required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals have submitted more codes, which translated into increased frequencies for some model variables. Notable decreases occurred in Other lung disorders (CC 115) (46.8% to 44.2%), Fibrosis of lung or other chronic lung disorders (CC 109) (16.3% to 14.1%), and Severe hematological disorders (CC 44) (3.6% to 2.2%), while notable increases occurred in Other psychiatric disorders (CC 60) (19.6% to 24.0%), Renal failure (CC 131) (29.4% to 31.7%), and Cardio-respiratory failure or shock (CC 79) (22.2% to 24.4%). Refer to [Table 4.4.1](#) for more detail.

4.4.3 Pneumonia Model Parameters and Performance

[Table 4.4.2](#) shows hierarchical regression 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 readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the area under the ROC curve (c-statistic) decreased slightly from 0.64 to 0.63 ([Table 4.4.4](#)).

4.4.4 Distribution of Hospital Volumes and RSRRs for Pneumonia

[Table 4.4.5](#) shows the distribution of hospital admission volumes and [Table 4.4.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 17.5% between July 2011 and June 2012 to 16.6% between July 2013 and June 2014. The median hospital RSRR in the combined three-year dataset was 16.9% (IQR 16.3% - 17.5%). [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 0.020 (SE: 0.001). 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 RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation above the national rate were 1.33 times higher than the odds of all-cause readmission if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.²²

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

Of 4,815 hospitals in the study cohort, 24 performed “better than the U.S. national rate,” 4,289 performed “no different from the U.S. national rate,” and 73 performed “worse than the U.S. national rate.” 429 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	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Total N	361,190	369,645	314,906	1,045,741
Observed readmission rate (%)	17.5	16.7	16.6	16.9
Mean age minus 65 (SD)	15.2 (8.3)	15.3 (8.4)	15.0 (8.5)	15.2 (8.4)
Male (%)	46.7	46.5	46.9	46.7
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	9.3	9.3	9.3	9.3
History of infection (CC 1, 3-6)	39.0	38.5	38.8	38.7
Septicemia/shock (CC 2)	8.5	8.7	9.7	8.9
Metastatic cancer or acute leukemia (CC 7)	5.2	5.1	5.3	5.2
Lung, upper digestive tract, and other severe cancers (CC 8)	7.2	7.0	7.5	7.2
Other major cancers (CC 9-10)	18.1	17.9	18.3	18.1
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	42.3	42.1	42.7	42.3
Protein-calorie malnutrition (CC 21)	12.8	12.7	12.8	12.8
Disorders of fluid/electrolyte/acid-base (CC 22-23)	41.3	40.9	41.8	41.3
Other gastrointestinal disorders (CC 36)	66.1	66.1	66.9	66.3
Severe hematological disorders (CC 44)	3.6	2.2	2.2	2.7
Iron deficiency or other unspecified anemias and blood disease (CC 47)	58.8	57.5	58.1	58.1
Dementia or other specified brain disorders (CC 49-50)	31.4	31.0	30.3	30.9
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	16.5	16.8	17.8	17.0
Major psychiatric disorders (CC 54-56)	14.2	14.2	14.4	14.2
Other psychiatric disorders (CC 60)	19.6	22.1	24.0	21.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	9.0	8.9	8.9	9.0
Cardio-respiratory failure or shock (CC 79)	22.2	22.4	24.4	22.9
Congestive heart failure (CC 80)	39.6	38.3	38.7	38.9
Acute coronary syndrome (CC 81-82)	7.6	7.5	7.7	7.6
Coronary atherosclerosis or angina (CC 83-84)	50.4	49.5	49.4	49.8
Valvular or rheumatic heart disease (CC 86)	25.4	25.2	25.7	25.4
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	44.4	44.5	45.3	44.7
Stroke (CC 95-96)	9.3	9.0	8.9	9.1
Vascular or circulatory disease (CC 104-106)	43.5	42.8	43.4	43.2
Chronic obstructive pulmonary disease (COPD) (CC 108)	55.9	54.7	55.2	55.3
Fibrosis of lung or other chronic lung disorders (CC 109)	16.3	14.5	14.1	15.0
Asthma (CC 110)	11.6	11.7	11.9	11.8
Pneumonia (CC 111-113)	43.8	42.8	42.6	43.1
Pleural effusion/pneumothorax (CC 114)	16.9	16.4	17.1	16.8
Other lung disorders (CC 115)	46.8	45.1	44.2	45.4
End-stage renal disease or dialysis (CC 129-130)	3.2	3.4	3.6	3.4
Renal failure (CC 131)	29.4	30.2	31.7	30.4

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Urinary tract infection (CC 135)	28.8	28.1	28.1	28.4
Other urinary tract disorders (CC 136)	25.6	24.7	24.4	24.9
Decubitus ulcer or chronic skin ulcer (CC 148-149)	11.6	11.2	11.3	11.4
Vertebral fractures (CC 157)	5.1	5.0	5.2	5.1
Other injuries (CC 162)	39.1	38.9	39.6	39.2

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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Intercept	-2.502	-2.528	-2.525	-2.523
Age minus 65 (years above 65, continuous)	-0.001	-0.001	0.000	-0.001
Male	0.043	0.037	0.068	0.048
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	-0.049	-0.055	-0.020	-0.042
History of infection (CC 1, 3-6)	0.060	0.047	0.026	0.044
Septicemia/shock (CC 2)	0.057	0.048	0.054	0.049
Metastatic cancer or acute leukemia (CC 7)	0.230	0.225	0.224	0.225
Lung, upper digestive tract, and other severe cancers (CC 8)	0.152	0.171	0.170	0.162
Other major cancers (CC 9-10)	0.048	0.052	0.023	0.041
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.075	0.080	0.079	0.077
Protein-calorie malnutrition (CC 21)	0.129	0.106	0.126	0.121
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.143	0.143	0.115	0.134
Other gastrointestinal disorders (CC 36)	0.080	0.077	0.057	0.073
Severe hematological disorders (CC 44)	0.167	0.201	0.248	0.205
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.183	0.163	0.179	0.175
Dementia or other specified brain disorders (CC 49-50)	0.032	-0.001	0.020	0.016
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	0.093	0.092	0.103	0.094
Major psychiatric disorders (CC 54-56)	0.044	0.042	0.018	0.036
Other psychiatric disorders (CC 60)	0.077	0.058	0.086	0.069
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.060	0.063	0.065	0.062
Cardio-respiratory failure or shock (CC 79)	0.150	0.157	0.133	0.147
Congestive heart failure (CC 80)	0.168	0.162	0.160	0.164
Acute coronary syndrome (CC 81-82)	0.086	0.063	0.083	0.074
Coronary atherosclerosis or angina (CC 83-84)	0.056	0.045	0.034	0.045
Valvular or rheumatic heart disease (CC 86)	0.065	0.078	0.056	0.068
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.105	0.087	0.081	0.091
Stroke (CC 95-96)	0.034	0.041	0.030	0.034
Vascular or circulatory disease (CC 104-106)	0.052	0.056	0.057	0.054

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.161	0.205	0.183	0.183
Fibrosis of lung or other chronic lung disorders (CC 109)	0.080	0.101	0.101	0.096
Asthma (CC 110)	-0.026	-0.015	-0.038	-0.026
Pneumonia (CC 111-113)	0.048	0.060	0.064	0.056
Pleural effusion/pneumothorax (CC 114)	0.099	0.081	0.123	0.100
Other lung disorders (CC 115)	0.037	0.034	0.026	0.034
End-stage renal disease or dialysis (CC 129-130)	0.243	0.211	0.187	0.213
Renal failure (CC 131)	0.124	0.149	0.132	0.133
Urinary tract infection (CC 135)	0.044	0.037	0.050	0.044
Other urinary tract disorders (CC 136)	0.051	0.047	0.037	0.047
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.078	0.102	0.093	0.090
Vertebral fractures (CC 157)	0.113	0.056	0.060	0.079
Other injuries (CC 162)	0.041	0.045	0.036	0.042

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

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
Male	1.04 (1.03 - 1.06)	1.04 (1.02 - 1.06)	1.07 (1.05 - 1.09)	1.05 (1.04 - 1.06)
History of Coronary Artery Bypass Graft (CABG) (ICD-9 codes V45.81, 36.10-36.16)	0.95 (0.92 - 0.98)	0.95 (0.92 - 0.98)	0.98 (0.95 - 1.01)	0.96 (0.94 - 0.98)
History of infection (CC 1, 3-6)	1.06 (1.04 - 1.08)	1.05 (1.03 - 1.07)	1.03 (1.01 - 1.05)	1.05 (1.03 - 1.06)
Septicemia/shock (CC 2)	1.06 (1.03 - 1.09)	1.05 (1.02 - 1.08)	1.06 (1.02 - 1.09)	1.05 (1.03 - 1.07)
Metastatic cancer or acute leukemia (CC 7)	1.26 (1.21 - 1.31)	1.25 (1.20 - 1.31)	1.25 (1.20 - 1.31)	1.25 (1.22 - 1.28)
Lung, upper digestive tract, and other severe cancers (CC 8)	1.16 (1.12 - 1.21)	1.19 (1.14 - 1.23)	1.19 (1.14 - 1.23)	1.18 (1.15 - 1.20)
Other major cancers (CC 9-10)	1.05 (1.02 - 1.07)	1.05 (1.03 - 1.08)	1.02 (1.00 - 1.05)	1.04 (1.03 - 1.06)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.08 (1.06 - 1.10)	1.08 (1.06 - 1.10)	1.08 (1.06 - 1.11)	1.08 (1.07 - 1.09)
Protein-calorie malnutrition (CC 21)	1.14 (1.11 - 1.17)	1.11 (1.08 - 1.14)	1.13 (1.10 - 1.17)	1.13 (1.11 - 1.15)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.15 (1.13 - 1.18)	1.15 (1.13 - 1.18)	1.12 (1.10 - 1.15)	1.14 (1.13 - 1.16)
Other gastrointestinal disorders (CC 36)	1.08 (1.06 - 1.11)	1.08 (1.06 - 1.10)	1.06 (1.04 - 1.08)	1.08 (1.06 - 1.09)
Severe hematological disorders (CC 44)	1.18 (1.13 - 1.23)	1.22 (1.16 - 1.29)	1.28 (1.21 - 1.36)	1.23 (1.19 - 1.26)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.20 (1.18 - 1.23)	1.18 (1.15 - 1.20)	1.20 (1.17 - 1.22)	1.19 (1.18 - 1.21)
Dementia or other specified brain disorders (CC 49-50)	1.03 (1.01 - 1.05)	1.00 (0.98 - 1.02)	1.02 (1.00 - 1.04)	1.02 (1.00 - 1.03)
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	1.10 (1.07 - 1.13)	1.10 (1.07 - 1.12)	1.11 (1.08 - 1.14)	1.10 (1.08 - 1.12)
Major psychiatric disorders (CC 54-56)	1.05 (1.02 - 1.07)	1.04 (1.02 - 1.07)	1.02 (0.99 - 1.05)	1.04 (1.02 - 1.05)
Other psychiatric disorders (CC 60)	1.08 (1.06 - 1.10)	1.06 (1.04 - 1.08)	1.09 (1.07 - 1.12)	1.07 (1.06 - 1.09)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.06 (1.03 - 1.09)	1.07 (1.03 - 1.10)	1.07 (1.03 - 1.10)	1.06 (1.05 - 1.08)
Cardio-respiratory failure or shock (CC 79)	1.16 (1.14 - 1.19)	1.17 (1.14 - 1.20)	1.14 (1.12 - 1.17)	1.16 (1.14 - 1.17)

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Congestive heart failure (CC 80)	1.18 (1.16 - 1.21)	1.18 (1.15 - 1.20)	1.17 (1.15 - 1.20)	1.18 (1.16 - 1.19)
Acute coronary syndrome (CC 81-82)	1.09 (1.06 - 1.12)	1.07 (1.03 - 1.10)	1.09 (1.05 - 1.12)	1.08 (1.06 - 1.10)
Coronary atherosclerosis or angina (CC 83-84)	1.06 (1.04 - 1.08)	1.05 (1.03 - 1.07)	1.03 (1.01 - 1.06)	1.05 (1.03 - 1.06)
Valvular or rheumatic heart disease (CC 86)	1.07 (1.05 - 1.09)	1.08 (1.06 - 1.10)	1.06 (1.03 - 1.08)	1.07 (1.06 - 1.08)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.11 (1.09 - 1.13)	1.09 (1.07 - 1.11)	1.08 (1.06 - 1.11)	1.10 (1.08 - 1.11)
Stroke (CC 95-96)	1.03 (1.00 - 1.07)	1.04 (1.01 - 1.07)	1.03 (1.00 - 1.07)	1.04 (1.02 - 1.05)
Vascular or circulatory disease (CC 104-106)	1.05 (1.03 - 1.07)	1.06 (1.04 - 1.08)	1.06 (1.04 - 1.08)	1.06 (1.04 - 1.07)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.17 (1.15 - 1.20)	1.23 (1.20 - 1.25)	1.20 (1.18 - 1.23)	1.20 (1.19 - 1.22)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.08 (1.06 - 1.11)	1.11 (1.08 - 1.13)	1.11 (1.08 - 1.14)	1.10 (1.09 - 1.12)
Asthma (CC 110)	0.97 (0.95 - 1.00)	0.99 (0.96 - 1.01)	0.96 (0.94 - 0.99)	0.97 (0.96 - 0.99)
Pneumonia (CC 111-113)	1.05 (1.03 - 1.07)	1.06 (1.04 - 1.08)	1.07 (1.04 - 1.09)	1.06 (1.05 - 1.07)
Pleural effusion/pneumothorax (CC 114)	1.10 (1.08 - 1.13)	1.08 (1.06 - 1.11)	1.13 (1.10 - 1.16)	1.11 (1.09 - 1.12)
Other lung disorders (CC 115)	1.04 (1.02 - 1.06)	1.03 (1.02 - 1.05)	1.03 (1.01 - 1.05)	1.04 (1.02 - 1.05)
End-stage renal disease or dialysis (CC 129-130)	1.28 (1.22 - 1.33)	1.24 (1.18 - 1.29)	1.21 (1.15 - 1.26)	1.24 (1.21 - 1.27)
Renal failure (CC 131)	1.13 (1.11 - 1.16)	1.16 (1.14 - 1.19)	1.14 (1.12 - 1.17)	1.14 (1.13 - 1.16)
Urinary tract infection (CC 135)	1.05 (1.02 - 1.07)	1.04 (1.02 - 1.06)	1.05 (1.03 - 1.08)	1.05 (1.03 - 1.06)
Other urinary tract disorders (CC 136)	1.05 (1.03 - 1.07)	1.05 (1.03 - 1.07)	1.04 (1.01 - 1.06)	1.05 (1.04 - 1.06)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.08 (1.05 - 1.11)	1.11 (1.08 - 1.14)	1.10 (1.07 - 1.13)	1.10 (1.08 - 1.11)
Vertebral fractures (CC 157)	1.12 (1.08 - 1.16)	1.06 (1.02 - 1.10)	1.06 (1.02 - 1.11)	1.08 (1.06 - 1.11)
Other injuries (CC 162)	1.04 (1.02 - 1.06)	1.05 (1.03 - 1.07)	1.04 (1.02 - 1.06)	1.04 (1.03 - 1.05)

