2016 Condition-Specific Measures Updates and Specifications Report
Hospital-Level 30-Day Risk-Standardized Readmission Measures

Acute Myocardial Infarction – Version 9.0
Chronic Obstructive Pulmonary Disease – Version 5.0
Heart Failure – Version 9.0
Pneumonia – Version 9.0
Stroke – Version 5.0

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) 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), chronic obstructive pulmonary disease (COPD), heart failure (HF), pneumonia, and stroke. This report serves as a single source of information about these measures for a wide range of readers. Reports describing hospital-wide readmission, procedure-specific readmission, condition-specific mortality, and other outcome measures can be found on *QualityNet*.

This report provides an overview of the measure methodology, methodology updates for 2016 public reporting, and the national results for 2016 public reporting. The appendices provide detailed specifications for each measure, including tables of codes used for cohort derivation and risk adjustment, as well as a history of annual updates.

Specifically, the report includes:

- **Section 2 - An overview of the AMI, COPD, HF, pneumonia, and stroke readmission measures:**
  - Background
  - Cohort inclusions and exclusions
    - included and excluded hospitalizations
    - how transferred patients are handled
    - differences in how the AMI, COPD, HF, and pneumonia measure scores are calculated for the Hospital Inpatient Quality Reporting program and the Hospital Readmissions Reduction Program (HRRP)
  - Unplanned readmission outcome
  - Risk-adjustment variables
  - Data sources
  - Readmission rate calculation
  - Categorization of hospitals' performance score

- **Section 3 - 2016 measure updates**

- **Section 4 - 2016 measure results**

- **Section 5 - Glossary**

The Appendices contain detailed measure information, including:

- Appendix A: Statistical approach to calculating RSRRs;
- Appendix B: Data quality assurance (QA);
- Appendix C: Annual updates to the 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 AMI Readmission Measure Methodology (2008)[1]
- Hospital 30-Day Readmission Following Admission for an Acute Exacerbation of Chronic Obstructive Pulmonary Disease, Measure Methodology Report (2011)[2]
- Hospital 30-Day Heart Failure Readmission Measure Methodology (2008)[3]
- Hospital 30-Day Pneumonia Readmission Measure Methodology (2008)[4]
- Hospital 30-Day Readmission Following Acute Ischemic Stroke Hospitalization Measure, Measure Methodology Report (2010)[5]
- 2009-2013 Measure Maintenance Technical Reports: AMI, HF, and Pneumonia 30-Day Risk-Standardized Readmission Measures[6-10]
- 2013 Measure Updates and Specifications Report: Hospital 30-Day Readmission Following an Admission for an Acute Exacerbation of COPD (Version 2.0)[11]
- 2013 Measure Updates and Specifications Report: Hospital 30-Day Readmission Following an Admission for an Acute Ischemic Stroke (Version 2.0)[12]
- 2014 Condition-Based Measure Updates and Specifications: AMI, COPD, HF, Pneumonia, and Stroke 30-Day Risk-Standardized Readmission Measures[13]
- 2015 Measures Updates and Specifications Report: Hospital-Level 30-Day Risk-Standardized Readmission Measures; Acute Myocardial Infarction, Heart Failure, Pneumonia, Chronic Obstructive Pulmonary Disease, and Stroke[14]

The AMI, HF, and pneumonia readmission measure methodologies are also described in the peer-reviewed medical literature.[15-17]

For resources on quality improvement activities aimed at reducing readmission in general, and for more information about the cost and business case for making such improvements, refer to the Reducing Readmissions section under the claims-based readmission measures page of *QualityNet*.

2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY

2.1 Background on Readmission Measures

In July 2009, CMS began publicly reporting 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 2014, CMS began publicly reporting two additional hospital 30-day readmission measures; namely, COPD and ischemic stroke. These two measures also include admissions to non-federal acute care hospitals and critical access hospitals.

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 AMI, COPD, HF, pneumonia, and stroke readmission measures for 2016 public reporting through a process of measure reevaluation. The measures are reevaluated annually in order to improve them by responding to stakeholder input and incorporating advances in science or changes in coding.

2.2 Overview of Measure Methodology

The 2016 risk-adjusted readmission measures use specifications from the initial measure methodology reports with refinements to the measures, as listed in Appendix C and described in the prior measures updates and specifications reports[1-14]. 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, COPD, HF, and pneumonia measures for HRRP, with certain differences in the measure cohorts, as noted in Section 2.2.1. These differences may make an individual hospital's results for the two programs slightly different.

2.2.1 Cohort

Index Admissions Included in the 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, COPD, HF, pneumonia, or ischemic 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
    - The pneumonia measure cohort also includes admissions with a principal discharge diagnosis of sepsis (not including severe sepsis) that have a

secondary discharge diagnosis of pneumonia coded as present on admission (POA) and no secondary diagnosis of severe sepsis coded as POA

- Enrolled in Medicare fee-for-service (FFS) Part A and Part B for the 12 months prior to the date of the admission, and enrolled in Part A during the index admission;
- Aged 65 or over;
- Discharged alive from a non-federal short-term acute care hospital; and,
- Not transferred to another acute care facility.

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes used to define the cohort inclusions for each measure are listed in Appendix D, in Table D.1.1, Table D.2.1, Table D.3.1, Table D.4.1, and Table D.5.1 for AMI, COPD, HF, pneumonia, and stroke, respectively.

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; 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 excluded as index admissions because it is unlikely these patients had clinically significant AMIs.

An additional exclusion criterion for the HF cohort is that patients with a procedure code for left ventricular assist device (LVAD) implantation or heart transplantation (Table D.3.2) either during the index admission or in the 12 months prior to the index admission are excluded as index admissions because these patients represent a clinically distinct, highly-selected group.

Admissions within 30 days of discharge from an index admission are excluded as index admissions. Thus, no hospitalization will be considered 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.

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.

The percentage of admissions excluded based on each criterion is shown in Section 4 in Figure 4.2.1, Figure 4.3.1, Figure 4.4.1, Figure 4.5.1, and Figure 4.6.1 for AMI, COPD, HF, pneumonia, and stroke, respectively.

Patients Transferred Between Hospitals

The measures consider multiple contiguous hospitalizations as a single acute episode of care. Cases that meet the below criteria are considered transfers regardless of whether or not the first institution indicates intent to transfer the patient in the discharge disposition code.

Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. The following criteria must be met:

- The second inpatient admission must occur on the same day or the next calendar day following discharge from the first inpatient admission at a short-term acute care hospital; and,
- The principal discharge diagnosis (and/or secondary diagnosis) for the final hospitalization in the transfer chain must meet the measure cohort inclusion criteria for that measure.

To include an admission in the measure cohort, the patient must ultimately be discharged to a non-acute care setting (for example, to home or a skilled nursing facility). Thus, for patients transferred from one short-term acute care hospital to another, only the last admission in the transfer chain is eligible for inclusion in the cohort. The previous admissions are not included. For example, if a patient is admitted to Hospital A, transfers to Hospital B, and then is discharged from Hospital B to a non-acute care setting, only the Hospital B admission would be included in the cohort, and a readmission within 30 days of discharge from the Hospital B admission would be captured in Hospital B's readmission outcome.

Hospital Readmissions Reduction Program (HRRP)

CMS uses the AMI, COPD, HF, and pneumonia readmission measures in the HRRP. The HRRP includes only subsection (d) hospitals and hospitals located in Maryland. Critical access hospitals, cancer hospitals, and hospitals in U.S. territories will not be included. Admissions to such hospitals will not be included as index admissions nor considered 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 2013 - 2016 IPPS Final Rules on the CMS website.

2.2.2 Outcome

All-Cause Unplanned Readmissions

The measures are designed to capture unplanned 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 considered readmissions in the measure outcome. For more detail about how planned readmissions are defined, refer to Section 2.2.3 and Appendix E.

All unplanned readmissions are considered an outcome, regardless of cause. There are a number of reasons for assessing 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 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.

Note that if a patient is readmitted to the **same** hospital on the **same** day of discharge for the **same condition** as the index admission, the measure considers the patient to have had one single continuous admission (that is, one index admission). However, if the condition is **different** from the index admission, this is considered a readmission in the measure.

30-Day Time Frame

The measures assess unplanned readmissions within a 30-day period from the date of discharge from an index admission. The measures use a 30-day time frame because older adult patients are more vulnerable to adverse health outcomes during this time[18]. Readmission occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities in an effort to reduce readmissions[19].

Multiple Readmissions

If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first is considered a readmission. The measures assess a dichotomous yes or no outcome of whether each admitted patient has any unplanned readmission within 30 days. If the first readmission after discharge is planned, any subsequent unplanned readmission is not considered in the 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 4.0)

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.

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 account for differences in patient mix among hospitals, the measures adjust for variables (for example, age, comorbid diseases, and indicators of patient frailty) that are clinically relevant and have relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending 12 months prior to, and including, the index admission.

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

The measures do not adjust for socioeconomic status (SES) because the association between SES and health outcomes can be due, in part, to differences in the quality of health care that 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[20]. Please note that the Office of the Assistant Secretary for Planning and Evaluation (ASPE) is conducting research to examine the impact of SES on quality measures, resource use, and other measures under the Medicare program as directed by the IMPACT Act. ASPE will issue an initial report to Congress by October 2016 and a final report to Congress by October 2019. The findings in these reports will be considered in future reevaluation of these measures.

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 the list of complications that are excluded from risk adjustment if they occur during the index admission, for AMI, COPD, HF, pneumonia, and stroke, respectively.

2.2.5 Data Sources

The data sources for these analyses are Medicare administrative claims data and enrollment information for patients with hospitalizations between July 1, 2012 and June 30, 2015. The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims for the 12 months prior to the index admission and one month subsequent to the index admission 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[21]. 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 effect. At the hospital level, the approach models the hospital-specific effects as arising from a normal distribution. The hospital effect represents the underlying risk of a readmission at the hospital, after accounting for patient risk. The hospital-specific effects are given a distribution to account for the clustering (non-independence) of patients within the same hospital[21]. If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects 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, COPD, HF, pneumonia, and stroke measures, respectively) and the hospital-specific effect on the risk of readmission. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log 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 effect using all hospitals in our sample is added in place of the hospital-specific effect. The results are log 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 the National Rate" if the 95% interval estimate surrounding the hospital's rate includes the national observed readmission rate.
- "Worse than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed readmission rate.
- "Better than the 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, "Number of Cases Too Small". This category is used when 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 2016 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. Modifications made to measure cohorts, risk models, and outcomes are informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, and empirical analyses including assessment of coding trends that reveal shifts in clinical practice or billing patterns. As this report describes, for 2016 public reporting, we made the following modifications to the measures:

- Updated the pneumonia measure specifications:
  - Expanded the cohort to include admissions for aspiration pneumonia as well as sepsis admissions (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA;
  - Updated the risk variable list in response to the cohort expansion;
- Updated the HF cohort to exclude patients with a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission;
- Updated the planned readmission algorithm based on findings from a validation study and review of those findings by clinical experts; and,
- Updated the stroke cohort to include the diagnosis code for "Acute, but ill-defined, cerebrovascular disease" (ICD-9-CM code 436).