Table 4.4.4 – Pneumonia Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Predictive ability, % (lowest decile – highest decile)	8.2 – 33.1	7.9 – 31.4	7.9 – 30.4	8.1 – 31.6
c-statistic	0.64	0.64	0.63	0.64

Table 4.4.5 – Distribution of Hospital Pneumonia Admission Volumes Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,739	4,721	4,664	4,815
Mean number of admissions (SD)	76.2 (74.8)	78.3 (79.1)	67.5 (69.1)	217.2 (220.0)
Range (min. – max.)	1 - 752	1 - 835	1 - 719	1 - 2306
25 th percentile	23	24	20	64
50 th percentile	52	53	45	146
75 th percentile	105	107	93	302

Table 4.4.6 – Distribution of Hospital Pneumonia RSRRs Over Different Time Periods

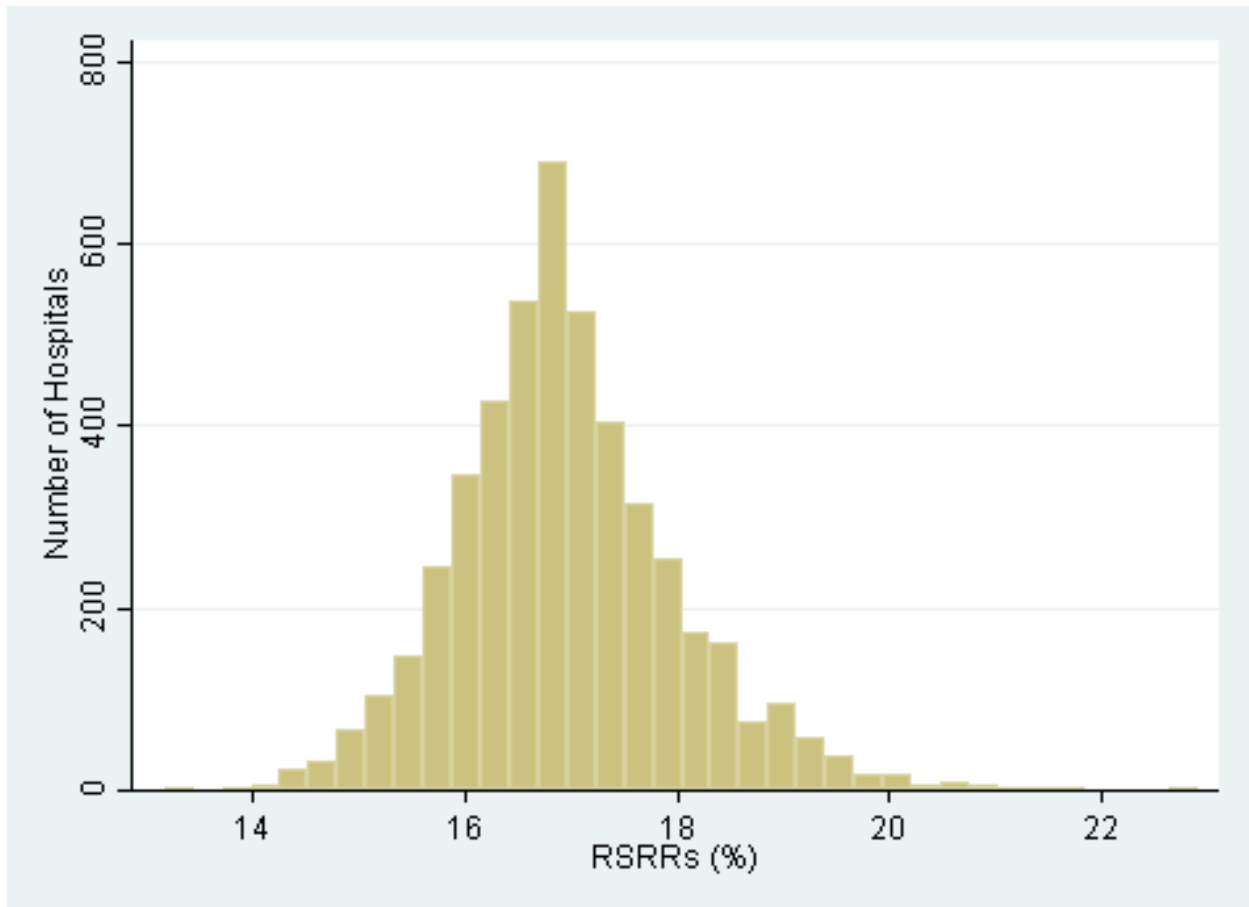
Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,739	4,721	4,664	4,815

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Mean (SD)	17.5 (0.7)	16.8 (0.8)	16.6 (0.7)	17.0 (1.1)
Range (min. – max.)	14.9 – 21.7	14.2 – 22.5	13.3 – 20.7	13.2 – 22.9
25 th percentile	17.1	16.3	16.2	16.3
50 th percentile	17.4	16.7	16.5	16.9
75 th percentile	17.8	17.1	17.0	17.5

Table 4.4.7 – Between Hospital Variance for Pneumonia

	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Between hospital variance (SE)	0.018 (0.002)	0.021 (0.002)	0.021 (0.002)	0.020 (0.001)

Figure 4.4.2 - Distribution of Hospital 30-Day Pneumonia RSRRs Between July 2011 and June 2014



N= 4,815 hospitals

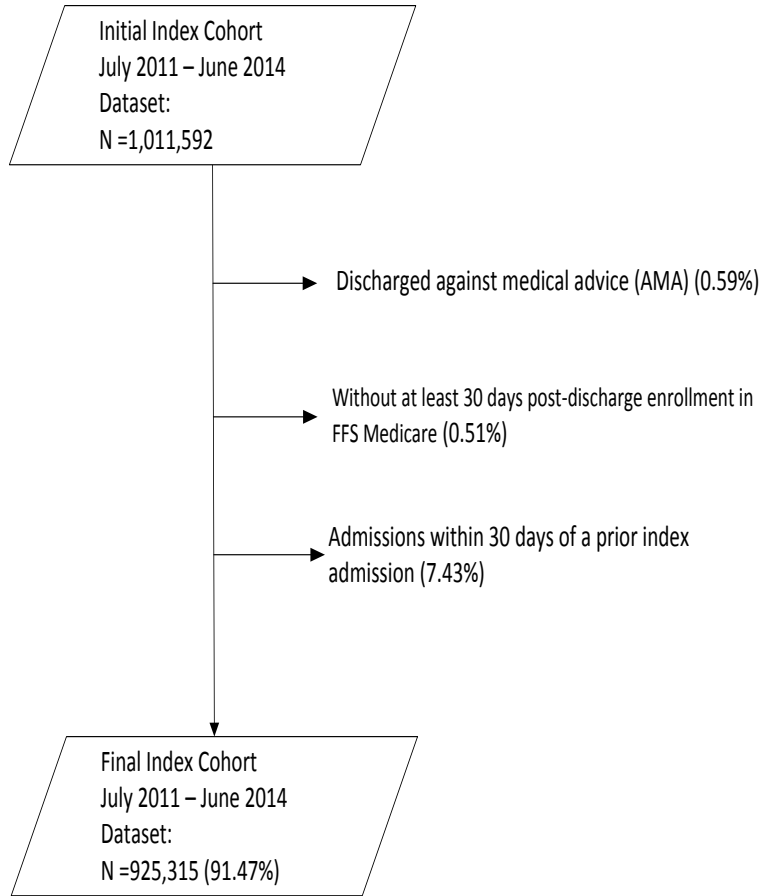
4.5 COPD Readmission 2015 Model Results

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 2011-June 2014 dataset is presented in [Figure 4.5.1](#).

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes hospitalizations for Medicare FFS patients aged 65 or over with a principal discharge diagnosis of COPD or principal diagnosis of respiratory failure with a secondary diagnosis of COPD with exacerbation; 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; who were not transferred to another acute care facility; and were alive at discharge.

Figure 4.5.1– COPD Cohort Exclusions in the July 2011-June 2014 Dataset



4.5.2 Frequency of COPD Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables ([Table 4.5.1](#)). Between July 2011-June 2012 and July 2013-June 2014, the observed readmission rate decreased from 21.0% to 19.5%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the 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 the version 5010 format changes DHHS required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals have submitted more codes, which translated into increased frequencies for some model variables. Notable decreases occurred in Fibrosis of lung or other chronic lung disorders (CC 109) (18.1% to 15.5%), Coronary atherosclerosis or angina (CC 83-84) (54.6% to 52.8%), and Congestive heart failure (CC 80) (45.7% to 44.6%), while notable increases occurred in Other psychiatric disorders (CC 60) (27.8% to 33.3%), Cardio-respiratory failure or shock (CC 79) (36.3% to 39.5%), Sleep apnea (ICD-9 codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, and 780.57) (17.7% to 19.9%), and Other endocrine/metabolic/nutritional disorders (CC 24) (80.9% to 83.1%). Refer to [Table 4.5.1](#) for more detail.

4.5.3 COPD Model Parameters and Performance

[Table 4.5.2](#) shows hierarchical regression 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 readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the area under the ROC curve (c-statistic) remained constant at 0.64 ([Table 4.5.4](#)).

4.5.4 Distribution of Hospital Volumes and RSRRs for COPD

[Table 4.5.5](#) shows the distribution of hospital admission volumes and [Table 4.5.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 21.0% between July 2011 and June 2012 to 19.5% between July 2013 and June 2014. The median hospital RSRR in the combined three-year dataset was 20.2% (IQR 19.6% -20.8%). [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 0.019 (SE: 0.001). 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 RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation above the national rate were 1.32 times higher than the odds of all-cause readmission if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.²²

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

Of 4,663 hospitals in the study cohort, 27 performed “better than the U.S. national rate,” 3,730 performed “no different from the U.S. national rate,” and 83 performed “worse than the U.S. national rate.” 823 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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Total N	318,209	326,867	280,239	925,315
Observed readmission rate (%)	21.0	20.1	19.5	20.2
Mean age minus 65 (SD)	11.8 (7.5)	11.9 (7.6)	11.6 (7.6)	11.8 (7.5)
History of mechanical ventilation (ICD-9 codes 93.90, 96.70, 96.71, 96.72)	9.8	9.7	11.0	10.1
Sleep apnea (ICD-9 codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	17.7	18.4	19.9	18.6
Respirator dependence/respiratory failure (CC 77-78)	1.4	1.3	1.3	1.3
Cardio-respiratory failure or shock (CC 79)	36.3	36.3	39.5	37.3
Congestive heart failure (CC 80)	45.7	44.0	44.6	44.7
Acute coronary syndrome (CC 81-82)	9.0	8.8	8.8	8.8
Coronary atherosclerosis or angina (CC 83-84)	54.6	53.5	52.8	53.7
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	43.1	42.7	43.3	43.0
Other and unspecified heart disease (CC 94)	21.3	20.6	20.6	20.9
Vascular or circulatory disease (CC 104-106)	43.6	42.9	43.1	43.2
Fibrosis of lung and other chronic lung disorders (CC 109)	18.1	15.9	15.5	16.5
Pneumonia (CC 111-113)	51.7	50.3	50.7	50.9
History of infection (CC 1, 3-6)	35.0	34.4	34.4	34.6
Metastatic cancer or acute leukemia (CC 7)	2.7	2.6	2.7	2.7
Lung, upper digestive tract, and other severe cancers (CC 8)	6.5	6.4	6.6	6.5
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	14.2	13.9	14.0	14.1
Other digestive and urinary neoplasms (CC 12)	7.0	6.8	6.7	6.8
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	44.3	43.7	43.4	43.8
Protein-calorie malnutrition (CC 21)	10.2	10.1	10.5	10.3
Disorders of fluid/electrolyte/acid-base (CC 22-23)	40.5	39.7	40.7	40.3
Other endocrine/metabolic/nutritional disorders (CC 24)	80.9	82.1	83.1	82.0
Pancreatic disease (CC 32)	2.4	2.3	2.4	2.4
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	12.6	12.0	11.9	12.2
Other gastrointestinal disorders (CC 36)	66.0	65.8	66.1	66.0
Severe hematological disorders (CC 44)	1.8	1.2	1.1	1.4
Iron deficiency or other unspecified anemias and blood disease (CC 47)	52.4	51.6	52.4	52.1
Dementia or other specified brain disorders (CC 49-50)	19.5	19.1	18.5	19.1
Drug/alcohol psychosis or dependence (CC 51-52)	4.6	4.8	5.3	4.9
Major psychiatric disorders (CC 54-56)	12.8	12.6	13.1	12.8
Depression (CC 58)	28.0	28.1	28.8	28.3
Anxiety disorders (CC 59)	5.1	5.5	6.2	5.6

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Other psychiatric disorders (CC 60)	27.8	30.7	33.3	30.5
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	6.0	5.8	5.9	5.9
Polyneuropathy (CC 71)	11.5	12.1	12.7	12.1
Hypertensive heart and renal disease or encephalopathy (CC 89)	21.9	22.2	23.0	22.3
Stroke (CC 95-96)	6.5	6.2	6.1	6.3
Renal failure (CC 131)	26.1	26.5	27.7	26.7
Decubitus ulcer or chronic skin ulcer (CC 148-149)	8.4	8.1	8.1	8.2
Cellulitis, local skin infection (CC 152)	13.6	13.3	13.2	13.3
Vertebral fractures (CC 157)	5.2	5.0	5.2	5.2

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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Intercept	-2.144	-2.156	-2.200	-2.169
Age minus 65 (years above 65, continuous)	-0.002	-0.001	-0.003	-0.002
History of mechanical ventilation (ICD-9 codes 93.90, 96.70, 96.71, 96.72)	0.156	0.126	0.188	0.151
Sleep apnea (ICD-9 codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	-0.017	0.004	-0.033	-0.014
Respirator dependence/respiratory failure (CC 77-78)	0.063	0.047	0.018	0.046
Cardio-respiratory failure or shock (CC 79)	0.197	0.188	0.206	0.196
Congestive heart failure (CC 80)	0.206	0.194	0.176	0.193
Acute coronary syndrome (CC 81-82)	0.081	0.092	0.066	0.078
Coronary atherosclerosis or angina (CC 83-84)	0.097	0.075	0.082	0.085
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.120	0.156	0.151	0.142
Other and unspecified heart disease (CC 94)	0.077	0.048	0.056	0.063
Vascular or circulatory disease (CC 104-106)	0.072	0.069	0.078	0.072
Fibrosis of lung and other chronic lung disorders (CC 109)	0.089	0.104	0.082	0.097
Pneumonia (CC 111-113)	0.094	0.086	0.094	0.092
History of infection (CC 1, 3-6)	0.059	0.063	0.076	0.064
Metastatic cancer or acute leukemia (CC 7)	0.255	0.213	0.174	0.216
Lung, upper digestive tract, and other severe cancers (CC 8)	0.201	0.183	0.223	0.200
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	0.014	0.003	0.032	0.015
Other digestive and urinary neoplasms (CC 12)	-0.035	-0.055	-0.049	-0.046
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	0.046	0.048	0.053	0.049
Protein-calorie malnutrition (CC 21)	0.138	0.139	0.124	0.137
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.162	0.149	0.138	0.150

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.065	-0.077	-0.056	-0.070
Pancreatic disease (CC 32)	0.062	0.037	0.041	0.046
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	0.081	0.060	0.072	0.071
Other gastrointestinal disorders (CC 36)	0.077	0.068	0.060	0.070
Severe hematological disorders (CC 44)	0.135	0.136	0.254	0.174
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.154	0.165	0.146	0.156
Dementia or other specified brain disorders (CC 49-50)	0.010	-0.014	-0.004	-0.003
Drug/alcohol psychosis or dependence (CC 51-52)	0.126	0.165	0.145	0.146
Major psychiatric disorders (CC 54-56)	0.036	0.037	0.047	0.040
Depression (CC 58)	0.029	0.018	0.016	0.024
Anxiety disorders (CC 59)	0.109	0.081	0.045	0.077
Other psychiatric disorders (CC 60)	0.107	0.103	0.106	0.100
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.043	0.074	0.057	0.058
Polyneuropathy (CC 71)	0.064	0.075	0.069	0.070
Hypertensive heart and renal disease or encephalopathy (CC 89)	0.104	0.100	0.126	0.111
Stroke (CC 95-96)	0.010	0.013	0.019	0.012
Renal failure (CC 131)	0.063	0.062	0.064	0.060
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.093	0.071	0.075	0.080
Cellulitis, local skin infection (CC 152)	0.050	0.066	0.037	0.052
Vertebral fractures (CC 157)	0.175	0.140	0.102	0.143

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

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
History of mechanical ventilation (ICD-9 codes 93.90, 96.70, 96.71, 96.72)	1.17 (1.13 - 1.20)	1.14 (1.10 - 1.17)	1.21 (1.17 - 1.24)	1.16 (1.14 - 1.18)
Sleep apnea (ICD-9 codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	0.98 (0.96 - 1.01)	1.00 (0.98 - 1.03)	0.97 (0.94 - 0.99)	0.99 (0.97 - 1.00)
Respirator dependence/respiratory failure (CC 77-78)	1.07 (1.00 - 1.14)	1.05 (0.98 - 1.12)	1.02 (0.95 - 1.10)	1.05 (1.01 - 1.09)
Cardio-respiratory failure or shock (CC 79)	1.22 (1.19 - 1.24)	1.21 (1.18 - 1.23)	1.23 (1.20 - 1.26)	1.22 (1.20 - 1.23)
Congestive heart failure (CC 80)	1.23 (1.20 - 1.26)	1.21 (1.19 - 1.24)	1.19 (1.17 - 1.22)	1.21 (1.20 - 1.23)
Acute coronary syndrome (CC 81-82)	1.08 (1.05 - 1.12)	1.10 (1.07 - 1.13)	1.07 (1.04 - 1.10)	1.08 (1.06 - 1.10)
Coronary atherosclerosis or angina (CC 83-84)	1.10 (1.08 - 1.12)	1.08 (1.06 - 1.10)	1.09 (1.06 - 1.11)	1.09 (1.08 - 1.10)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.13 (1.11 - 1.15)	1.17 (1.15 - 1.19)	1.16 (1.14 - 1.19)	1.15 (1.14 - 1.17)
Other and unspecified heart disease (CC 94)	1.08 (1.06 - 1.10)	1.05 (1.03 - 1.07)	1.06 (1.03 - 1.08)	1.07 (1.05 - 1.08)
Vascular or circulatory disease (CC 104-106)	1.08 (1.05 - 1.10)	1.07 (1.05 - 1.09)	1.08 (1.06 - 1.10)	1.08 (1.06 - 1.09)
Fibrosis of lung and other chronic lung disorders (CC 109)	1.09 (1.07 - 1.12)	1.11 (1.08 - 1.14)	1.09 (1.06 - 1.11)	1.10 (1.09 - 1.12)

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Pneumonia (CC 111-113)	1.10 (1.08 - 1.12)	1.09 (1.07 - 1.11)	1.10 (1.08 - 1.12)	1.10 (1.08 - 1.11)
History of infection (CC 1, 3-6)	1.06 (1.04 - 1.08)	1.07 (1.04 - 1.09)	1.08 (1.06 - 1.10)	1.07 (1.05 - 1.08)
Metastatic cancer or acute leukemia (CC 7)	1.29 (1.22 - 1.36)	1.24 (1.17 - 1.31)	1.19 (1.12 - 1.26)	1.24 (1.20 - 1.28)
Lung, upper digestive tract, and other severe cancers (CC 8)	1.22 (1.18 - 1.27)	1.20 (1.16 - 1.25)	1.25 (1.20 - 1.30)	1.22 (1.20 - 1.25)
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	1.01 (0.99 - 1.04)	1.00 (0.98 - 1.03)	1.03 (1.00 - 1.06)	1.02 (1.00 - 1.03)
Other digestive and urinary neoplasms (CC 12)	0.97 (0.93 - 1.00)	0.95 (0.91 - 0.98)	0.95 (0.92 - 0.99)	0.96 (0.94 - 0.98)
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	1.05 (1.03 - 1.07)	1.05 (1.03 - 1.07)	1.05 (1.03 - 1.08)	1.05 (1.04 - 1.06)
Protein-calorie malnutrition (CC 21)	1.15 (1.12 - 1.18)	1.15 (1.12 - 1.18)	1.13 (1.10 - 1.17)	1.15 (1.13 - 1.17)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.18 (1.15 - 1.20)	1.16 (1.14 - 1.18)	1.15 (1.12 - 1.17)	1.16 (1.15 - 1.18)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.94 (0.91 - 0.96)	0.93 (0.90 - 0.95)	0.95 (0.92 - 0.97)	0.93 (0.92 - 0.95)
Pancreatic disease (CC 32)	1.06 (1.01 - 1.12)	1.04 (0.98 - 1.10)	1.04 (0.98 - 1.10)	1.05 (1.01 - 1.08)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.09 (1.06 - 1.11)	1.06 (1.03 - 1.09)	1.08 (1.04 - 1.11)	1.07 (1.06 - 1.09)
Other gastrointestinal disorders (CC 36)	1.08 (1.06 - 1.10)	1.07 (1.05 - 1.09)	1.06 (1.04 - 1.09)	1.07 (1.06 - 1.09)
Severe hematological disorders (CC 44)	1.15 (1.08 - 1.21)	1.15 (1.07 - 1.23)	1.29 (1.19 - 1.40)	1.19 (1.14 - 1.24)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.17 (1.14 - 1.19)	1.18 (1.16 - 1.20)	1.16 (1.13 - 1.18)	1.17 (1.16 - 1.18)
Dementia or other specified brain disorders (CC 49-50)	1.01 (0.99 - 1.03)	0.99 (0.96 - 1.01)	1.00 (0.97 - 1.02)	1.00 (0.98 - 1.01)
Drug/alcohol psychosis or dependence (CC 51-52)	1.13 (1.09 - 1.18)	1.18 (1.14 - 1.23)	1.16 (1.11 - 1.20)	1.16 (1.13 - 1.18)
Major psychiatric disorders (CC 54-56)	1.04 (1.01 - 1.06)	1.04 (1.01 - 1.07)	1.05 (1.02 - 1.08)	1.04 (1.02 - 1.06)
Depression (CC 58)	1.03 (1.01 - 1.05)	1.02 (1.00 - 1.04)	1.02 (0.99 - 1.04)	1.02 (1.01 - 1.04)
Anxiety disorders (CC 59)	1.12 (1.07 - 1.16)	1.09 (1.05 - 1.13)	1.05 (1.01 - 1.09)	1.08 (1.06 - 1.10)
Other psychiatric disorders (CC 60)	1.11 (1.09 - 1.14)	1.11 (1.09 - 1.13)	1.11 (1.09 - 1.14)	1.11 (1.09 - 1.12)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.04 (1.01 - 1.08)	1.08 (1.04 - 1.12)	1.06 (1.02 - 1.10)	1.06 (1.04 - 1.08)
Polyneuropathy (CC 71)	1.07 (1.04 - 1.10)	1.08 (1.05 - 1.11)	1.07 (1.04 - 1.10)	1.07 (1.06 - 1.09)
Hypertensive heart and renal disease or encephalopathy (CC 89)	1.11 (1.08 - 1.14)	1.11 (1.08 - 1.14)	1.13 (1.10 - 1.17)	1.12 (1.10 - 1.14)
Stroke (CC 95-96)	1.01 (0.98 - 1.05)	1.01 (0.98 - 1.05)	1.02 (0.98 - 1.06)	1.01 (0.99 - 1.03)
Renal failure (CC 131)	1.07 (1.04 - 1.09)	1.06 (1.04 - 1.09)	1.07 (1.04 - 1.10)	1.06 (1.05 - 1.08)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.10 (1.06 - 1.13)	1.07 (1.04 - 1.11)	1.08 (1.04 - 1.12)	1.08 (1.06 - 1.10)
Cellulitis, local skin infection (CC 152)	1.05 (1.03 - 1.08)	1.07 (1.04 - 1.10)	1.04 (1.01 - 1.07)	1.05 (1.04 - 1.07)
Vertebral fractures (CC 157)	1.19 (1.15 - 1.24)	1.15 (1.11 - 1.19)	1.11 (1.06 - 1.15)	1.15 (1.13 - 1.18)

Table 4.5.4 – COPD Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Predictive ability, % (lowest decile – highest decile)	10.4 – 38.1	10.1 – 36.2	9.7 – 35.5	10.1 – 36.5
c-statistic	0.64	0.64	0.64	0.64

Table 4.5.5 – Distribution of Hospital COPD Admission Volumes Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,541	4,515	4,495	4,663
Mean number of admissions (SD)	70.1 (77.4)	72.4 (80.4)	62.3 (69.7)	198.4 (224.6)
Range (min. – max.)	1 – 906	1 – 984	1 – 862	1 - 2673
25 th percentile	15	15	12	38
50 th percentile	43	44	38	116
75 th percentile	101	104	89	285