In addition, each year we assess measure characteristics and revise the statistical software code used to calculate measure results. As a part of these annual reevaluation activities, we undertook the following activities:

- Validated the performance of each condition-specific model and its corresponding risk-adjustment variables in three recent one-year time periods (July 2012-June 2013, July 2013-June 2014, and July 2014-June 2015);
- Evaluated and validated model performance for the three years combined (July 2012-June 2015);
- Updated the measures' SAS analytic package (SAS pack) and documentation; and,
- Applied the 2015 version of the AHRQ CCS to the planned readmission algorithm.

Although hospitals are using International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) coding for discharges effective on or after October 1, 2015, ICD-10 codes for use in defining the cohorts, ICD-10-based Condition Category (CC) Groups for use in risk adjustment, and ICD-10-based Agency for Healthcare Research and Quality (AHRQ) Clinical Classification Software (CCS) diagnosis and procedure categories for use in planned readmission categorization were not incorporated into the measure specifications this year, as the measurement period for 2016 public reporting does not include claims data after June 30, 2015.

3.2 Detailed Discussion of Measure Updates

3.2.1 Updates to Pneumonia Measure

Expansion of Pneumonia Cohort

The pneumonia cohort was expanded to include:

- Admissions with aspiration pneumonia as a principal discharge diagnosis; and,
- Admissions with sepsis (not including severe sepsis) as a principal discharge diagnosis that have a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA.

Rationale for Pneumonia Cohort Expansion

This expansion is intended to ensure that the pneumonia readmission measure more fully reflects the population of Medicare FFS beneficiaries being treated for pneumonia at hospitals in the United States. The previous version of this measure in reporting programs did not include patients hospitalized with pneumonia when sepsis was considered the principal diagnosis. Clinically, these sepsis patients may represent more severely ill patients with pneumonia, but are often treated by the same groups of physicians and staff, using similar treatment strategies. Similarly, the previously reported measure did not include patients with aspiration pneumonia, despite the fact that it is often difficult to differentiate aspiration syndromes from other forms of pneumonia. These aspiration pneumonia patients are also treated using similar approaches, by the same groups of physicians and staff. The measure inclusion criteria have been broadened to include aspiration pneumonia and sepsis admissions, as described above, in order to capture a broader population of patients admitted for pneumonia and a more consistent clinical cohort across hospitals. The need to make these changes was further underscored by wide variation across hospitals in the use of sepsis codes among pneumonia patients and, to a lesser extent, aspiration pneumonia codes. This variation suggests systematic differences in hospital coding practice that could potentially bias efforts to compare hospital performance for pneumonia hospitalizations.

Effect of Pneumonia Cohort Expansion on Measure

To determine the impact of expanding the cohort, we conducted analyses of Medicare FFS hospitalizations between July 2010 and June 2013 using the national pneumonia readmission measure cohort data. Results are summarized in Table 3.2.1 and Table 3.2.2. The cohort expansion adds a large number of admissions to the measure. Hospitalizations in the expanded cohort of pneumonia patients had a slightly higher 30-day readmission rate when compared to the current cohort. Lastly, cohort expansion resulted in an increase in the number of hospitals considered outliers as well as changes in the outlier status classification of hospitals; however, much of the observed movement of hospitals between the two cohort definitions can be attributed to the increase in cohort size and in turn increased hospital volumes.

For more information on the rationale for the cohort expansion or the history behind the change, or for details of the analyses supporting the re-specified cohort, refer to the Reevaluation and Re-Specification Report of the Hospital-Level 30-Day Risk-Standardized Measures Following Hospitalization for Pneumonia, zip file "AMI, HF, PN, COPD, and Stroke Readmission Updates", posted to the CMS website in July 2015[22].

Table 3.2.1 – Effect of Pneumonia Cohort Expansion on Pneumonia Admission Volume and Observed Readmission Rates

Characteristic	Previous Measure Cohort (version 8.0)	Expanded Measure Cohort (version 8.2)
Number of admissions	1,113,308	1,502,035
Unplanned readmission rate	17.1%	17.7%

Table 3.2.2 – Hospital-Level Reclassification of Outlier Status for the Previous Pneumonia Measure Cohort and the Expanded Pneumonia Measure Cohort

Previous Measure Cohort (version 8.0)	Expanded Measure Cohort (version 8.2) Number of Hospitals		
	Better than the National Rate	No Different than the National Rate	Worse than the National Rate
Better than the National Rate	32	2	0
No Different than the National Rate	66	3,974	139
Worse than the National Rate	0	9	110

Addition of Risk-Adjustment Variables

1. Incorporated Respiratory dependence/tracheostomy status (CC 77) if present in the 12 months prior to the index admission.
2. Modified one currently included clinical risk variable: Respiratory arrest (CC 78) was added to the previously defined Cardio-respiratory failure and shock (CC 79) risk variable, redefining it as Cardio-respiratory failure and shock; respiratory arrest (CC 78–79) in the risk model**.**

Rationale for Addition of Risk-Adjustment Variables

During measure reevaluation, we determined that these risk variables (CC 77 and CC 78) were common (that is, with a prevalence of greater than 10% in the population) and had strong associations with readmission (odds ratio [OR] greater than 1.5) in the expanded pneumonia cohort. These risk variables also had high levels of face validity in terms of the clinical expectation that these conditions would be associated with worse outcomes if they occurred during the 12 months prior to the index admission.

3.2.2 Update to HF Cohort Exclusions

Exclusion of LVADs and Heart Transplants from Cohort

The exclusion criteria for the HF measure have been modified to remove patients with an ICD-9 procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission from the HF measure cohort (Table D.3.2).

Rationale for LVAD/Heart Transplant Exclusion

Patients with HF who receive an LVAD or undergo heart transplantation represent a highly-selected, clinically distinct group that are appropriate exclusions for the measure. Over the past five to ten years, there has been a marked increase in the use of LVADs, especially for "destination" therapy[23]. These LVAD patients essentially define a new cohort of patients that did not exist when the HF measure was originally developed. HF patients with an LVAD or who undergo heart transplantation have the most severe and clinically advanced heart failure and often complex coexisting medical conditions. As such, they are expected to have increased health care utilization.

Effect of LVAD/Heart Transplant Exclusion on Measure

Patients receiving an LVAD or heart transplant during the index admission or in the year prior to admission accounted for only 0.19% of the overall measure cohort. RSRRs are not significantly different based on whether these admissions are included or excluded from the estimates.

3.2.3 Update to Version 4.0 of Planned Readmission Algorithm

The planned readmission algorithm version 4.0 was modified from version 3.0 for 2016 public reporting. The changes from version 3.0 to version 4.0 have been applied to each readmission measure. Version 4.0 incorporates improvements made following a validation study of the algorithm which used data from a medical record review of 634 charts at seven hospitals and review of the results of that study by clinical experts.

Removal of Potentially Planned Procedure Categories

Version 4.0 removes the following five AHRQ CCS categories from the potentially planned procedure list (Table PR.3):

- AHRQ CCS 47 - Diagnostic cardiac catheterization; coronary arteriography
- AHRQ CCS 48 - Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
- AHRQ CCS 62 - Other diagnostic cardiovascular procedures
- AHRQ CCS 157 - Amputation of lower extremity
- AHRQ CCS 169 - Debridement of wound; infection or burn

Rationale for Removal of Potentially Planned Procedure Categories

The planned readmission algorithm version 3.0 categorized the five AHRQ CCS procedure categories above as planned. However, the validation study revealed that they were very often found to be unplanned in medical record review. We determined that any potential change in the algorithm warranted review by clinical experts in order

to reverse the decision of the development working group to include these procedure categories on the list of potentially planned procedures. Two panels of cardiology experts, including interventional cardiologists and electrophysiologists, were convened. Removal of these procedure categories was confirmed by the panels.

Note that AHRQ CCS 169 was previously made an exception in stroke; it was always considered unplanned in the stroke readmission measure. With this update, AHRQ CCS 169 is now not considered a potentially planned procedure category for all five condition-specific readmission measures.

Addition of Potentially Planned Procedures Category

Version 4.0 of the planned readmission algorithm adds AHRQ CCS procedure category 1, Incision and excision of CNS (central nervous system), to the potentially planned procedure list (Table PR.3).

Rationale for Addition of Potentially Planned Procedures Category

A stakeholder suggested that CMS add AHRQ CCS procedure category 1, Incision and excision of CNS, to the list of potentially planned procedures because procedures within this CCS category are usually performed during planned admissions. The stakeholder suggested that initial hospitalizations in which CNS tumors are diagnosed are often followed by a period of diagnostic testing after which patients are electively readmitted for resection. A clinical expert panel was convened and confirmed the observations of this single stakeholder, and recommended inclusion of AHRQ CCS 1 on the planned readmission algorithm's potentially planned procedures list.

Full descriptions of the rationale for each change are listed in Table 3.2.3. The full list of codes in version 4.0 of the planned readmission algorithm is located in Appendix E.

Table 3.2.3 – Updates to Planned Readmission Algorithm Version 3.0

Action	Procedure category	Rationale
Remove from planned procedure list	Diagnostic cardiac catheterization; coronary arteriography (AHRQ CCS 47)	These cardiac procedures are rarely the main reason for an elective inpatient hospitalization. Typically, these procedures are done during an observation stay. Removal of these procedure categories from the potentially planned procedures list reduces the rate of misclassification of unplanned readmissions as planned.
	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator (AHRQ CCS 48)	
	Other diagnostic cardiovascular procedures (AHRQ CCS 62)	
	Amputation of lower extremity (AHRQ CCS 157)	Readmissions for these procedures typically represent worsening of wound unresponsive to previous management. Removal of these procedure categories from the potentially

Action	Procedure category	Rationale
	Debridement of wound; infection or burn (AHRQ CCS 169)	planned procedures list reduces the rate of misclassification of unplanned readmissions as planned (with the exception of AHRQ CCS 169, which was always considered unplanned in the stroke readmission measure).
Add to planned procedure list	Incision and excision of CNS (AHRQ CCS 1)	Patients admitted with newly diagnosed brain tumors may be electively readmitted for definitive management. The addition of this procedure category to the acute diagnoses list reduces the misclassification of planned readmissions as unplanned.

Effect on the Measures

These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designated as planned or unplanned. The impact of the planned readmission algorithm changes on the AMI, COPD, HF, pneumonia, and stroke readmission measures is summarized in Table 3.2.4, Table 3.2.5, Table 3.2.6, Table 3.2.7, and Table 3.2.8, respectively.

Table 3.2.4 – Effect of Planned Readmission Algorithm on AMI Measure (2011-2014)

	AMI with Planned Readmission Version 3.0	AMI with Planned Readmission Version 4.0
Number of Admissions	517,303	517,303
Number of Unplanned Readmissions	87,874	90,495
Unplanned Readmission Rate	17.0%	17.5%
Number of Planned Readmissions	10,313	7,692
Planned Readmission Rate	2.0%	1.5%
% of Readmissions that are Planned	10.5%	7.8%

Table 3.2.5 – Effect of Planned Readmission Algorithm on COPD Measure (2011-2014)

	COPD with Planned Readmission Version 3.0	COPD with Planned Readmission Version 4.0
Number of Admissions	925,315	925,315
Number of Unplanned Readmissions	187,157	188,568
Unplanned Readmission Rate	20.2%	20.4%
Number of Planned Readmissions	5,196	3,785
Planned Readmission Rate	0.6%	0.4%
% of Readmissions that are Planned	2.7%	2.0%

Table 3.2.6 – Effect of Planned Readmission Algorithm on HF Measure (2011-2014)

	HF with Planned Readmission Version 3.0	HF with Planned Readmission Version 4.0
Number of Admissions	1,212,321	1,212,321
Number of Unplanned Readmissions	266,799	271,864
Unplanned Readmission Rate	22.0%	22.4%
Number of Planned Readmissions	14,692	9,627
Planned Readmission Rate	1.2%	0.8%
% of Readmissions that are Planned	5.2%	3.4%

Table 3.2.7 – Effect of Planned Readmission Algorithm on Pneumonia Measure (2011-2014)

	Pneumonia with Planned Readmission Version 3.0	Pneumonia with Planned Readmission Version 4.0
Number of Admissions	1,469,277	1,469,277
Number of Unplanned Readmissions	256,234	258,178
Unplanned Readmission Rate	17.4%	17.6%
Number of Planned Readmissions	7,701	5,757
Planned Readmission Rate	0.5%	0.4%
% of Readmissions that are Planned	2.9%	2.2%

Table 3.2.8 – Effect of Planned Readmission Algorithm on Stroke Measure (2011-2014)

	Stroke with Planned Readmission Version 3.0	Stroke with Planned Readmission Version 4.0
Number of Admissions	508,082	508,082
Number of Unplanned Readmissions	64,569	65,229
Unplanned Readmission Rate	12.7%	12.8%
Number of Planned Readmissions	5,434	4,774
Planned Readmission Rate	1.1%	0.9%
% of Readmissions that are Planned	7.8%	6.8%

3.2.4 Update to Stroke Measure

Addition of ICD-9 Code 436 to Cohort

The ischemic stroke cohort was expanded to include admissions with an ICD-9 principal discharge diagnosis code of 436, “Acute, but ill-defined, cerebrovascular disease”.

Rationale for Addition of ICD-9 Code 436

Although ICD-9 code 436 is not specific and could, in theory, include intracerebral hemorrhage, these codes are most commonly ischemic strokes coded as 436[24]. This code may be used either because there is insufficient documentation to use a more specific code, or because some hospitals use older coding terminology to assign diagnoses of cerebrovascular accidents. Admissions coded with ICD-9 code 436 as the principal discharge diagnosis are appropriate inclusions for the stroke measure. Addition of this code will allow for a more comprehensive cohort of true ischemic stroke patients, across all hospitals.

Effect of Addition of ICD-9 Code 436

Patients with a principal discharge diagnosis of 436, "Acute, but ill-defined, cerebrovascular disease", accounted for only 0.13% of the overall measure cohort.

3.3 Changes to SAS Pack

We revised the measure calculation SAS pack to reflect all changes to the cohort definitions and the measure outcomes. The new SAS pack and documentation are available upon request by emailing cmsreadmissionmeasures@yale.edu. **Do *NOT* submit patient-identifiable information (for example, date of birth, Social Security number, health insurance claim number) to this address.**

The SAS pack describes the data files and data elements that feed the model software. Please be aware that CMS does not provide training or technical support for the software. CMS has made the SAS 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 2016 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[1-14].

We evaluated the performance of the models, using the July 2012 to June 2015 data for 2016 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, an indication of perfect prediction. Perfect prediction implies 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, COPD, HF, pneumonia, and stroke) are presented in Sections 4.2, 4.3, 4.4, 4.5, and 4.6, respectively.

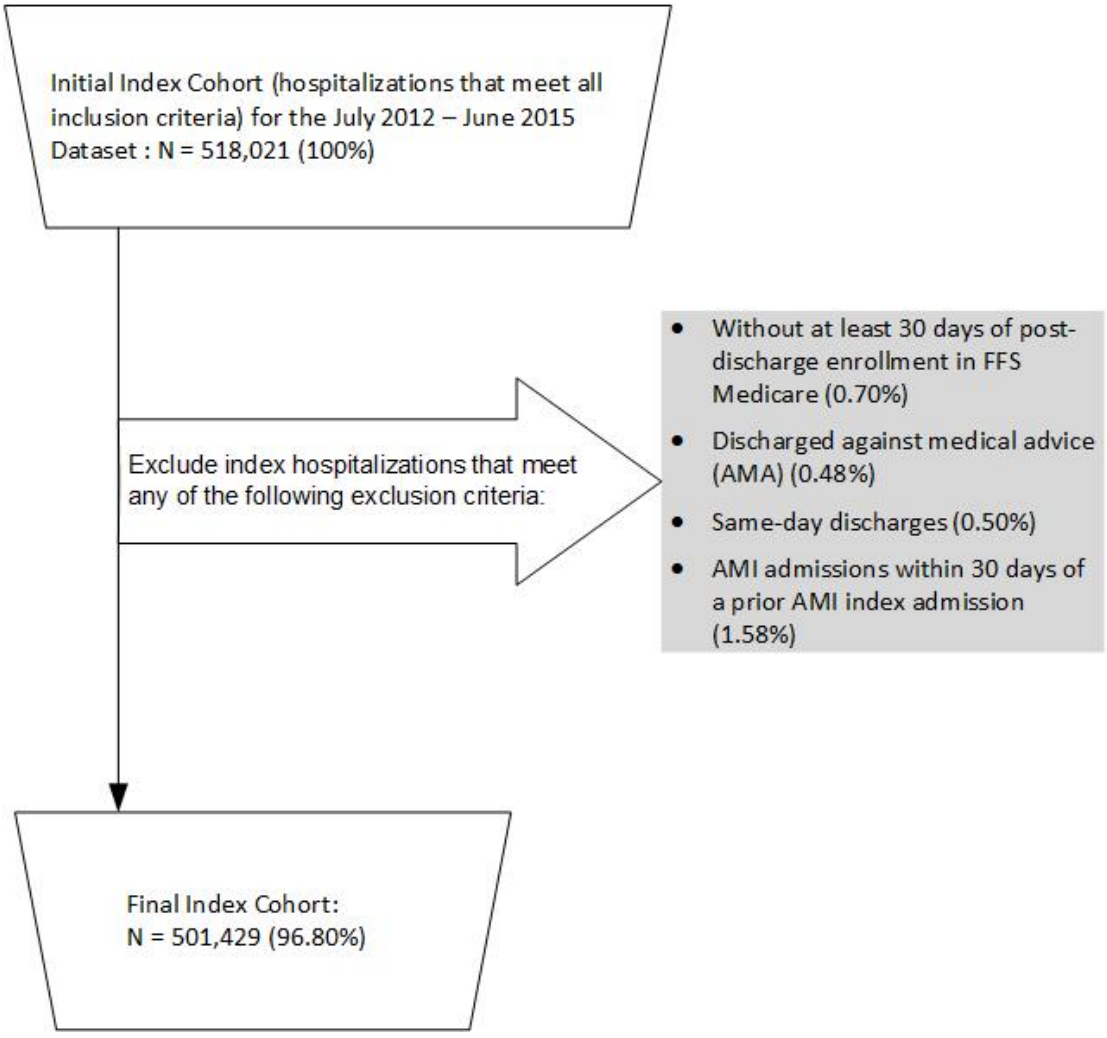
4.2 AMI Readmission 2016 Model Results

4.2.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in Section 2.2.1. The percentage of AMI admissions meeting each exclusion criterion in the July 2012-June 2015 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 short-term acute care hospitalizations for Medicare patients aged 65 or over with a principal discharge diagnosis of AMI; enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission; who were not transferred to another acute care facility; and were alive at discharge.

Figure 4.2.1 – AMI Cohort Exclusions in the July 2012-June 2015 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. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 17.6% to 16.4%. Notable changes in the frequencies for model variables include:

- Decreases in Congestive heart failure (31.9% to 30.5%), Acute coronary syndrome (21.9% to 20.6%), Iron deficiency or other unspecified anemias and blood disease (48.1% to 47.1%), Cerebrovascular disease (21.2% to 20.0%), Chronic Obstructive Pulmonary Disease (COPD) (31.0% to 30.0%), Pneumonia (23.1% to 22.1%), and Other urinary tract disorders (22.0% to 20.8%)
- Increases in Male % (51.6% to 53.0%), History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (18.3% to 19.9%), and Renal failure (27.5% to 28.7%)

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 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 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 17.6% between July 2012 and June 2013 to 16.4% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 16.8% (Interquartile Range [IQR] 16.6% - 17.1%). 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 0.018 (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 (SD) above the national rate were 1.30 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0[21].