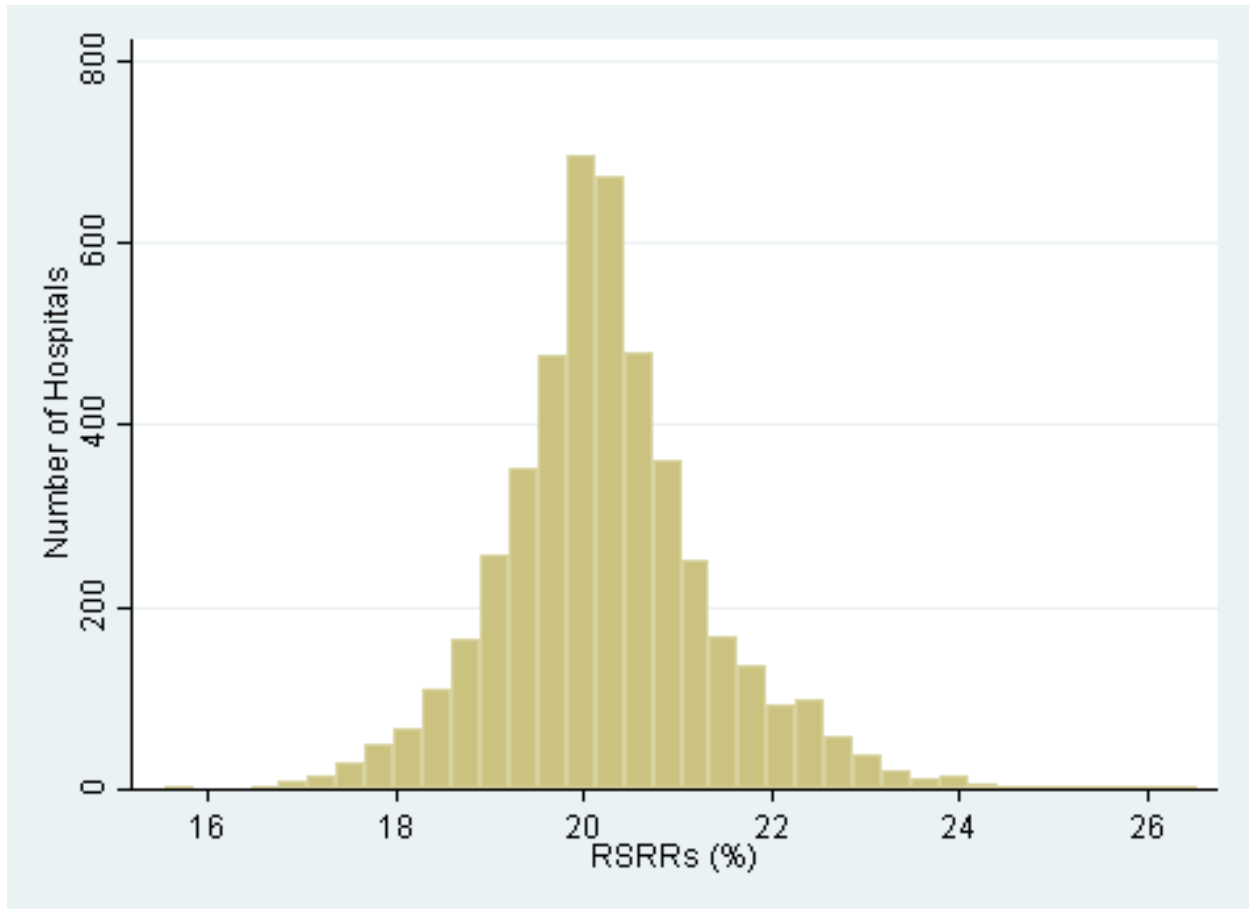
Table 4.5.6 – Distribution of Hospital COPD RSRRs Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,541	4,515	4,495	4,663
Mean (SD)	21.0 (0.8)	20.1 (0.9)	19.5 (0.7)	20.3 (1.2)
Range (min. – max.)	17.9 - 26.2	16.6 - 25.3	16.9 - 24.5	15.5 - 26.6
25 th percentile	20.5	19.6	19.1	19.6
50 th percentile	20.9	20.1	19.5	20.2
75 th percentile	21.4	20.5	19.9	20.8

Table 4.5.7 – Between Hospital Variance for COPD

	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Between hospital variance (SE)	0.018 (0.002)	0.020 (0.002)	0.018 (0.002)	0.019 (0.001)

Figure 4.5.2 - Distribution of Hospital 30-Day COPD RSRRs Between July 2011 and June 2014



N= 4,663 hospitals

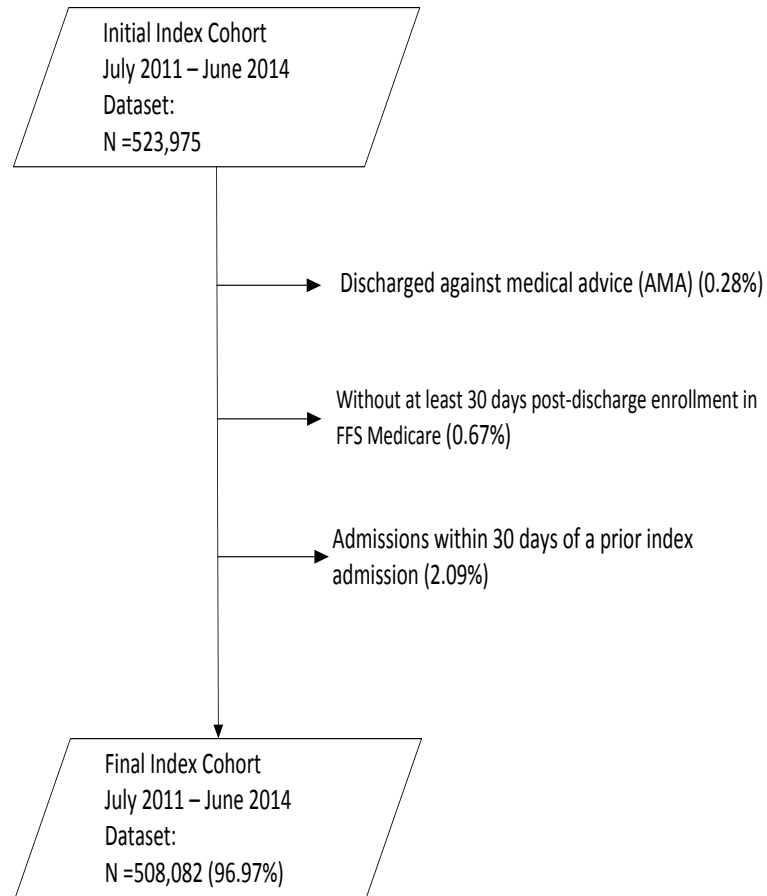
4.6 Stroke Readmission 2015 Model Results

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 2011-June 2014 dataset is presented in [Figure 4.6.1](#).

Admissions may have been counted in more than one exclusion category because they are not mutually exclusive. The index cohort includes hospitalizations for Medicare FFS patients aged 65 or over with a principal discharge diagnosis of stroke; 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; who were not transferred to another acute care facility; and were alive at discharge.

Figure 4.6.1– Stroke Cohort Exclusions in the July 2011-June 2014 Dataset



4.6.2 Frequency of Stroke Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables ([Table 4.6.1](#)). Between July 2011-June 2012 and July 2013-June 2014, the observed readmission rate decreased from 13.3% to 12.1%.

However, the frequency of some model variables increased, which may reflect an increased rate of comorbidity in the 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 the version 5010 format changes DHHS required. Hospitals could begin to submit up to 25 diagnosis and procedure codes starting in 2010. Over time, more hospitals have submitted more codes, which translated into increased frequencies for some model variables. Notable decreases occurred in Congestive heart failure (CC 80) (25.0% to 23.9%), Precerebral arterial occlusion and transient cerebral ischemia (CC 97) (23.7% to 22.7%), and Other lung disorders (CC 115) (22.9% to 21.0%), while notable increases occurred in Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120) (41.7% to 42.8%), Other endocrine/metabolic/nutritional disorders (CC 24) (83.4% to 85.7%), and Renal failure (CC 131) (20.1% to 21.7%). Refer to [Table 4.6.1](#) for more detail.

4.6.3 Stroke Model Parameters and Performance

[Table 4.6.2](#) shows hierarchical regression 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 readmission model by individual year and for the combined three-year dataset. Overall, the variable effect sizes were relatively constant across years. In addition, model performance was stable over the three-year time period; the area under the ROC curve (c-statistic) increased slightly from 0.60 to 0.61 ([Table 4.6.4](#)).

4.6.4 Distribution of Hospital Volumes and RSRRs for Stroke

[Table 4.6.5](#) shows the distribution of hospital admission volumes and [Table 4.6.6](#) shows the distribution of hospital RSRRs. The mean RSRR decreased over the three-year period, from 13.3% between July 2011 and June 2012 to 12.1% between July 2013 and June 2014. The median hospital RSRR in the combined three-year dataset was 12.6% (IQR 12.3% - 13.1%). [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 0.032 (SE: 0.002). 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 RSRRs for the combined dataset. The odds of all-cause readmission if treated at a hospital one standard deviation above the national rate were 1.43 times higher than the odds of all-cause readmission if treated at a hospital one standard deviation below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0.²²

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

Of 4,462 hospitals in the study cohort, 19 performed “better than the U.S. national rate,” 2,685 performed “no different from the U.S. national rate,” and 58 performed “worse than the U.S. national rate.” 1,700 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	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Total N	170,538	169,939	167,605	508,082
Observed readmission rate (%)	13.3	12.8	12.1	12.7
Mean age minus 65 (SD)	15.2 (8.1)	15.1 (8.2)	15.1 (8.3)	15.1 (8.2)
Male (%)	41.5	41.7	42.1	41.8
Congestive heart failure (CC 80)	25.0	24.2	23.9	24.4
Hypertensive heart disease (CC 90)	5.7	5.3	4.8	5.3
Cerebral hemorrhage (CC 95)	2.0	2.1	2.2	2.1
Ischemic or unspecified stroke (CC 96)	24.2	23.4	23.3	23.6
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	23.7	23.3	22.7	23.2
Hemiplegia, paralysis, functional disability (CC 100-102)	11.1	10.7	10.9	10.9
Metastatic cancer or acute leukemia (CC 7)	2.3	2.3	2.3	2.3
Cancer (CC 8-12)	18.7	18.7	18.4	18.6
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	41.7	42.6	42.8	42.4
Protein-calorie malnutrition (CC 21)	6.6	6.4	6.4	6.5
Disorders of fluid/electrolyte/acid-base (CC 22-23)	27.0	27.1	27.2	27.1
Other endocrine/metabolic/nutritional disorders (CC 24)	83.4	84.7	85.7	84.6
Severe hematological disorders (CC 44)	1.3	1.0	0.9	1.1
Iron deficiency or other unspecified anemias and blood disease (CC 47)	37.8	37.3	37.1	37.4
Dementia or other specified brain disorders (CC 49-50)	31.8	31.9	31.6	31.8
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	2.3	2.3	2.5	2.4
Seizure disorders and convulsions (CC 74)	7.5	7.5	7.7	7.6
Vascular or circulatory disease (CC 104-106)	33.0	32.7	32.5	32.7
Chronic obstructive pulmonary disease (COPD) (CC 108)	22.9	22.5	22.0	22.5
Other lung disorders (CC 115)	22.9	21.9	21.0	21.9
End-stage renal disease or dialysis (CC 129-130)	1.6	1.6	1.5	1.6
Renal failure (CC 131)	20.1	20.9	21.7	20.9
Other urinary tract disorders (CC 136)	19.0	18.7	18.1	18.6
Decubitus ulcer or chronic skin ulcer (CC 148-149)	7.1	6.8	6.9	7.0
Major symptoms, abnormalities (CC 166)	62.7	62.3	62.2	62.4

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

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Intercept	-2.366	-2.464	-2.482	-2.441
Age minus 65 (years above 65, continuous)	0.002	0.002	-0.001	0.001
Male	0.038	0.037	0.025	0.035
Congestive heart failure (CC 80)	0.182	0.143	0.194	0.171

Variable	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Hypertensive heart disease (CC 90)	0.117	0.107	0.060	0.086
Cerebral hemorrhage (CC 95)	0.026	-0.046	0.024	-0.003
Ischemic or unspecified stroke (CC 96)	-0.001	0.015	0.019	0.010
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	0.016	0.020	0.046	0.028
Hemiplegia, paralysis, functional disability (CC 100-102)	0.023	0.017	-0.016	0.009
Metastatic cancer or acute leukemia (CC 7)	0.312	0.400	0.373	0.359
Cancer (CC 8-12)	0.001	-0.002	0.022	0.007
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	0.136	0.157	0.147	0.141
Protein-calorie malnutrition (CC 21)	0.331	0.239	0.285	0.284
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.112	0.104	0.110	0.109
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.060	-0.008	-0.013	-0.030
Severe hematological disorders (CC 44)	0.232	0.126	0.169	0.186
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.164	0.214	0.215	0.195
Dementia or other specified brain disorders (CC 49-50)	0.077	0.050	0.027	0.051
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	0.108	0.133	0.089	0.107
Seizure disorders and convulsions (CC 74)	0.122	0.123	0.127	0.120
Vascular or circulatory disease (CC 104-106)	0.080	0.053	0.052	0.059
Chronic obstructive pulmonary disease (COPD) (CC 108)	0.168	0.136	0.170	0.159
Other lung disorders (CC 115)	0.094	0.090	0.031	0.076
End-stage renal disease or dialysis (CC 129-130)	0.330	0.329	0.225	0.298
Renal failure (CC 131)	0.099	0.159	0.154	0.136
Other urinary tract disorders (CC 136)	0.122	0.102	0.139	0.122
Decubitus ulcer or chronic skin ulcer (CC 148-149)	-0.010	0.045	0.042	0.023
Major symptoms, abnormalities (CC 166)	0.047	0.069	0.073	0.063

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

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Age minus 65 (years above 65, continuous)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
Male	1.04 (1.01 - 1.07)	1.04 (1.01 - 1.07)	1.03 (0.99 - 1.06)	1.04 (1.02 - 1.05)
Congestive heart failure (CC 80)	1.20 (1.16 - 1.24)	1.15 (1.11 - 1.20)	1.21 (1.17 - 1.26)	1.19 (1.16 - 1.21)
Hypertensive heart disease (CC 90)	1.12 (1.06 - 1.19)	1.11 (1.05 - 1.18)	1.06 (0.99 - 1.14)	1.09 (1.05 - 1.13)
Cerebral hemorrhage (CC 95)	1.03 (0.94 - 1.13)	0.96 (0.87 - 1.05)	1.02 (0.93 - 1.13)	1.00 (0.94 - 1.05)
Ischemic or unspecified stroke (CC 96)	1.00 (0.96 - 1.04)	1.02 (0.98 - 1.06)	1.02 (0.98 - 1.06)	1.01 (0.99 - 1.03)
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	1.02 (0.98 - 1.05)	1.02 (0.98 - 1.06)	1.05 (1.01 - 1.09)	1.03 (1.01 - 1.05)
Hemiplegia, paralysis, functional disability (CC 100-102)	1.02 (0.98 - 1.07)	1.02 (0.97 - 1.07)	0.98 (0.94 - 1.04)	1.01 (0.98 - 1.04)

Variable	07/2011-06/2012 OR (95% CI)	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2011-06/2014 OR (95% CI)
Metastatic cancer or acute leukemia (CC 7)	1.37 (1.25 - 1.49)	1.49 (1.37 - 1.63)	1.45 (1.33 - 1.59)	1.43 (1.36 - 1.51)
Cancer (CC 8-12)	1.00 (0.96 - 1.04)	1.00 (0.96 - 1.04)	1.02 (0.98 - 1.06)	1.01 (0.99 - 1.03)
Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120)	1.15 (1.11 - 1.18)	1.17 (1.14 - 1.21)	1.16 (1.12 - 1.20)	1.15 (1.13 - 1.17)
Protein-calorie malnutrition (CC 21)	1.39 (1.32 - 1.46)	1.27 (1.20 - 1.34)	1.33 (1.26 - 1.40)	1.33 (1.29 - 1.37)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.12 (1.08 - 1.16)	1.11 (1.07 - 1.15)	1.12 (1.08 - 1.16)	1.12 (1.09 - 1.14)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.94 (0.91 - 0.98)	0.99 (0.95 - 1.04)	0.99 (0.94 - 1.03)	0.97 (0.95 - 0.99)
Severe hematological disorders (CC 44)	1.26 (1.14 - 1.40)	1.13 (1.00 - 1.29)	1.18 (1.04 - 1.35)	1.20 (1.12 - 1.29)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.18 (1.14 - 1.22)	1.24 (1.20 - 1.28)	1.24 (1.20 - 1.28)	1.22 (1.19 - 1.24)
Dementia or other specified brain disorders (CC 49-50)	1.08 (1.05 - 1.12)	1.05 (1.02 - 1.09)	1.03 (0.99 - 1.06)	1.05 (1.03 - 1.07)
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	1.11 (1.02 - 1.21)	1.14 (1.05 - 1.24)	1.09 (1.00 - 1.19)	1.11 (1.06 - 1.17)
Seizure disorders and convulsions (CC 74)	1.13 (1.07 - 1.19)	1.13 (1.07 - 1.19)	1.14 (1.08 - 1.20)	1.13 (1.09 - 1.16)
Vascular or circulatory disease (CC 104-106)	1.08 (1.05 - 1.12)	1.05 (1.02 - 1.09)	1.05 (1.02 - 1.09)	1.06 (1.04 - 1.08)
Chronic obstructive pulmonary disease (COPD) (CC 108)	1.18 (1.14 - 1.22)	1.15 (1.11 - 1.19)	1.19 (1.14 - 1.23)	1.17 (1.15 - 1.20)
Other lung disorders (CC 115)	1.10 (1.06 - 1.14)	1.09 (1.06 - 1.13)	1.03 (1.00 - 1.07)	1.08 (1.06 - 1.10)
End-stage renal disease or dialysis (CC 129-130)	1.39 (1.27 - 1.53)	1.39 (1.27 - 1.53)	1.25 (1.14 - 1.38)	1.35 (1.28 - 1.42)
Renal failure (CC 131)	1.10 (1.06 - 1.15)	1.17 (1.13 - 1.22)	1.17 (1.12 - 1.21)	1.15 (1.12 - 1.17)
Other urinary tract disorders (CC 136)	1.13 (1.09 - 1.17)	1.11 (1.07 - 1.15)	1.15 (1.11 - 1.19)	1.13 (1.11 - 1.15)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.99 (0.94 - 1.04)	1.05 (0.99 - 1.10)	1.04 (0.99 - 1.10)	1.02 (0.99 - 1.06)
Major symptoms, abnormalities (CC 166)	1.05 (1.01 - 1.09)	1.07 (1.03 - 1.11)	1.08 (1.04 - 1.12)	1.07 (1.04 - 1.09)

Table 4.6.4 – Stroke Generalized Linear Modeling (Logistic Regression) Performance Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Predictive ability, % (lowest decile – highest decile)	7.7 – 22.7	7.6 – 22.0	7.3 – 21.5	7.6 – 22.1
c-statistic	0.60	0.60	0.61	0.61

Table 4.6.5 – Distribution of Hospital Stroke Admission Volumes Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,233	4,161	4,079	4,462
Mean number of admissions (SD)	40.3 (52.1)	40.8 (53.7)	41.1 (54.2)	113.9 (156.2)
Range (min. – max.)	1 – 458	1 – 493	1 – 480	1 – 1431
25 th percentile	5	5	5	12
50 th percentile	18	18	18	46
75 th percentile	57	57	59	162

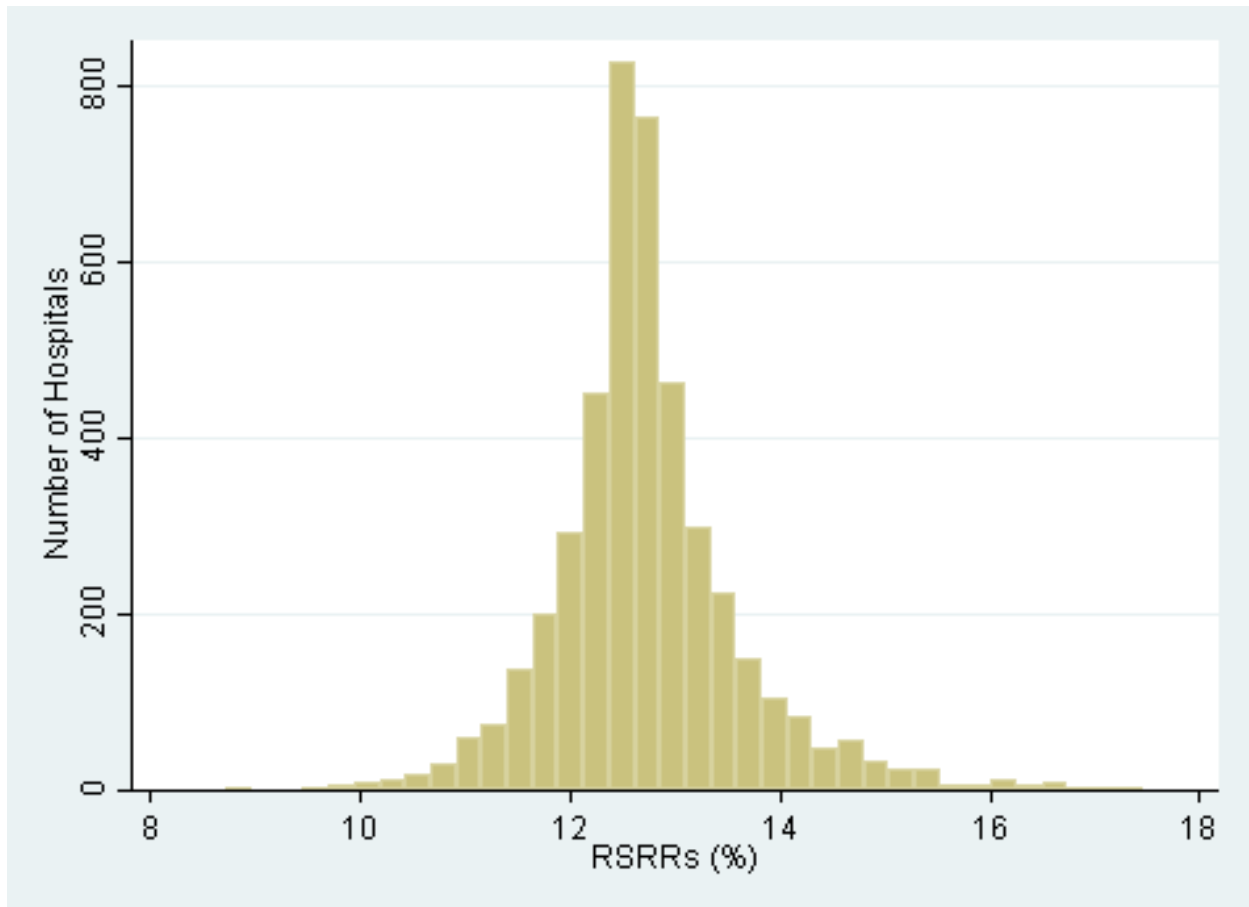
Table 4.6.6 – Distribution of Hospital Stroke RSRRs Over Different Time Periods

Characteristic	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Number of hospitals	4,233	4,161	4,079	4,462
Mean (SD) (%)	13.3 (0.6)	12.8 (0.6)	12.1 (0.5)	12.7 (0.9)
Range (min. – max.)	10.9 – 16.7	10.1 – 16.4	10.3 – 15.6	8.7 – 17.5
25 th percentile	13.0	12.5	11.9	12.3
50 th percentile	13.2	12.7	12.0	12.6
75 th percentile	13.5	13.0	12.3	13.1

Table 4.6.7 – Between Hospital Variance for Stroke

	07/2011-06/2012	07/2012-06/2013	07/2013-06/2014	07/2011-06/2014
Between hospital variance (SE)	0.026 (0.004)	0.027 (0.004)	0.027 (0.004)	0.032 (0.002)

Figure 4.6.2- Distribution of Hospital 30-Day Stroke RSRRs Between July 2011 and June 2014



N=4,462 hospitals

5. GLOSSARY

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

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

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

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

Confidence interval (CI): A CI is a range of probable values for an estimate that characterizes the amount of associated uncertainty. For example, the 95% CI for the ORs associated with risk-adjustment variables in the model indicates there is 95% confidence that the OR lies between the lower and the upper limit of the interval. The 95% CI serves as a proxy for statistical significance for ORs; if the CI does not contain the value of 1.0 the association is considered significant.

Expected readmissions: The number of readmissions 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 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 readmission 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 readmission risk.

Hospital-specific intercept: A measure of the hospital quality of care that is calculated based on the hospital's actual readmission rate relative to hospitals with similar patients, considering how many patients it served, its patients' risk factors, and how many were readmitted. The hospital-specific effect 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 effect is used in the numerator to calculate "predicted" readmissions.

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 readmission 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 readmission rate: All included hospitalizations with the outcome divided by all included hospitalizations.

Odds ratio (OR): The ORs express the relative odds of the outcome for each of the predictor variables. For example, the OR for Protein-calorie malnutrition (CC 21) represents the odds of the outcome for patients with that risk variable present relative to those without the risk variable present. The model coefficient for each risk variable is the log (odds) for that variable.

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

Planned readmissions: A readmission within 30 days of discharge from an acute care hospital that is a scheduled part of the patient's plan of care. Planned readmissions are not counted as outcomes in these measures.

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

Procedure Category: A group of related procedure codes, as grouped by the AHRQ CCS.

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

Unplanned readmissions: Acute clinical events a patient experienced that require urgent rehospitalization. Unplanned readmissions are counted as outcomes in these measures.

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7. APPENDICES

Appendix A. Statistical Approach to RSRRs for AMI, HF, Pneumonia, COPD, and Stroke Measures

We estimate the hospital-specific RSRRs using hierarchical generalized linear models. This strategy accounts for within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes. We model the probability of readmission as a function of patient age and clinically relevant comorbidities with an intercept for the hospital-specific random effect.

We use the following strategy to calculate hospital-specific RSRRs, which we calculate as the ratio of a hospital's "predicted" readmissions to "expected" readmissions multiplied by the national observed readmission rate. The expected number of readmissions 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 number of readmissions for each hospital is estimated given the same patient mix but an estimated hospital-specific intercept. Operationally, the expected number of readmissions for each hospital is obtained by summing the expected probabilities of readmissions for all patients in the hospital. The expected probability of readmission 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 number of readmissions 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 logistic regression model 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:

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

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

Where $h(\cdot)$ is a logit link, Y_{ij} is whether the j^{th} patient in the i^{th} hospital was readmitted (equal to 1 if readmitted within 30 days, zero otherwise); α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \dots, Z_{p_{ij}})$ the patient-specific covariates, μ is the adjusted average hospital intercept across all hospitals in the sample, and τ^2 is the between-hospital variance component.²³ This model separates within-hospital variation from between-hospital variation. The hierarchical logistic regression 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, $\hat{\mu}$, $\{\hat{\alpha}_1, \hat{\alpha}_2, \dots, \hat{\alpha}_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$ where i is the total number of hospitals. We calculate a standardized outcome measure, RSRR, for each hospital by computing the ratio of the predicted number of readmission to the expected number of readmissions, multiplied by the national observed readmission rate, \bar{y} . Specifically, we calculate

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

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

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

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

If the “predicted” number of readmissions is higher (or lower) than the “expected” number of readmissions for a given hospital, its \widehat{RSRR} will be higher (or lower) than the national observed readmission rate. For each hospital, we compute an interval estimate of \widehat{RSRR}_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{RSRR}_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, $\{\hat{\alpha}_i^{(b)}, \widehat{var}(\alpha_i^{(b)}); i = 1, 2, \dots, I\}$
3. We generate a hospital random effect by sampling from the distribution of the hospital-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \widehat{var}(\hat{\alpha}_i^{(b)}))$ for the unique set of hospitals sampled in Step 1.
 4. Within each unique hospital i sampled in Step 1, and for each case j in that hospital, we calculate $\hat{y}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\widehat{RSRR}_i(Z)^{(b)}$ 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).²⁴

Appendix B. Data Quality Assurance (QA)

We use a two-phase approach to internal QA for the readmission 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 CORE conducted to maintain and report these readmission 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 that work is conducted by another contractor.