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

Of 4,227 hospitals in the study cohort, 12 performed "Better than the National Rate," 2,181 performed "No Different than the National Rate," and 26 performed "Worse than the National Rate." 2,008 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	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	173,301	163,821	164,307	501,429
Observed readmission rate (%)	17.6	16.5	16.4	16.8
Mean age minus 65 (SD)	13.7 (8.3)	13.4 (8.3)	13.3 (8.4)	13.5 (8.4)
Male (%)	51.6	52.5	53.0	52.3
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	18.3	18.9	19.9	19.1
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	12.2	11.9	12.2	12.1
Congestive heart failure (CC 80)	31.9	30.9	30.5	31.1
Acute coronary syndrome (CC 81-82)	21.9	21.4	20.6	21.3
Anterior myocardial infarction (ICD-9 diagnosis codes 410.00-410.12)	7.0	6.9	6.6	6.9
Other location of myocardial infarction (ICD-9 diagnosis codes 410.20-410.62)	10.9	11.1	10.8	10.9
Angina pectoris/old myocardial infarction (CC 83)	28.4	28.1	28.8	28.4
Coronary atherosclerosis/other chronic ischemic heart disease (CC 84)	86.6	86.6	86.5	86.6
Valvular or rheumatic heart disease (CC 86)	32.5	32.0	32.5	32.4
Specified arrhythmias and other heart rhythm disorders (CC 92- 93)	35.9	35.5	35.6	35.7
History of infection (CC 1, 3-6)	27.0	26.4	26.3	26.6
Metastatic cancer or acute leukemia (CC 7)	2.0	2.0	2.1	2.0
Cancer (CC 8-12)	18.8	18.9	18.8	18.9
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	47.4	47.5	47.6	47.5
Protein-calorie malnutrition (CC 21)	6.4	6.1	6.2	6.2
Disorders of fluid/electrolyte/acid-base (CC 22-23)	28.9	28.7	28.7	28.7
Iron deficiency or other unspecified anemias and blood disease (CC 47)	48.1	47.3	47.1	47.5
Dementia or other specified brain disorders (CC 49-50)	19.9	19.2	19.0	19.4
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	6.5	6.5	6.4	6.5
Stroke (CC 95-96)	7.2	7.1	6.9	7.1
Cerebrovascular disease (CC 97-99, 103)	21.2	20.6	20.0	20.6
Vascular or circulatory disease (CC 104-106)	36.5	35.9	35.6	36.0
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	31.0	30.2	30.0	30.4
Asthma (CC 110)	6.9	7.0	7.1	7.0
Pneumonia (CC 111-113)	23.1	22.0	22.1	22.4
Dialysis status (CC 130)	3.4	3.4	3.5	3.4
Renal failure (CC 131)	27.5	27.9	28.7	28.0
Other urinary tract disorders (CC 136)	22.0	21.2	20.8	21.4
Decubitus ulcer or chronic skin ulcer (CC 148-149)	7.8	7.7	7.5	7.7

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

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.391	-2.507	-2.482	-2.459
Age minus 65 (years above 65, continuous)	0.010	0.010	0.010	0.010
Male	-0.101	-0.093	-0.085	-0.092
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	-0.052	-0.070	-0.049	-0.057
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	0.032	0.022	0.023	0.025
Congestive heart failure (CC 80)	0.171	0.193	0.194	0.185
Acute coronary syndrome (CC 81-82)	-0.012	0.010	0.004	0.001
Anterior myocardial infarction (ICD-9 diagnosis codes 410.00-410.12)	0.216	0.247	0.257	0.243
Other location of myocardial infarction (ICD-9 diagnosis codes 410.20-410.62)	-0.110	-0.090	-0.080	-0.091
Angina pectoris/old myocardial infarction (CC 83)	0.068	0.046	0.028	0.048
Coronary atherosclerosis/other chronic ischemic heart disease (CC 84)	0.025	0.042	0.003	0.026
Valvular or rheumatic heart disease (CC 86)	0.121	0.135	0.121	0.127
Specified arrhythmias and other heart rhythm disorders (CC 92- 93)	0.092	0.089	0.059	0.081
History of infection (CC 1, 3-6)	0.041	0.030	0.031	0.033
Metastatic cancer or acute leukemia (CC 7)	0.235	0.260	0.263	0.252
Cancer (CC 8-12)	0.012	0.032	0.018	0.020
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.171	0.177	0.189	0.177
Protein-calorie malnutrition (CC 21)	0.094	0.100	0.145	0.112
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.122	0.121	0.136	0.127
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.294	0.301	0.272	0.289
Dementia or other specified brain disorders (CC 49-50)	0.002	-0.007	-0.023	-0.011
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.072	0.058	0.073	0.068
Stroke (CC 95-96)	0.004	0.019	0.029	0.015
Cerebrovascular disease (CC 97-99, 103)	0.063	0.040	0.047	0.051
Vascular or circulatory disease (CC 104-106)	0.094	0.131	0.110	0.111
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.254	0.253	0.275	0.259
Asthma (CC 110)	0.001	-0.002	-0.005	-0.003
Pneumonia (CC 111-113)	0.139	0.140	0.180	0.151
Dialysis status (CC 130)	0.335	0.291	0.213	0.278
Renal failure (CC 131)	0.135	0.118	0.169	0.139
Other urinary tract disorders (CC 136)	0.065	0.092	0.100	0.085
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.091	0.109	0.118	0.104

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

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 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	0.90 (0.88 - 0.93)	0.91 (0.89 - 0.94)	0.92 (0.89 - 0.94)	0.91 (0.90 - 0.93)
History of Percutaneous Transluminal Coronary Angioplasty (PTCA) (ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07)	0.95 (0.92 - 0.98)	0.93 (0.90 - 0.97)	0.95 (0.92 - 0.99)	0.95 (0.93 - 0.96)
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	1.03 (0.99 - 1.07)	1.02 (0.98 - 1.07)	1.02 (0.98 - 1.07)	1.03 (1.00 - 1.05)
Congestive heart failure (CC 80)	1.19 (1.15 - 1.23)	1.21 (1.17 - 1.26)	1.21 (1.17 - 1.26)	1.20 (1.18 - 1.23)
Acute coronary syndrome (CC 81-82)	0.99 (0.96 - 1.02)	1.01 (0.98 - 1.05)	1.00 (0.97 - 1.04)	1.00 (0.98 - 1.02)
Anterior myocardial infarction (ICD-9 diagnosis codes 410.00-410.12)	1.24 (1.18 - 1.31)	1.28 (1.21 - 1.35)	1.29 (1.22 - 1.37)	1.28 (1.24 - 1.32)
Other location of myocardial infarction (ICD-9 diagnosis codes 410.20-410.62)	0.90 (0.86 - 0.94)	0.91 (0.87 - 0.96)	0.92 (0.88 - 0.97)	0.91 (0.89 - 0.94)
Angina pectoris/old myocardial infarction (CC 83)	1.07 (1.04 - 1.10)	1.05 (1.01 - 1.08)	1.03 (1.00 - 1.06)	1.05 (1.03 - 1.07)
Coronary atherosclerosis/other chronic ischemic heart disease (CC 84)	1.03 (0.99 - 1.07)	1.04 (1.00 - 1.09)	1.00 (0.96 - 1.05)	1.03 (1.00 - 1.05)
Valvular or rheumatic heart disease (CC 86)	1.13 (1.10 - 1.16)	1.15 (1.11 - 1.18)	1.13 (1.10 - 1.16)	1.14 (1.12 - 1.15)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.10 (1.07 - 1.13)	1.09 (1.06 - 1.13)	1.06 (1.03 - 1.09)	1.08 (1.07 - 1.10)
History of infection (CC 1, 3-6)	1.04 (1.01 - 1.07)	1.03 (1.00 - 1.06)	1.03 (1.00 - 1.06)	1.03 (1.02 - 1.05)
Metastatic cancer or acute leukemia (CC 7)	1.26 (1.16 - 1.38)	1.30 (1.19 - 1.42)	1.30 (1.19 - 1.42)	1.29 (1.22 - 1.35)
Cancer (CC 8-12)	1.01 (0.98 - 1.05)	1.03 (1.00 - 1.07)	1.02 (0.98 - 1.06)	1.02 (1.00 - 1.04)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.19 (1.16 - 1.22)	1.19 (1.16 - 1.23)	1.21 (1.17 - 1.24)	1.19 (1.17 - 1.21)
Protein-calorie malnutrition (CC 21)	1.10 (1.05 - 1.15)	1.11 (1.05 - 1.16)	1.16 (1.10 - 1.22)	1.12 (1.09 - 1.15)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.13 (1.09 - 1.17)	1.13 (1.09 - 1.17)	1.15 (1.11 - 1.19)	1.14 (1.11 - 1.16)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.34 (1.30 - 1.38)	1.35 (1.31 - 1.39)	1.31 (1.27 - 1.35)	1.33 (1.31 - 1.36)
Dementia or other specified brain disorders (CC 49-50)	1.00 (0.97 - 1.04)	0.99 (0.96 - 1.03)	0.98 (0.94 - 1.01)	0.99 (0.97 - 1.01)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.08 (1.02 - 1.13)	1.06 (1.01 - 1.12)	1.08 (1.02 - 1.13)	1.07 (1.04 - 1.10)
Stroke (CC 95-96)	1.00 (0.96 - 1.06)	1.02 (0.97 - 1.07)	1.03 (0.98 - 1.09)	1.02 (0.99 - 1.05)
Cerebrovascular disease (CC 97-99, 103)	1.07 (1.03 - 1.10)	1.04 (1.01 - 1.08)	1.05 (1.01 - 1.09)	1.05 (1.03 - 1.07)
Vascular or circulatory disease (CC 104-106)	1.10 (1.07 - 1.13)	1.14 (1.11 - 1.18)	1.12 (1.08 - 1.15)	1.12 (1.10 - 1.14)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.29 (1.25 - 1.33)	1.29 (1.25 - 1.33)	1.32 (1.28 - 1.36)	1.30 (1.27 - 1.32)
Asthma (CC 110)	1.00 (0.95 - 1.05)	1.00 (0.95 - 1.05)	1.00 (0.95 - 1.05)	1.00 (0.97 - 1.03)
Pneumonia (CC 111-113)	1.15 (1.11 - 1.19)	1.15 (1.11 - 1.19)	1.20 (1.16 - 1.24)	1.16 (1.14 - 1.19)
Dialysis status (CC 130)	1.40 (1.31 - 1.49)	1.34 (1.25 - 1.43)	1.24 (1.16 - 1.32)	1.32 (1.27 - 1.37)
Renal failure (CC 131)	1.14 (1.11 - 1.18)	1.13 (1.09 - 1.17)	1.18 (1.14 - 1.23)	1.15 (1.13 - 1.17)
Other urinary tract disorders (CC 136)	1.07 (1.04 - 1.10)	1.10 (1.06 - 1.13)	1.11 (1.07 - 1.14)	1.09 (1.07 - 1.11)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.10 (1.05 - 1.15)	1.12 (1.06 - 1.17)	1.13 (1.07 - 1.18)	1.11 (1.08 - 1.14)

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	6.2 - 31.8	5.7 - 30.5	5.4 - 30.7	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	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,838	3,706	3,669	4,227
Mean number of admissions (SD)	45.2 (67.0)	44.2 (63.7)	44.8 (64.3)	118.6 (186.9)
Range (min. – max.)	1 - 574	1 - 505	1 - 570	1 - 1,649
25th percentile	3	3	3	6
50th percentile	15	15	16	30
75th percentile	63	63	64	163