Phase I

The first step in the QA process is to ensure the validity of the input data files. No new variables that impacted the measures 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 the prior time period.

In general, we use both manual scan and descriptive analyses to conduct data validity checks, including cross-checking readmission 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 readmission measures: data preparation, sample selection, hierarchical modeling, and calculation of RSRRs. 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.

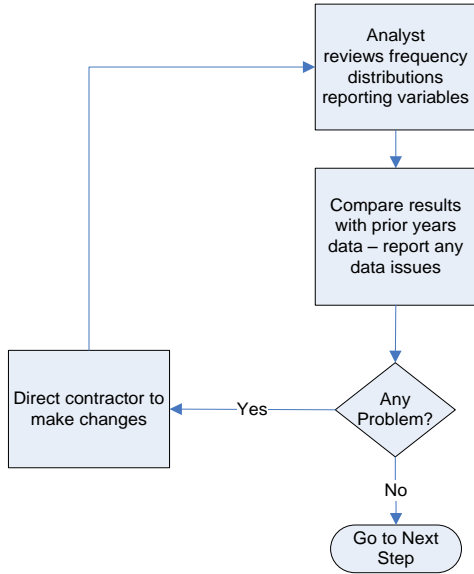
Phase II

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

Pre SAS Package Processing QA



SAS Package QA

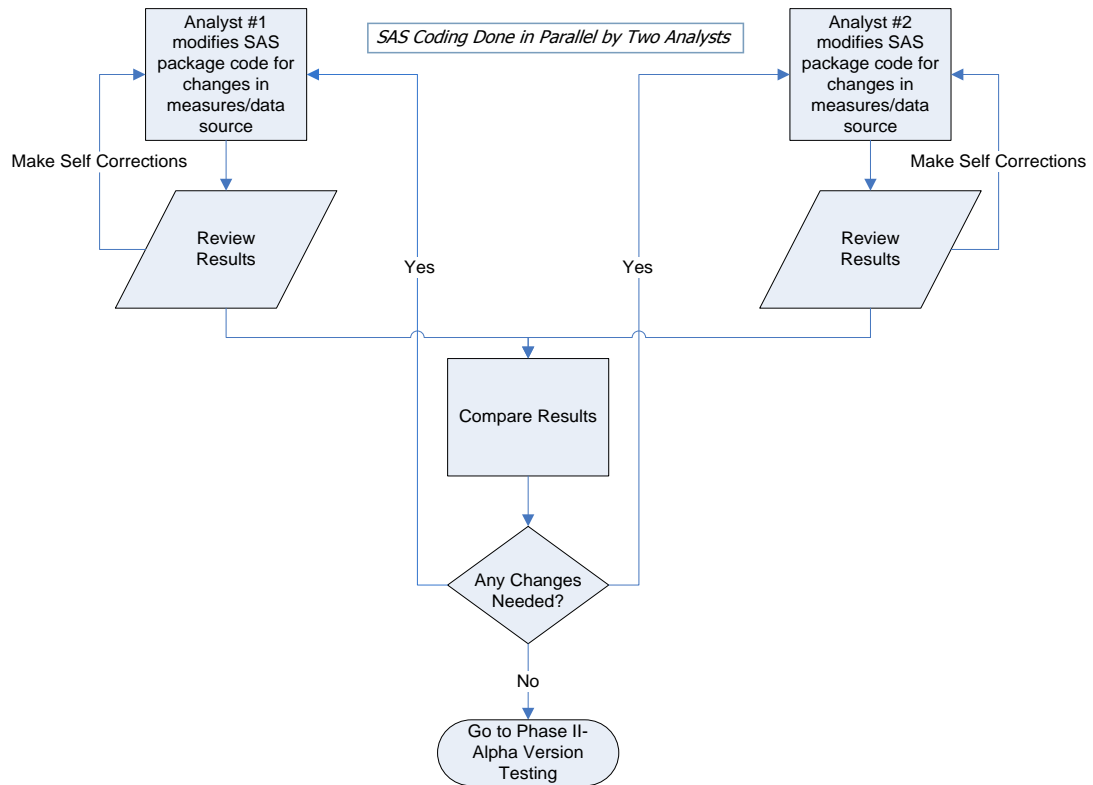
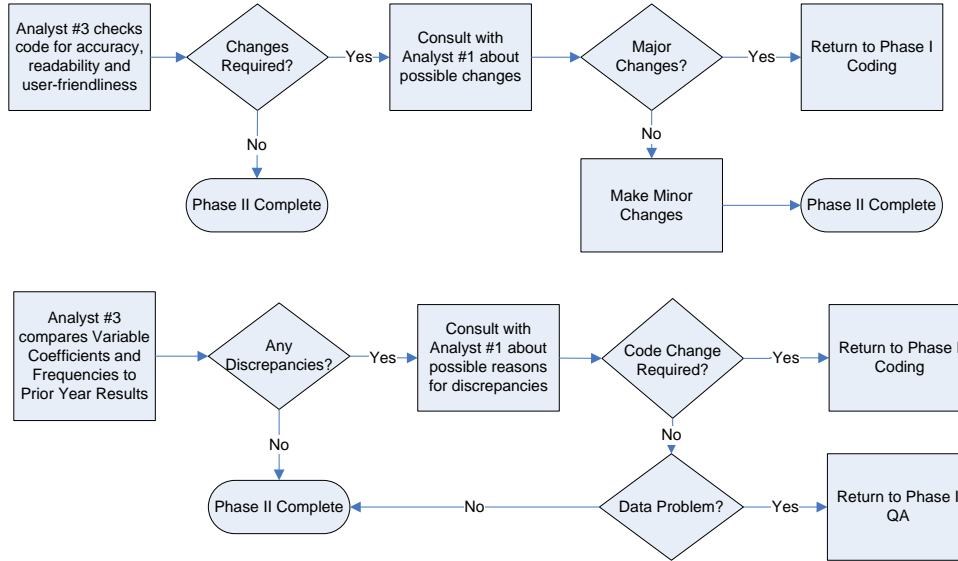


Figure B.2 - CORE QA Phase II

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 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.

2015

2015 Measures Updates and Specifications Report (Version 8.0 - AMI, HF, and Pneumonia) (Version 4.0 - COPD and Stroke)

1. Updated version of the AHRQ CCS software as it applies to the planned readmission algorithm.
 - Rationale: An updated version of the AHRQ CCS software was released in 2014.

2014

2014 Measures Updates and Specifications Report (Version 7.0 - AMI, HF, and Pneumonia) (Version 3.0 - COPD and Stroke)

1. Respecified the measures by adding the CMS planned readmission algorithm version 3.0.
 - Rationale: Version 3.0 incorporates improvements made following a validation study of the algorithm using data from a medical record review. These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designates as planned by removing two procedure categories and adding several acute diagnoses.
2. Updated version of the AHRQ CCS software
 - Rationale: An updated version of the AHRQ CCS software was released in 2013.

2013

2013 Measures Updates and Specifications Report AMI, HF, Pneumonia (Version 6.0)

1. Respecified the measures by adding the CMS planned readmission algorithm version 2.1.
 - Rationale: Unplanned readmissions are acute clinical events a patient experiences that require urgent rehospitalization. In contrast, planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients scheduled for elective or necessary procedures within 30 days of discharge.
2. Updated CC map.
 - Rationale: Prior to 2014, 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. Respecified the measures by adding the CMS planned readmission algorithm version 2.1.
 - Rationale: Unplanned readmissions are acute clinical events a patient experiences that require urgent rehospitalization. In contrast, planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients scheduled for elective or necessary procedures within 30 days of discharge.
2. Updated CC map.

- Rationale: Prior to 2014, 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 Stroke (Version 2.0)

1. Respecified the measures by adding the CMS planned readmission algorithm version 2.1.
 - Rationale: Unplanned readmissions are acute clinical events a patient experiences that require urgent rehospitalization. In contrast, planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients scheduled for elective or necessary procedures within 30 days of discharge.
2. Updated CC map.
 - Rationale: Prior to 2014, the ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.
3. Removed one stroke ICD-9 code (436)
 - Rationale: ICD-9-CM code 436 is not commonly used to define acute ischemic stroke.

2012

2012 Measures Maintenance Report AMI, HF, Pneumonia (Version 5.0)

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. 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.
3. Updated CC map.
 - Rationale: Prior to 2014, the ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2011

2011 Measures Maintenance Report AMI, HF, Pneumonia (Version 4.0)

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: Prior to 2014, the ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2010

2010 Measures Maintenance Report AMI, HF, Pneumonia (Version 3.0)

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 includes more clinical covariates for risk adjustment.
2. Updated handling of admissions to psychiatric and rehabilitation hospitals.
 - Rationale: Psych and rehab hospitals in Maryland have the same provider ID number as acute care hospitals. Therefore, readmissions are not counted if the patient has a principal diagnosis code beginning with a “V57” (indication of admission to a rehab unit) or if all three of the following criteria are met: (1) the admission being evaluated as a potential readmission has a psychiatric principal discharge diagnosis code (ICD-9 codes 290-319); (2) the index admission has a discharge disposition code to a psychiatric hospital or psychiatric unit from the index admission; and (3) the admission being evaluated as a potential readmission occurred during the same day as or the day following the index discharge.
 - The criteria for identifying such admissions are available in the 2010 Measures Maintenance Report.
3. Updated CC map.
 - Rationale: Prior to 2014, the ICD-9-CM CC map was updated annually to capture all relevant comorbidities coded in patient administrative claims data.

2009

2009 Measures Maintenance Report AMI, HF, Pneumonia (Version 2.0)

1. Used three years of claims and enrollment data for public reporting.
 - Rationale: Three years of data increased the precision of the hospital RSRR estimates by increasing the number of admissions used to calculate the rates. CMS developed the measures using one year of data.
2. Excluded patients discharged against medical advice (AMA).
 - Rationale: Providers are unable to deliver full care and prepare the patient for discharge when patients leave AMA.
3. Updated CC map.
 - Rationale: Prior to 2014, the ICD-9-CM CC map was 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 are VA Beneficiaries**
Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
- 3. Aged 65 or over**
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
- 4. Discharged alive from a non-federal acute care hospital or VA hospital**
Rationale: Patients who are alive are eligible for a readmission.
- 5. Not transferred to another acute care facility**
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
- 6. 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 criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure. This requirement is dropped for patients with an index admission within a VA hospital.

Exclusion Criteria for AMI Measure

- 1. Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- 2. Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- 3. Same day discharges**
Rationale: Patients admitted and then discharged on the same day are not included as an index admission because it is unlikely these admissions are for clinically significant AMIs.

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

ICD-9-CM Codes	Description
410.00	Acute myocardial infarction of anterolateral wall, episode of care unspecified
410.01	Acute myocardial infarction of anterolateral wall, initial episode of care

ICD-9-CM Codes	Description
410.10	Acute myocardial infarction of other anterior wall, episode of care unspecified
410.11	Acute myocardial infarction of other anterior wall, initial episode of care
410.20	Acute myocardial infarction of inferolateral wall, episode of care unspecified
410.21	Acute myocardial infarction of inferolateral wall, initial episode of care
410.30	Acute myocardial infarction of inferoposterior wall, episode of care unspecified
410.31	Acute myocardial infarction of inferoposterior wall, initial episode of care
410.40	Acute myocardial infarction of other inferior wall, episode of care unspecified
410.41	Acute myocardial infarction of other inferior wall, initial episode of care
410.50	Acute myocardial infarction of other lateral wall, episode of care unspecified
410.51	Acute myocardial infarction of other lateral wall, initial episode of care
410.60	True posterior wall infarction, episode of care unspecified
410.61	True posterior wall infarction, initial episode of care
410.70	Subendocardial infarction, episode of care unspecified
410.71	Subendocardial infarction, initial episode of care
410.80	Acute myocardial infarction of other specified sites, episode of care unspecified
410.81	Acute myocardial infarction of other specified sites, initial episode of care
410.90	Acute myocardial infarction of unspecified site, episode of care unspecified
410.91	Acute myocardial infarction of unspecified site, initial episode of care

Risk Adjustment

Table D.1.2 – Risk Variables for AMI Measure

Variable	Description
n/a	Age minus 65 (years above 65, continuous)
n/a	Male
ICD-9 codes V45.82, 00.66, 36.06, 36.07	History of Percutaneous Transluminal Coronary Angioplasty (PTCA)
ICD-9 codes V45.81, 36.10–36.16	History of Coronary Artery Bypass Graft (CABG)
ICD-9 codes 410.00-410.12	Anterior myocardial infarction
ICD-9 codes 410.20-410.62	Other location of myocardial infarction

Variable	Description
CC 1, 3-6	History of infection
CC 7	Metastatic cancer or acute leukemia
CC 8-12	Cancer
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 47	Iron deficiency or other specified anemias and blood disease
CC 49-50	Dementia and other specified brain disorders
CC 67-69, 100-102, 177-178	Hemiplegia, paraplegia, paralysis, functional disability
CC 80	Congestive heart failure
CC 81-82	Acute coronary syndrome
CC 83	Angina pectoris/old myocardial infarction
CC 84	Coronary atherosclerosis
CC 86	Valvular or rheumatic heart disease
CC 92-93	Specified arrhythmias and other heart rhythm disorders
CC 95-96	Stroke
CC 97-99, 103	Cerebrovascular disease
CC 104-106	Vascular or circulatory disease
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 110	Asthma
CC 111-113	Pneumonia
CC 129-130	End-stage renal disease or dialysis
CC 131	Renal failure
CC 136	Other urinary tract disorders
CC 148-149	Decubitus ulcer or chronic skin ulcer

Table D.1.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of AMI Measure

(Includes the subset of risk variables from Table D.1.2 that are not used in risk adjustment if occurring only during the index admission)

Variable	Description
CC 6	Other infectious diseases
CC 17	Diabetes with acute complications
CC 23	Disorders of fluid/electrolyte/acid-Base
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of ischemic heart disease
CC 92	Specified arrhythmias
CC 93	Other heart rhythm and conduction disorders

Variable	Description
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 129	End-stage renal disease
CC 130	Dialysis status
CC 131	Renal failure
CC 148	Decubitus ulcer of skin
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for AMI Measure

1. 30-day time frame

Rationale: Outcomes occurring within 30 days of discharge 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 to reduce readmissions.