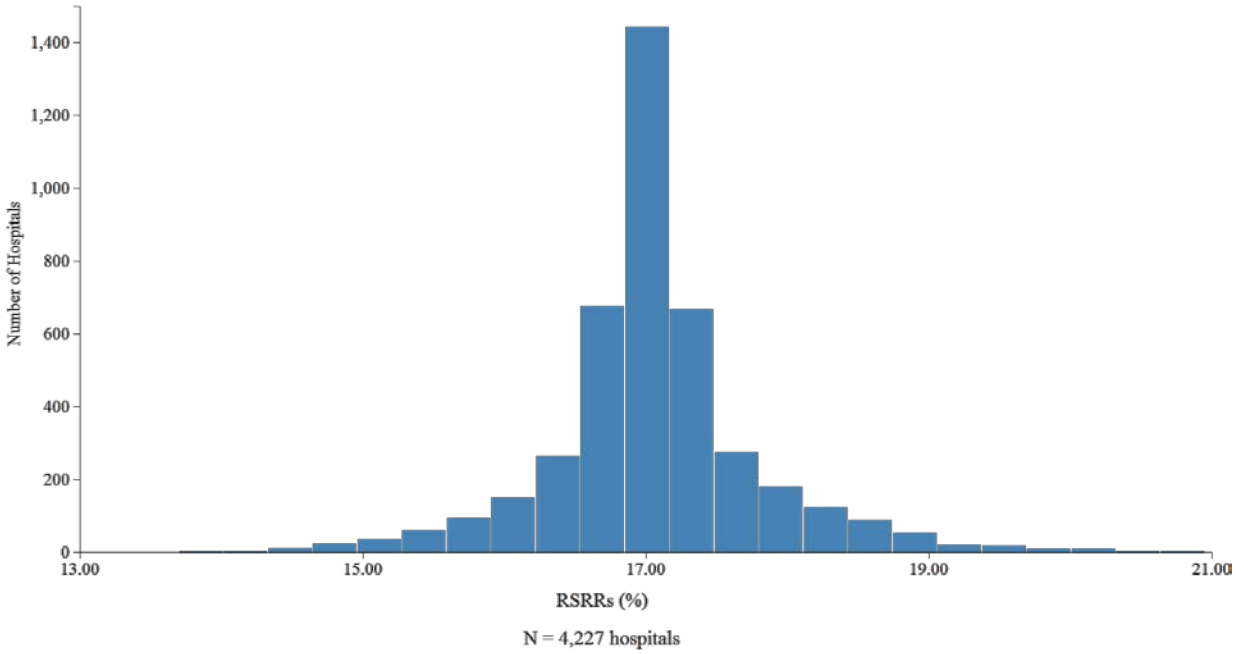
Table 4.2.6 – Distribution of Hospital AMI RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	3,838	3,706	3,669	4,227
Mean (SD)	17.6 (0.6)	16.5 (0.6)	16.4 (0.4)	16.9 (0.7)
Range (min. – max.)	14.8 - 20.8	14.0 - 20.2	14.3 - 18.7	13.1 - 20.6
25th percentile	17.4	16.3	16.3	16.6
50th percentile	17.5	16.5	16.4	16.8
75th percentile	17.8	16.7	16.5	17.1

Table 4.2.7 – Between-Hospital Variance for AMI

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.020 (0.003)	0.019 (0.003)	0.012 (0.003)	0.018 (0.002)

Figure 4.2.2 – Distribution of Hospital 30-Day AMI RSRRs Between July 2012 and June 2015



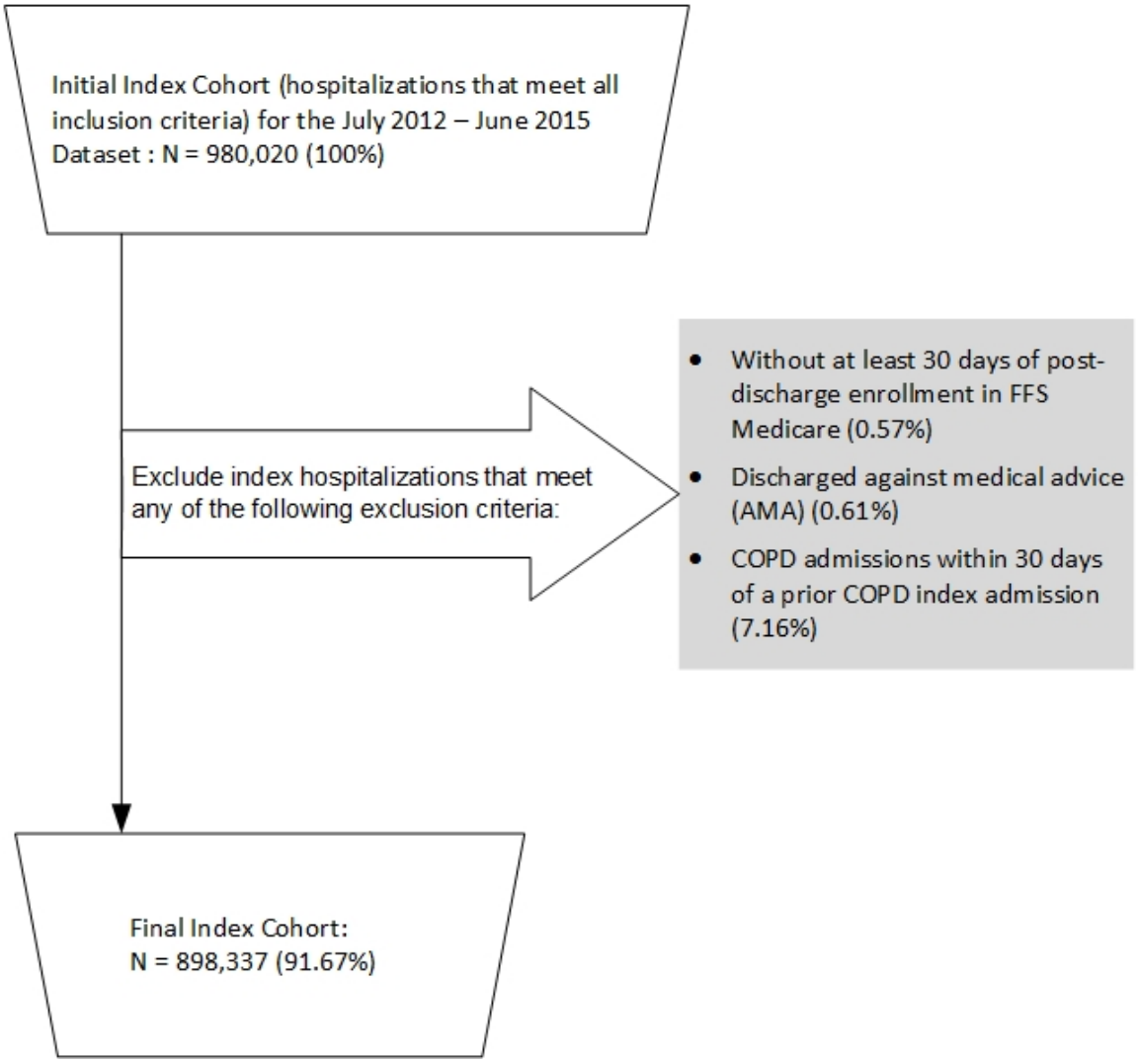
4.3 COPD Readmission 2016 Model Results

4.3.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in Section 2.2.1. The percentage of COPD admissions meeting each exclusion criterion in the July 2012-June 2015 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 short-term acute care hospitalizations for Medicare patients aged 65 or over with a principal discharge diagnosis of COPD or principal discharge diagnosis of respiratory failure with a secondary diagnosis of COPD with exacerbation; enrolled in Medicare FFS Part A and Part B 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 4.3.1 – COPD Cohort Exclusions in the July 2012-June 2015 Dataset



4.3.2 Frequency of COPD Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 20.3% to 19.8%. Notable changes in the frequencies for model variables include:

- Decreases in Coronary atherosclerosis or angina (53.5% to 52.2%) and Pneumonia (50.3% to 49.1%)
- Increases in History of mechanical ventilation (9.8% to 11.0%), Sleep apnea (18.4% to 20.7%), Cardio-respiratory failure and shock (36.3% to 40.2%), Other endocrine/metabolic/nutritional disorders (82.0% to 83.9%), Depression (28.0% to 29.1%), Anxiety disorders (5.4% to 6.4%), Other psychiatric disorders (30.6% to 34.0%), Hypertensive heart and renal disease or encephalopathy (22.2% to 23.7%), and Renal failure (26.5% to 28.3%)

Refer to Table 4.3.1 for more detail.

4.3.3 COPD 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 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 c-statistic decreased slightly from 0.64 to 0.63 (Table 4.3.4).

4.3.4 Distribution of Hospital Volumes and RSRRs for COPD

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 20.3% between July 2012 and June 2013 to 19.8% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 19.9% (IQR 19.3% - 20.5%). 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 0.019 (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 SD above the national rate were 1.32 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0[21].

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

Of 4,645 hospitals in the study cohort, 30 performed "Better than the National Rate," 3,698 performed "No Different than the National Rate," and 82 performed "Worse than the National Rate." 835 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 COPD Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	328,250	281,745	288,342	898,337
Observed readmission rate (%)	20.3	19.8	19.8	20.0
Mean age minus 65 (SD)	11.8 (7.6)	11.6 (7.6)	11.7 (7.6)	11.7 (7.6)
History of mechanical ventilation (ICD-9 procedure codes 93.90, 96.70, 96.71, 96.72)	9.8	11.0	11.0	10.6
Sleep apnea (ICD-9 diagnosis codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	18.4	19.9	20.7	19.6
Respirator dependence/respiratory failure (CC 77-78)	1.3	1.4	1.3	1.3
Cardio-respiratory failure and shock (CC 79)	36.3	39.5	40.2	38.5
Congestive heart failure (CC 80)	43.9	44.5	43.8	44.1
Acute coronary syndrome (CC 81-82)	8.8	8.8	8.7	8.7
Coronary atherosclerosis or angina (CC 83-84)	53.5	52.8	52.2	52.9
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	42.7	43.4	43.3	43.1
Other or unspecified heart disease (CC 94)	20.6	20.7	20.9	20.7
Vascular or circulatory disease (CC 104-106)	42.8	43.0	42.9	42.9
Fibrosis of lung or other chronic lung disorders (CC 109)	15.9	15.4	14.8	15.4
Pneumonia (CC 111-113)	50.3	50.6	49.1	50.0
History of infection (CC 1, 3-6)	34.3	34.3	33.7	34.1
Metastatic cancer or acute leukemia (CC 7)	2.6	2.7	2.7	2.7
Lung, upper digestive tract, and other severe cancers (CC 8)	6.4	6.6	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)	13.9	14.0	13.9	13.9
Other digestive and urinary neoplasms (CC 12)	6.8	6.6	6.6	6.7
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	43.7	43.3	43.0	43.4
Protein-calorie malnutrition (CC 21)	10.1	10.5	10.5	10.4
Disorders of fluid/electrolyte/acid-base (CC 22-23)	39.7	40.7	40.2	40.2
Other endocrine/metabolic/nutritional disorders (CC 24)	82.0	83.1	83.9	82.9
Pancreatic disease (CC 32)	2.3	2.4	2.4	2.4
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	12.0	11.9	11.5	11.8
Other gastrointestinal disorders (CC 36)	65.7	66.0	66.0	65.9
Severe hematological disorders (CC 44)	1.2	1.1	1.0	1.1
Iron deficiency or other unspecified anemias and blood disease (CC 47)	51.6	52.3	51.5	51.8
Dementia or other specified brain disorders (CC 49-50)	19.1	18.5	18.2	18.6
Drug/alcohol psychosis or dependence (CC 51-52)	4.8	5.2	5.3	5.1
Major psychiatric disorders (CC 54-56)	12.6	13.1	13.0	12.9
Depression (CC 58)	28.0	28.7	29.1	28.6
Anxiety disorders (CC 59)	5.4	6.1	6.4	5.9

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Other psychiatric disorders (CC 60)	30.6	33.2	34.0	32.5
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	5.8	5.8	5.9	5.8
Polyneuropathy (CC 71)	12.0	12.6	12.9	12.5
Hypertensive heart and renal disease or encephalopathy (CC 89)	22.2	23.0	23.7	22.9
Stroke (CC 95-96)	6.2	6.1	6.1	6.1
Renal failure (CC 131)	26.5	27.7	28.3	27.4
Decubitus ulcer or chronic skin ulcer (CC 148-149)	8.0	8.1	7.9	8.0
Cellulitis, local skin infection (CC 152)	13.1	13.0	12.9	13.0
Vertebral fractures (CC 157)	5.0	5.2	5.2	5.1

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

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.142	-2.189	-2.190	-2.178
Age minus 65 (years above 65, continuous)	-0.001	-0.004	0.000	-0.001
History of mechanical ventilation (ICD-9 procedure codes 93.90, 96.70, 96.71, 96.72)	0.123	0.184	0.155	0.150
Sleep apnea (ICD-9 diagnosis codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	0.002	-0.029	-0.014	-0.011
Respirator dependence/respiratory failure (CC 77-78)	0.041	0.026	0.048	0.038
Cardio-respiratory failure and shock (CC 79)	0.189	0.203	0.204	0.199
Congestive heart failure (CC 80)	0.198	0.174	0.190	0.188
Acute coronary syndrome (CC 81-82)	0.095	0.068	0.067	0.076
Coronary atherosclerosis or angina (CC 83-84)	0.079	0.090	0.049	0.072
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.159	0.154	0.154	0.156
Other or unspecified heart disease (CC 94)	0.051	0.058	0.067	0.061
Vascular or circulatory disease (CC 104-106)	0.071	0.083	0.074	0.075
Fibrosis of lung or other chronic lung disorders (CC 109)	0.102	0.081	0.080	0.091
Pneumonia (CC 111-113)	0.085	0.093	0.084	0.087
History of infection (CC 1, 3-6)	0.064	0.073	0.047	0.059
Metastatic cancer or acute leukemia (CC 7)	0.205	0.166	0.185	0.186
Lung, upper digestive tract, and other severe cancers (CC 8)	0.176	0.219	0.206	0.198
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 9-11)	0.005	0.031	0.021	0.018
Other digestive and urinary neoplasms (CC 12)	-0.052	-0.050	-0.032	-0.045
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.052	0.055	0.061	0.055
Protein-calorie malnutrition (CC 21)	0.137	0.118	0.089	0.119
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.145	0.138	0.144	0.142

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.075	-0.054	-0.064	-0.066
Pancreatic disease (CC 32)	0.038	0.036	0.086	0.051
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	0.061	0.075	0.063	0.065
Other gastrointestinal disorders (CC 36)	0.069	0.063	0.051	0.063
Severe hematological disorders (CC 44)	0.139	0.270	0.198	0.197
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.162	0.145	0.170	0.160
Dementia or other specified brain disorders (CC 49-50)	-0.015	-0.007	0.012	-0.004
Drug/alcohol psychosis or dependence (CC 51-52)	0.167	0.140	0.175	0.162
Major psychiatric disorders (CC 54-56)	0.035	0.041	0.032	0.035
Depression (CC 58)	0.015	0.019	0.006	0.015
Anxiety disorders (CC 59)	0.085	0.047	0.066	0.065
Other psychiatric disorders (CC 60)	0.098	0.105	0.091	0.096
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.075	0.055	0.062	0.064
Polyneuropathy (CC 71)	0.077	0.073	0.080	0.078
Hypertensive heart and renal disease or encephalopathy (CC 89)	0.097	0.125	0.095	0.107
Stroke (CC 95-96)	0.013	0.017	0.004	0.010
Renal failure (CC 131)	0.062	0.061	0.069	0.063
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.073	0.080	0.053	0.069
Cellulitis, local skin infection (CC 152)	0.067	0.039	0.067	0.058
Vertebral fractures (CC 157)	0.138	0.091	0.148	0.127

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

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 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 procedure codes 93.90, 96.70, 96.71, 96.72)	1.13 (1.10 - 1.17)	1.20 (1.17 - 1.24)	1.17 (1.13 - 1.20)	1.16 (1.14 - 1.18)
Sleep apnea (ICD-9 diagnosis codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57)	1.00 (0.98 - 1.03)	0.97 (0.95 - 1.00)	0.99 (0.96 - 1.01)	0.99 (0.98 - 1.00)
Respirator dependence/respiratory failure (CC 77-78)	1.04 (0.97 - 1.12)	1.03 (0.96 - 1.10)	1.05 (0.98 - 1.13)	1.04 (1.00 - 1.08)
Cardio-respiratory failure and shock (CC 79)	1.21 (1.18 - 1.23)	1.23 (1.20 - 1.25)	1.23 (1.20 - 1.25)	1.22 (1.20 - 1.24)
Congestive heart failure (CC 80)	1.22 (1.19 - 1.24)	1.19 (1.16 - 1.22)	1.21 (1.18 - 1.24)	1.21 (1.19 - 1.22)
Acute coronary syndrome (CC 81-82)	1.10 (1.07 - 1.13)	1.07 (1.04 - 1.11)	1.07 (1.04 - 1.10)	1.08 (1.06 - 1.10)
Coronary atherosclerosis or angina (CC 83-84)	1.08 (1.06 - 1.10)	1.09 (1.07 - 1.12)	1.05 (1.03 - 1.07)	1.08 (1.06 - 1.09)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.17 (1.15 - 1.20)	1.17 (1.14 - 1.19)	1.17 (1.14 - 1.19)	1.17 (1.16 - 1.18)
Other or unspecified heart disease (CC 94)	1.05 (1.03 - 1.08)	1.06 (1.04 - 1.08)	1.07 (1.05 - 1.09)	1.06 (1.05 - 1.08)
Vascular or circulatory disease (CC 104-106)	1.07 (1.05 - 1.09)	1.09 (1.06 - 1.11)	1.08 (1.06 - 1.10)	1.08 (1.07 - 1.09)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.11 (1.08 - 1.13)	1.08 (1.06 - 1.11)	1.08 (1.06 - 1.11)	1.10 (1.08 - 1.11)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Pneumonia (CC 111-113)	1.09 (1.07 - 1.11)	1.10 (1.08 - 1.12)	1.09 (1.07 - 1.11)	1.09 (1.08 - 1.10)
History of infection (CC 1, 3-6)	1.07 (1.05 - 1.09)	1.08 (1.05 - 1.10)	1.05 (1.03 - 1.07)	1.06 (1.05 - 1.07)
Metastatic cancer or acute leukemia (CC 7)	1.23 (1.16 - 1.30)	1.18 (1.11 - 1.25)	1.20 (1.14 - 1.28)	1.20 (1.17 - 1.24)
Lung, upper digestive tract, and other severe cancers (CC 8)	1.19 (1.15 - 1.24)	1.25 (1.20 - 1.29)	1.23 (1.18 - 1.28)	1.22 (1.19 - 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 (0.98 - 1.03)	1.03 (1.00 - 1.06)	1.02 (0.99 - 1.05)	1.02 (1.00 - 1.03)
Other digestive and urinary neoplasms (CC 12)	0.95 (0.92 - 0.98)	0.95 (0.92 - 0.99)	0.97 (0.93 - 1.01)	0.96 (0.94 - 0.98)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.05 (1.03 - 1.07)	1.06 (1.04 - 1.08)	1.06 (1.04 - 1.09)	1.06 (1.05 - 1.07)
Protein-calorie malnutrition (CC 21)	1.15 (1.12 - 1.18)	1.13 (1.09 - 1.16)	1.09 (1.06 - 1.13)	1.13 (1.11 - 1.15)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.16 (1.13 - 1.18)	1.15 (1.12 - 1.17)	1.15 (1.13 - 1.18)	1.15 (1.14 - 1.17)
Other endocrine/metabolic/nutritional disorders (CC 24)	0.93 (0.91 - 0.95)	0.95 (0.92 - 0.98)	0.94 (0.91 - 0.97)	0.94 (0.92 - 0.95)
Pancreatic disease (CC 32)	1.04 (0.98 - 1.10)	1.04 (0.98 - 1.10)	1.09 (1.03 - 1.15)	1.05 (1.02 - 1.09)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.06 (1.04 - 1.09)	1.08 (1.05 - 1.11)	1.07 (1.04 - 1.10)	1.07 (1.05 - 1.09)
Other gastrointestinal disorders (CC 36)	1.07 (1.05 - 1.09)	1.07 (1.04 - 1.09)	1.05 (1.03 - 1.08)	1.07 (1.05 - 1.08)
Severe hematological disorders (CC 44)	1.15 (1.07 - 1.24)	1.31 (1.21 - 1.42)	1.22 (1.12 - 1.33)	1.22 (1.16 - 1.27)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.18 (1.15 - 1.20)	1.16 (1.13 - 1.18)	1.19 (1.16 - 1.21)	1.17 (1.16 - 1.19)
Dementia or other specified brain disorders (CC 49-50)	0.99 (0.96 - 1.01)	0.99 (0.97 - 1.02)	1.01 (0.99 - 1.04)	1.00 (0.98 - 1.01)
Drug/alcohol psychosis or dependence (CC 51-52)	1.18 (1.14 - 1.23)	1.15 (1.11 - 1.20)	1.19 (1.15 - 1.24)	1.18 (1.15 - 1.20)
Major psychiatric disorders (CC 54-56)	1.04 (1.01 - 1.06)	1.04 (1.01 - 1.07)	1.03 (1.00 - 1.06)	1.04 (1.02 - 1.05)
Depression (CC 58)	1.02 (0.99 - 1.04)	1.02 (1.00 - 1.04)	1.01 (0.98 - 1.03)	1.02 (1.00 - 1.03)
Anxiety disorders (CC 59)	1.09 (1.05 - 1.13)	1.05 (1.01 - 1.09)	1.07 (1.03 - 1.11)	1.07 (1.04 - 1.09)
Other psychiatric disorders (CC 60)	1.10 (1.08 - 1.13)	1.11 (1.09 - 1.14)	1.10 (1.07 - 1.12)	1.10 (1.09 - 1.12)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.08 (1.04 - 1.12)	1.06 (1.02 - 1.10)	1.06 (1.02 - 1.11)	1.07 (1.04 - 1.09)
Polyneuropathy (CC 71)	1.08 (1.05 - 1.11)	1.08 (1.05 - 1.11)	1.08 (1.05 - 1.11)	1.08 (1.06 - 1.10)
Hypertensive heart and renal disease or encephalopathy (CC 89)	1.10 (1.07 - 1.13)	1.13 (1.10 - 1.17)	1.10 (1.07 - 1.13)	1.11 (1.10 - 1.13)
Stroke (CC 95-96)	1.01 (0.98 - 1.05)	1.02 (0.98 - 1.06)	1.00 (0.97 - 1.04)	1.01 (0.99 - 1.03)
Renal failure (CC 131)	1.06 (1.04 - 1.09)	1.06 (1.03 - 1.09)	1.07 (1.04 - 1.10)	1.07 (1.05 - 1.08)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.08 (1.04 - 1.11)	1.08 (1.05 - 1.12)	1.06 (1.02 - 1.09)	1.07 (1.05 - 1.09)
Cellulitis, local skin infection (CC 152)	1.07 (1.04 - 1.10)	1.04 (1.01 - 1.07)	1.07 (1.04 - 1.10)	1.06 (1.04 - 1.08)
Vertebral fractures (CC 157)	1.15 (1.11 - 1.19)	1.10 (1.05 - 1.14)	1.16 (1.12 - 1.21)	1.14 (1.11 - 1.16)