2. All-cause unplanned readmission

Rationale: From a patient perspective, an unplanned readmission from any cause is an adverse event.

3. Unplanned readmission

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge.

Appendix D.2 HF

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 are VA Beneficiaries**
Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
- 3. Aged 65 or over**
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
- 4. Discharged alive from a non-federal acute care hospital or VA hospital**
Rationale: Patients who are alive are eligible for a readmission.
- 5. Not transferred to another acute care facility**
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
- 6. 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 criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure. This requirement is dropped for patients with an index admission within a VA hospital.

Exclusion Criteria for HF Measure

- 1. Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- 2. Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

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

ICD-9-CM Codes	Description
402.01	Malignant hypertensive heart disease with heart failure
402.11	Benign hypertensive heart disease with heart failure
402.91	Unspecified hypertensive heart disease with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease

ICD-9-CM Codes	Description
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure
428.22	Chronic systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.32	Chronic diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.42	Chronic combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified

Risk Adjustment

Table D.2.2 – Risk Variables for HF Measure

Variable	Description
n/a	Age minus 65 (years above 65, continuous)
n/a	Male
ICD-9 codes V45.81, 36.10–36.16	History of Coronary Artery Bypass Graft (CABG)
CC 7	Metastatic cancer or acute leukemia
CC 8-12	Cancer
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 25-30	Liver or biliary disease

Variable	Description
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
CC 36	Other gastrointestinal disorders
CC 44	Severe hematological disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49-50	Dementia or other specified brain disorders
CC 51-53	Drug/alcohol abuse/dependence/psychosis
CC 54-56	Major psychiatric disorders
CC 58	Depression
CC 60	Other psychiatric disorders
CC 67-69, 100-102, 177-178	Hemiplegia, paraplegia, paralysis, functional disability
CC 79	Cardio-respiratory failure or shock
CC 80	Congestive heart failure
CC 81-82	Acute coronary syndrome
CC 83-84	Coronary atherosclerosis or angina
CC 86	Valvular or rheumatic heart disease
CC 92-93	Specified arrhythmias and other heart rhythm disorders
CC 94	Other or unspecified heart disease
CC 95-96	Stroke
CC 104-106	Vascular or circulatory disease
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 109	Fibrosis of lung or other chronic lung disorders
CC 110	Asthma
CC 111-113	Pneumonia
CC 129-130	End-stage renal disease or dialysis
CC 131	Renal failure
CC 132	Nephritis
CC 136	Other urinary tract disorders
CC 148-149	Decubitus ulcer or chronic skin ulcer

Table D.2.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of HF Measure

(Includes the subset of risk variables from Table D.2.2 that are not used in risk adjustment if occurring only during the index admission)

Variable	Description
CC 17	Diabetes with acute complications
CC 23	Disorders of fluid/electrolyte/acid-base
CC 28	Acute liver failure/disease

Variable	Description
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
CC 79	Cardio-respiratory failure and shock
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of 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 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 129	End-stage renal disease
CC 130	Dialysis status
CC 131	Renal failure
CC 132	Nephritis
CC 148	Decubitus ulcer of skin
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for HF Measure

1. 30-day time frame

Rationale: Outcomes occurring within 30 days of discharge 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 readmissions.

2. All-cause unplanned readmission

Rationale: From a patient perspective, an unplanned readmission from any cause is an adverse event.

3. Unplanned readmission

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge.

Appendix D.3 Pneumonia

Cohort

Inclusion Criteria for Pneumonia Measure

- 1. Principal discharge diagnosis of pneumonia**
Rationale: Pneumonia is the condition targeted for measurement ([Table D.3.1](#)).
- 2. Enrolled in Medicare FFS or are VA Beneficiaries**
Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries.
- 3. Aged 65 or over**
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
- 4. Discharged alive from a non-federal acute care hospital or VA hospital**
Rationale: Patients who are alive are eligible for a readmission.
- 5. Not transferred to another acute care facility**
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
- 6. 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 criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure. This requirement is dropped for patients with an index admission within a VA hospital.

Exclusion Criteria for Pneumonia Measure

- 1. Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- 2. Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

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	Pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia, unspecified
481	Pneumococcal pneumonia (<i>Streptococcus pneumoniae</i> pneumonia)

ICD-9-CM Codes	Description
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	Methicillin susceptible 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 2009 H1N1 influenza virus with pneumonia

Risk Adjustment

Table D.3.2 – Risk Variables for Pneumonia Measure

Variable	Description
n/a	Age minus 65 (years above 65, continuous)
n/a	Male
ICD-9 codes V45.81, 36.10–36.16	History of Coronary Artery Bypass Graft (CABG)
CC 1, 3-6	History of infection
CC 2	Septicemia/shock
CC 7	Metastatic cancer or acute leukemia
CC 8	Lung, upper digestive tract, and other severe cancers
CC 9-10	Other major cancers

Variable	Description
CC 15-19, 119-120	Diabetes mellitus (DM) or DM complications
CC 21	Protein-calorie malnutrition
CC 22-23	Disorders of fluid/electrolyte/acid-base
CC 36	Other gastrointestinal disorders
CC 44	Severe hematological disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49-50	Dementia or other specified brain disorders
CC 51-53	Drug/alcohol abuse/dependence/psychosis
CC 54-56	Major psychiatric disorders
CC 60	Other psychiatric disorders
CC 67-69, 100-102, 177-178	Hemiplegia, paraplegia, paralysis, functional disability
CC 79	Cardio-respiratory failure and shock
CC 80	Congestive heart failure
CC 81-82	Acute coronary syndrome
CC 83-84	Coronary atherosclerosis or angina
CC 86	Valvular or rheumatic heart disease
CC 92-93	Specified arrhythmias and other heart rhythm disorders
CC 95-96	Stroke
CC 104-106	Vascular or circulatory disease
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 109	Fibrosis of lung or other chronic lung disorders
CC 110	Asthma
CC 111-113	Pneumonia
CC 114	Pleural effusion/pneumothorax
CC 115	Other lung disorders
CC 129-130	End-stage renal disease or dialysis
CC 131	Renal failure
CC 135	Urinary tract infection
CC 136	Other urinary tract disorders
CC 148-149	Decubitus ulcer or chronic skin ulcer
CC 157	Vertebral fractures
CC 162	Other injuries

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

(Includes the subset of risk variables from Table D.3.2 that are not used in risk adjustment if occurring only during the index admission)

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 79	Cardio-respiratory failure or shock
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of 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 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 135	Urinary tract infection
CC 148	Decubitus ulcer of skin
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for Pneumonia Measure

1. 30-day time frame

Rationale: Outcomes occurring within 30 days of discharge 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 to reduce readmissions.

2. All-cause unplanned readmission

Rationale: From a patient perspective, an unplanned readmission from any cause is an adverse event.

3. Unplanned readmission

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge.

Appendix D.4 COPD

Cohort

Inclusion Criteria for COPD Measure

- 1. Principal discharge diagnosis of COPD or principal diagnosis of respiratory failure with a secondary diagnosis of COPD with exacerbation**
Rationale: COPD is the condition targeted for measurement. Respiratory failure patients with a secondary diagnosis of COPD are also included to capture the full spectrum of severity among patients hospitalized with exacerbations of COPD ([Table D.4.1](#)).
- 2. Enrolled in Medicare FFS**
Rationale: Claims data are consistently available only for Medicare FFS beneficiaries.
- 3. Aged 65 or over**
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
- 4. Discharged alive from a non-federal acute care hospital**
Rationale: Patients who are alive are eligible for a readmission.
- 5. Not transferred to another acute care facility**
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
- 6. 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 criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.

Exclusion Criteria for COPD Measure

- 1. Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- 2. Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

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

ICD-9-CM Codes	Description
491.21	Obstructive chronic bronchitis with (acute) exacerbation
491.22	Obstructive chronic bronchitis with acute bronchitis
491.8	Other chronic bronchitis
491.9	Unspecified chronic bronchitis
492.8	Other emphysema
493.20	Chronic obstructive asthma, unspecified

ICD-9-CM Codes	Description
493.21	Chronic obstructive asthma with status asthmaticus
493.22	Chronic obstructive asthma with (acute) exacerbation
496	Chronic airway obstruction, not elsewhere classified
518.81	Acute respiratory failure (Principal diagnosis when combined with a secondary diagnosis of COPD with exacerbation [491.21, 491.22, 493.21, or 493.22])
518.82	Other pulmonary insufficiency, not elsewhere classified (Principal diagnosis when combined with a secondary diagnosis of COPD with exacerbation [491.21, 491.22, 493.21, or 493.22])
518.84	Acute and chronic respiratory failure (Principal diagnosis when combined with a secondary diagnosis of COPD with exacerbation [491.21, 491.22, 493.21, or 493.22])
799.1	Respiratory arrest (Principal diagnosis when combined with a secondary diagnosis of COPD with exacerbation [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 minus 65 (years above 65, continuous)
ICD-9 codes 93.90, 96.70, 96.71, 96.72	History of mechanical ventilation
ICD-9 codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57	Sleep apnea
CC 1, 3-6	History of infection
CC 7	Metastatic cancer or 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 32	Pancreatic disease
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
CC 36	Other gastrointestinal disorders
CC 44	Severe hematological disorders

Variable	Description
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49-50	Dementia or other specified brain disorders
CC 51-52	Drug/alcohol psychosis or dependence
CC 54-56	Major psychiatric disorders
CC 58	Depression
CC 59	Anxiety disorders
CC 60	Other psychiatric disorders
CC 67-69, 100-102, 177-178	Hemiplegia, paraplegia, paralysis, functional disability
CC 71	Polyneuropathy
CC 77-78	Respirator dependence/respiratory failure
CC 79	Cardio-respiratory failure and shock
CC 80	Congestive heart failure
CC 81-82	Acute coronary syndrome
CC 83-84	Chronic atherosclerosis or angina
CC 89	Hypertensive heart and renal disease or encephalopathy
CC 92-93	Specified arrhythmias and other heart rhythm disorders
CC 94	Other or unspecified heart disease
CC 95-96	Stroke
CC 104-106	Vascular or circulatory disease
CC 109	Fibrosis of lung or other chronic lung disorders
CC 111-113	Pneumonia
CC 131	Renal failure
CC 148-149	Decubitus ulcer or chronic skin ulcer
CC 152	Cellulitis, local skin infection
CC 157	Vertebral fractures

Table D.4.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of COPD Measure

(Includes the subset of risk variables from Table D.4.2 that are not used in risk adjustment if occurring only during the index admission)

Variable	Description
CC 6	Other infectious diseases
CC 17	Diabetes with acute complications
CC 23	Disorders of fluid/electrolyte/acid-base
CC 34	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
CC 77	Respirator dependence/tracheostomy status
CC 78	Respiratory arrest
CC 79	Cardio-respiratory failure or shock

Variable	Description
CC 80	Congestive heart failure
CC 81	Acute myocardial infarction
CC 82	Other acute/subacute forms of ischemic heart disease
CC 92	Specified arrhythmias
CC 93	Other heart rhythm and conduction disorders
CC 95	Cerebral hemorrhage
CC 96	Ischemic or unspecified stroke
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 131	Renal failure
CC 148	Decubitus ulcer of skin
CC 152	Cellulitis, local skin infection
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 discharge 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 to reduce readmissions.

2. All-cause unplanned readmission

Rationale: From a patient perspective, an unplanned readmission from any cause is an adverse event.

3. Unplanned readmission

Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge.

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**
Rationale: Currently claims-data are consistently available only for Medicare FFS beneficiaries.
- 3. Aged 65 or over**
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because they are considered to be too clinically distinct from Medicare patients 65 and over.
- 4. Discharged alive from a non-federal acute care hospital**
Rationale: Patients who are alive are eligible for a readmission.
- 5. Not transferred to another acute care facility**
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
- 6. 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 criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.