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	10.3 - 36.5	9.8 - 35.9	9.7 - 35.4	10.0 - 35.9
c-statistic	0.64	0.64	0.63	0.64

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,515	4,498	4,457	4,645
Mean number of admissions (SD)	72.7 (80.8)	62.6 (70.0)	64.7 (73.5)	193.4 (221.3)
Range (min. – max.)	1 - 985	1 - 866	1 - 867	1 - 2,718
25th percentile	15	13	13	37
50th percentile	44	38	39	111
75th percentile	104	89	93	279

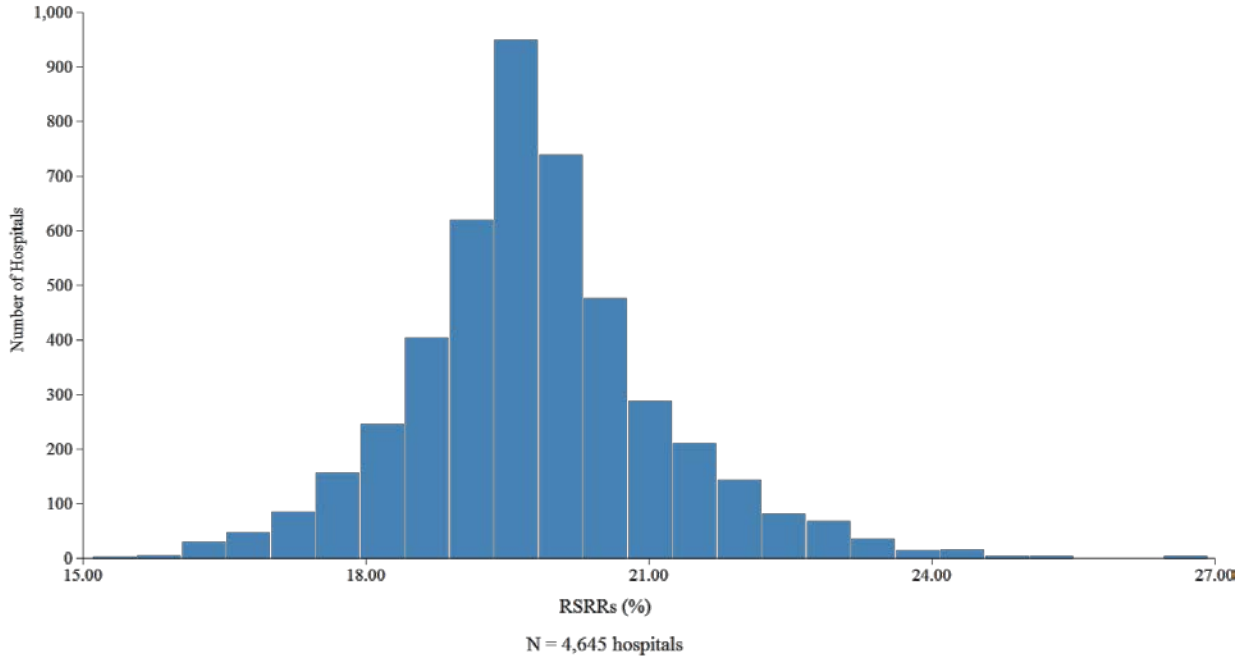
Table 4.3.6 – Distribution of Hospital COPD RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,515	4,498	4,457	4,645
Mean (SD)	20.3 (0.9)	19.8 (0.7)	19.8 (0.8)	20.0 (1.2)
Range (min. – max.)	16.8 - 25.6	17.1 - 24.8	16.8 - 23.9	16.0 - 26.1
25th percentile	19.8	19.4	19.4	19.3
50th percentile	20.3	19.7	19.7	19.9
75th percentile	20.7	20.1	20.1	20.5

Table 4.3.7 – Between-Hospital Variance for COPD

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.020 (0.002)	0.018 (0.002)	0.019 (0.002)	0.019 (0.001)

Figure 4.3.2 – Distribution of Hospital 30-Day COPD RSRRs Between July 2012 and June 2015



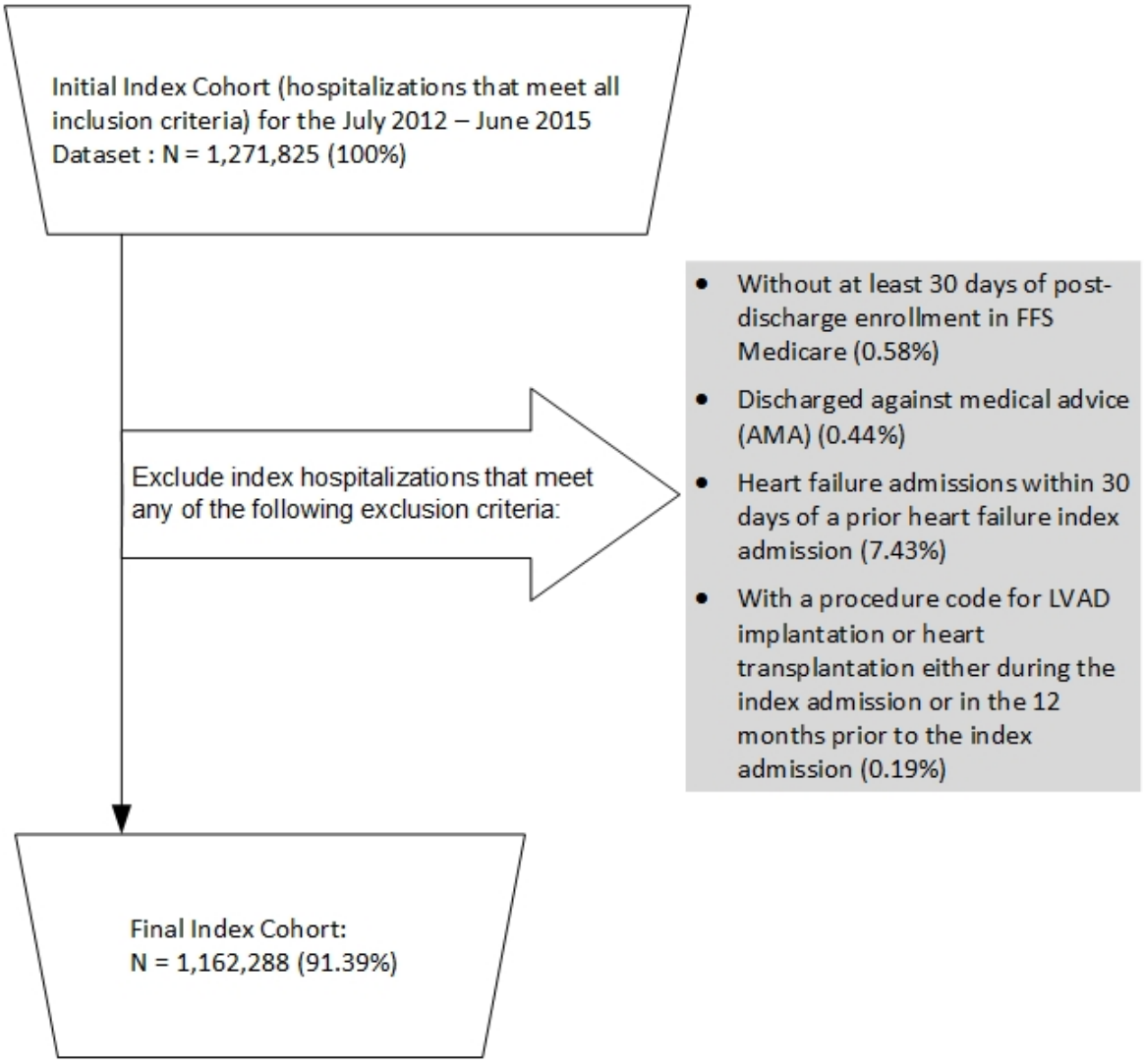
4.4 HF Readmission 2016 Model Result

4.4.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in Section 2.2.1. The percentage of HF admissions meeting each exclusion criterion in the July 2012-June 2015 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 short-term acute care hospitalizations for Medicare patients aged 65 or over with a principal discharge diagnosis of HF; enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission; who were not transferred to another acute care facility; and were alive at discharge.