Exclusion Criteria for Stroke Measure

- 1. Without at least 30 days of post-discharge enrollment in FFS Medicare**
Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- 2. Discharged against medical advice (AMA)**
Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

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

ICD-9-CM Codes	Description
433.01	Occlusion and stenosis of basilar artery with cerebral infarction
433.11	Occlusion and stenosis of carotid artery with cerebral infarction
433.21	Occlusion and stenosis of vertebral artery with cerebral infarction
433.31	Occlusion and stenosis of multiple and bilateral precerebral arteries with cerebral infarction
433.81	Occlusion and stenosis of other specified precerebral artery with cerebral infarction

ICD-9-CM Codes	Description
433.91	Occlusion and stenosis of unspecified precerebral artery with cerebral infarction
434.01	Cerebral thrombosis with cerebral infarction
434.11	Cerebral embolism with cerebral infarction
434.91	Cerebral artery occlusion, unspecified with cerebral infarction

Risk Adjustment

Table D.5.2 – Risk Variables for Stroke Measure

Variable	Description
n/a	Age minus 65 (years above 65, continuous)
n/a	Male
CC 7	Metastatic cancer or acute leukemia
CC 8-12	Cancer
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 44	Severe hematological disorders
CC 47	Iron deficiency or other unspecified anemias and blood disease
CC 49-50	Dementia or other specified brain disorders
CC 67-69, 177-178	Quadriplegia, paraplegia, functional disability
CC 74	Seizure disorders And convulsions
CC 80	Congestive heart failure
CC 90	Hypertensive heart disease
CC 95	Cerebral hemorrhage
CC 96	Ischemic or unspecified stroke
CC 97	Precerebral arterial occlusion and transient cerebral ischemia
CC 100-102	Hemiplegia, paralysis, functional disability
CC 104-106	Vascular or circulatory disease
CC 108	Chronic obstructive pulmonary disease (COPD)
CC 115	Other lung disorders
CC 129-130	End-stage renal disease or dialysis
CC 131	Renal failure
CC 136	Other urinary tract disorders
CC 148-149	Decubitus ulcer or chronic skin ulcer
CC 166	Major symptoms, abnormalities

Table D.5.3 – Complications of Care Variables Not Used in Risk Adjustment If Occurring Only During the Index Admission of Stroke Measure

(Includes the subset of risk variables from Table D.5.2 that are not used in risk adjustment if occurring only during the index admission)

Variable	Description
CC 17	Diabetes with acute complications
CC 23	Disorders of fluid/electrolyte/acid-base
CC 80	Congestive heart failure
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 Deficits
CC 104	Vascular disease with complications
CC 105	Vascular disease
CC 106	Other circulatory disease
CC 130	Dialysis status
CC 131	Renal failure
CC 148	Decubitus ulcer of skin
CC 177	Amputation status, lower limb/amputation
CC 178	Amputation status, upper limb

Outcome

Outcome Criteria for Stroke Measure

1. 30-day time frame

Rationale: Outcomes occurring within 30 days of discharge 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 to reduce readmissions.

2. All-cause unplanned readmission

Rationale: From a patient perspective, an unplanned readmission from any cause is an adverse event.

3. Unplanned readmission

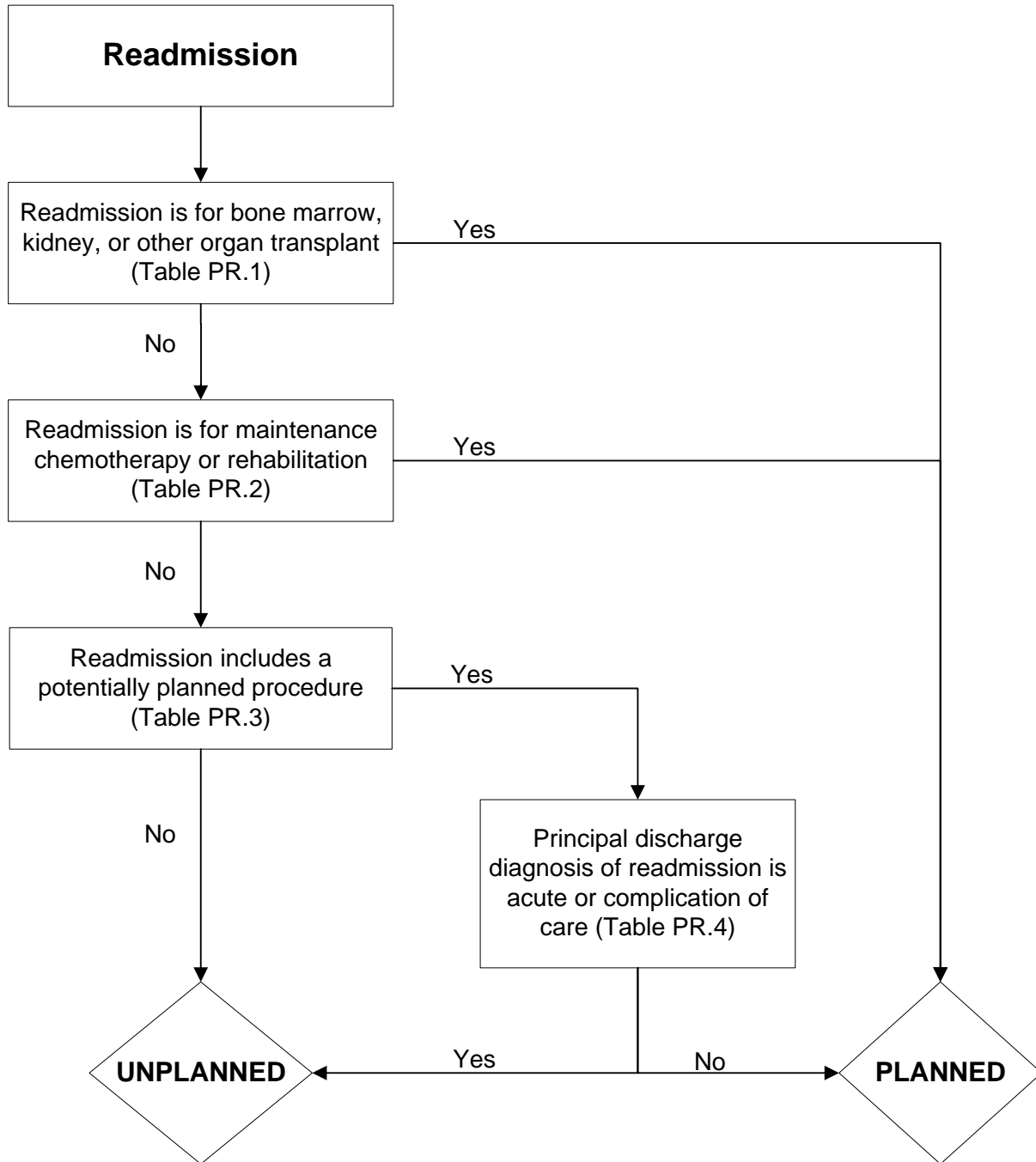
Rationale: Planned readmissions are generally not a signal of quality of care. Including planned readmissions in a readmission measure could create a disincentive to provide appropriate care to patients who are scheduled for elective or necessary procedures within 30 days of discharge.

4. Adaptation of planned readmission algorithm version 3.0

Rationale: The stroke readmission measure makes one modification to the planned readmission algorithm version 3.0 in [Table PR.3](#): it does not consider readmissions for Debridement of Wound; Infection or Burn (Procedure CCS 169) as planned because such treatments are commonly provided for decubitus ulcers that can be complications of care following admission for a stroke.

Appendix E. Planned Readmission Algorithm

Figure PR.1 – Planned Readmission Algorithm Version 3.0 Flowchart



Planned Readmission Algorithm Version 3.0 Tables – AMI, HF, Pneumonia, COPD, and Stroke Measures

Table PR.1 - Procedure Categories That are Always Planned (Version 3.0)

Procedure CCS	Description
64	Bone marrow transplant
105	Kidney transplant
134	Cesarean section (Included only in all-payer population, not Medicare)
135	Forceps; vacuum; and breech delivery (Included only in all-payer population, not Medicare)
176	Other organ transplantation

Table PR.2 - Diagnosis Categories That are Always Planned (Version 3.0)

Diagnosis CCS	Description
45	Maintenance chemotherapy
194	Forceps delivery (Included only in all-payer population, not Medicare)
196	Normal pregnancy and/or delivery (Included only in all-payer population, not Medicare)
254	Rehabilitation (Includes only V52.0, V52.1, V52.4, V52.8, V52.9, V53.8, and V58.82 - Refer to Appendix C for more detail)

Table PR.3- Potentially Planned Procedure Categories (Version 3.0)

Procedure CCS	Description
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
47	Diagnostic cardiac catheterization; coronary arteriography
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
62	Other diagnostic cardiovascular procedures
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral

Procedure CCS	Description
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
169	Debridement of wound; infection or burn (This procedure category is always considered unplanned in the stroke readmission measure)
170	Excision of skin lesion
172	Skin graft
ICD-9 Codes	Description
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from Procedure CCS 42- Other OR Rx procedures on respiratory system and mediastinum)
38.18	Endarterectomy leg vessel (from Procedure CCS 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from Procedure CCS 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from Procedure CCS 218- Psychological and psychiatric evaluation and therapy)

Table PR.4- Acute Diagnosis Categories (Version 3.0)

Diagnosis CCS	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
99	Hypertension with complications
100	Acute myocardial infarction (with the exception of ICD-9 codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis

Diagnosis CCS	Description
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances

Diagnosis CCS	Description
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
ICD-9 codes	Description
Acute ICD-9 codes within Diagnosis CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
032.82	Diphtheritic myocarditis
036.40	Meningococcal carditis, unspecified
036.41	Meningococcal pericarditis
036.42	Meningococcal endocarditis
036.43	Meningococcal myocarditis
074.20	Coxsackie carditis, unspecified
074.21	Coxsackie pericarditis
074.22	Coxsackie endocarditis
074.23	Coxsackie myocarditis
112.81	Candidal endocarditis
115.03	Infection by Histoplasma capsulatum, pericarditis
115.04	Infection by Histoplasma capsulatum, endocarditis
115.13	Infection by Histoplasma duboisii pericarditis
115.14	Histoplasma duboisii, endocarditis
115.93	Histoplasmosis, unspecified, pericarditis
115.94	Histoplasmosis, unspecified, endocarditis
130.3	Myocarditis due to toxoplasmosis
391.0	Acute rheumatic pericarditis
391.1	Acute rheumatic endocarditis

Diagnosis CCS	Description
391.2	Acute rheumatic myocarditis
391.8	Other acute rheumatic heart disease, unspecified
391.9	Acute rheumatic heart disease, unspecified
392.0	Rheumatic chorea with heart involvement
398.0	Rheumatic myocarditis
398.90	Rheumatic heart disease, unspecified
398.99	Other Rheumatic heart diseases
420.0	Acute pericarditis in diseases classified elsewhere
420.90	Acute pericarditis, unspecified
420.91	Acute idiopathic pericarditis
420.99	Other acute pericarditis
421.0	Acute and subacute bacterial endocarditis
421.1	Acute and subacute infective endocarditis in diseases classified elsewhere
421.9	Acute endocarditis, unspecified
422.0	Acute myocarditis in diseases classified elsewhere
422.90	Acute myocarditis, unspecified
422.91	Idiopathic myocarditis
422.92	Septic myocarditis
422.93	Toxic myocarditis
422.99	Other acute myocarditis
423.0	Hemopericardium
423.1	Adhesive pericarditis
423.2	Constrictive pericarditis
423.3	Cardiac tamponade
429.0	Myocarditis, unspecified
Acute ICD-9 codes within Diagnosis CCS 105: Conduction disorders	
426.0	Atrioventricular block, complete
426.10	Atrioventricular block, unspecified
426.11	First degree atrioventricular block
426.12	Mobitz (type) II atrioventricular block
426.13	Other second degree atrioventricular block
426.2	Left bundle branch hemiblock
426.3	Other left bundle branch block
426.4	Right bundle branch block
426.50	Bundle branch block, unspecified
426.51	Right bundle branch block and left posterior fascicular block
426.52	Right bundle branch block and left anterior fascicular block
426.53	Other bilateral bundle branch block
426.54	Trifascicular block
426.6	Other heart block
426.7	Anomalous atrioventricular excitation
426.81	Lown-Ganong-Levine syndrome

Diagnosis CCS	Description
426.82	Long QT syndrome
426.9	Conduction disorder, unspecified
Acute ICD-9 codes within Diagnosis CCS 106: Dysrhythmia	
427.2	Paroxysmal tachycardia, unspecified
427.69	Other premature beats
427.89	Other specified cardiac dysrhythmias
427.9	Cardiac dysrhythmia, unspecified
785.0	Tachycardia, unspecified
Acute ICD-9 codes within Diagnosis CCS 108: Congestive heart failure; nonhypertensive	
398.91	Rheumatic heart failure (congestive)
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Systolic heart failure, unspecified
428.21	Acute systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Diastolic heart failure, unspecified
428.31	Acute diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Acute combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure, unspecified
Acute ICD-9 codes within Diagnosis CCS 149: Biliary tract disease	
574.00	Calculus of gallbladder with acute cholecystitis, without mention of obstruction
574.01	Calculus of gallbladder with acute cholecystitis, with obstruction
574.30	Calculus of bile duct with acute cholecystitis, without mention of obstruction
574.31	Calculus of bile duct with acute cholecystitis, with obstruction
574.60	Calculus of gallbladder and bile duct with acute cholecystitis, without mention of obstruction
574.61	Calculus of gallbladder and bile duct with acute cholecystitis, with obstruction
574.80	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, without mention of obstruction
574.81	Calculus of gallbladder and bile duct with acute and chronic cholecystitis, with obstruction
575.0	Acute cholecystitis
575.12	Acute and chronic cholecystitis
576.1	Cholangitis
Acute ICD-9 codes with Diagnosis CCS 152: Pancreatic disorders	
577.0	Acute pancreatitis