Figure 4.4.1 – HF Cohort Exclusions in the July 2012-June 2015 Dataset



4.4.2 Frequency of HF Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 22.4% to 21.7%. Notable changes in the frequencies for model variables include:

- Decreases in Congestive heart failure (76.3% to 75.2%), Coronary atherosclerosis or angina (74.4% to 72.5%), Fibrosis of lung or other chronic lung disorders (10.4% to 9.4%), and Other urinary tract disorders (33.2% to 31.1%)
- Increases in Cardio-respiratory failure and shock (28.4% to 31.3%), Drug/alcohol abuse/dependence/psychosis (13.9% to 15.1%), Other psychiatric disorders (20.0% to 22.6%), and Renal failure (51.7% to 53.3%)

Refer to Table 4.4.1 for more detail.

4.4.3 HF 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 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 c-statistic remained constant at 0.61 (Table 4.4.4).

4.4.4 Distribution of Hospital Volumes and RSRRs for HF

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 22.5% between July 2012 and June 2013 to 21.7% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 21.9% (IQR 21.2% - 22.6%). 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 SD above the national rate were 1.33 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0[21].

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

Of 4,639 hospitals in the study cohort, 89 performed “Better than the National Rate,” 3,590 performed “No Different from the National Rate,” and 129 performed “Worse

than the National Rate." 831 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 HF Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	394,190	380,103	387,998	1,162,288
Observed readmission rate (%)	22.4	21.6	21.7	21.9
Mean age minus 65 (SD)	16.0 (8.3)	15.9 (8.4)	15.9 (8.4)	15.9 (8.4)
Male (%)	44.9	45.6	45.7	45.4
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	20.0	19.7	19.4	19.7
Cardio-respiratory failure and shock (CC 79)	28.4	29.8	31.3	29.9
Congestive heart failure (CC 80)	76.3	75.8	75.2	75.8
Acute coronary syndrome (CC 81-82)	17.1	16.8	16.8	16.9
Coronary atherosclerosis or angina (CC 83-84)	74.4	73.6	72.5	73.5
Valvular or rheumatic heart disease (CC 86)	54.8	54.6	55.1	54.8
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	68.9	68.9	69.4	69.1
Other or unspecified heart disease (CC 94)	33.8	33.4	33.8	33.7
Vascular or circulatory disease (CC 104-106)	53.6	53.5	53.5	53.5
Metastatic cancer or acute leukemia (CC 7)	2.3	2.3	2.3	2.3
Cancer (CC 8-12)	21.2	21.3	21.2	21.2
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	54.5	55.0	54.9	54.8
Protein-calorie malnutrition (CC 21)	10.1	10.0	10.0	10.1
Disorders of fluid/electrolyte/acid-base (CC 22-23)	50.2	50.3	50.5	50.3
Liver or biliary disease (CC 25-30)	11.3	11.3	11.5	11.3
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	15.6	15.3	15.0	15.3
Other gastrointestinal disorders (CC 36)	64.3	64.4	65.1	64.6
Severe hematological disorders (CC 44)	2.5	2.4	2.2	2.4
Iron deficiency or other unspecified anemias and blood disease (CC 47)	64.4	64.2	63.9	64.1
Dementia or other specified brain disorders (CC 49-50)	24.7	24.5	24.2	24.5
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	13.9	14.4	15.1	14.5
Major psychiatric disorders (CC 54-56)	10.7	10.9	11.0	10.9
Depression (CC 58)	21.8	22.0	22.4	22.0
Other psychiatric disorders (CC 60)	20.0	21.4	22.6	21.3
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	8.7	8.6	8.5	8.6
Stroke (CC 95-96)	9.4	9.2	9.3	9.3
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	49.5	49.0	48.8	49.1
Fibrosis of lung or other chronic lung disorders (CC 109)	10.4	9.7	9.4	9.9
Asthma (CC 110)	10.0	10.1	10.4	10.2
Pneumonia (CC 111-113)	46.2	45.8	46.0	46.0
Dialysis status (CC 130)	4.8	4.6	4.5	4.7
Renal failure (CC 131)	51.7	52.5	53.3	52.5
Nephritis (CC 132)	4.2	4.4	4.4	4.3
Other urinary tract disorders (CC 136)	33.2	32.3	31.1	32.2
Decubitus ulcer or chronic skin ulcer (CC 148-149)	14.6	14.7	14.6	14.6

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

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.076	-2.125	-2.116	-2.106
Age minus 65 (years above 65, continuous)	-0.001	-0.004	-0.003	-0.003
Male	-0.011	-0.029	-0.022	-0.019
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	-0.003	0.010	-0.024	-0.004
Cardio-respiratory failure and shock (CC 79)	0.083	0.097	0.081	0.088
Congestive heart failure (CC 80)	0.123	0.130	0.114	0.122
Acute coronary syndrome (CC 81-82)	0.115	0.108	0.104	0.106
Coronary atherosclerosis or angina (CC 83-84)	0.057	0.059	0.088	0.065
Valvular or rheumatic heart disease (CC 86)	0.046	0.057	0.063	0.059
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.030	0.063	0.047	0.047
Other or unspecified heart disease (CC 94)	0.033	0.032	0.027	0.033
Vascular or circulatory disease (CC 104-106)	0.072	0.070	0.056	0.065
Metastatic cancer or acute leukemia (CC 7)	0.121	0.159	0.171	0.148
Cancer (CC 8-12)	0.028	0.016	0.019	0.021
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.072	0.093	0.096	0.084
Protein-calorie malnutrition (CC 21)	0.078	0.079	0.098	0.086
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.118	0.090	0.111	0.107
Liver or biliary disease (CC 25-30)	0.074	0.066	0.078	0.071
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	0.069	0.066	0.066	0.066
Other gastrointestinal disorders (CC 36)	0.057	0.064	0.057	0.061
Severe hematological disorders (CC 44)	0.150	0.189	0.155	0.166
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.139	0.127	0.133	0.133
Dementia or other specified brain disorders (CC 49-50)	0.002	0.013	0.011	0.006
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	0.077	0.099	0.118	0.098
Major psychiatric disorders (CC 54-56)	0.034	0.043	0.059	0.045
Depression (CC 58)	0.005	0.008	-0.025	-0.001
Other psychiatric disorders (CC 60)	0.062	0.054	0.066	0.059
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.040	0.056	0.028	0.041
Stroke (CC 95-96)	0.040	0.014	0.038	0.030
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.143	0.152	0.157	0.149
Fibrosis of lung or other chronic lung disorders (CC 109)	0.068	0.063	0.071	0.070
Asthma (CC 110)	0.025	0.031	0.022	0.024
Pneumonia (CC 111-113)	0.090	0.082	0.081	0.083
Dialysis status (CC 130)	0.080	0.136	0.121	0.107
Renal failure (CC 131)	0.157	0.165	0.166	0.163

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Nephritis (CC 132)	0.130	0.067	0.117	0.106
Other urinary tract disorders (CC 136)	0.058	0.051	0.040	0.051
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.087	0.115	0.083	0.094

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

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 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	0.99 (0.97 - 1.01)	0.97 (0.96 - 0.99)	0.98 (0.96 - 0.99)	0.98 (0.97 - 0.99)
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	1.00 (0.98 - 1.02)	1.01 (0.99 - 1.03)	0.98 (0.96 - 1.00)	1.00 (0.98 - 1.01)
Cardio-respiratory failure and shock (CC 79)	1.07 (1.06 - 1.09)	1.10 (1.08 - 1.12)	1.10 (1.08 - 1.12)	1.09 (1.08 - 1.10)
Congestive heart failure (CC 80)	1.13 (1.11 - 1.15)	1.09 (1.07 - 1.11)	1.12 (1.10 - 1.14)	1.11 (1.10 - 1.12)
Acute coronary syndrome (CC 81-82)	1.15 (1.13 - 1.17)	1.14 (1.11 - 1.16)	1.14 (1.12 - 1.16)	1.14 (1.13 - 1.15)
Coronary atherosclerosis or angina (CC 83-84)	1.09 (1.07 - 1.11)	1.10 (1.08 - 1.12)	1.08 (1.06 - 1.11)	1.09 (1.08 - 1.10)
Valvular or rheumatic heart disease (CC 86)	1.13 (1.11 - 1.16)	1.14 (1.11 - 1.16)	1.12 (1.10 - 1.15)	1.13 (1.12 - 1.14)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.08 (1.06 - 1.09)	1.07 (1.05 - 1.09)	1.06 (1.04 - 1.08)	1.07 (1.06 - 1.08)
Other or unspecified heart disease (CC 94)	1.15 (1.14 - 1.17)	1.16 (1.14 - 1.18)	1.17 (1.15 - 1.19)	1.16 (1.15 - 1.17)
Vascular or circulatory disease (CC 104-106)	1.09 (1.08 - 1.11)	1.09 (1.07 - 1.11)	1.08 (1.07 - 1.10)	1.09 (1.08 - 1.10)
Metastatic cancer or acute leukemia (CC 7)	1.17 (1.15 - 1.19)	1.18 (1.16 - 1.20)	1.18 (1.16 - 1.20)	1.18 (1.16 - 1.19)
Cancer (CC 8-12)	1.06 (1.04 - 1.08)	1.05 (1.04 - 1.07)	1.04 (1.02 - 1.06)	1.05 (1.04 - 1.06)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.09 (1.07 - 1.12)	1.12 (1.10 - 1.15)	1.09 (1.06 - 1.11)	1.10 (1.09 - 1.11)
Protein-calorie malnutrition (CC 21)	1.06 (1.04 - 1.08)	1.07 (1.05 - 1.09)	1.06 (1.04 - 1.08)	1.06 (1.05 - 1.07)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.12 (1.10 - 1.15)	1.11 (1.09 - 1.14)	1.11 (1.09 - 1.13)	1.11 (1.10 - 1.13)
Liver or biliary disease (CC 25-30)	1.05 (1.03 - 1.07)	1.06 (1.04 - 1.08)	1.07 (1.05 - 1.08)	1.06 (1.05 - 1.07)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.03 (1.01 - 1.05)	1.07 (1.05 - 1.09)	1.05 (1.03 - 1.07)	1.05 (1.04 - 1.06)
Other gastrointestinal disorders (CC 36)	1.03 (1.00 - 1.05)	1.03 (1.01 - 1.06)	1.02 (1.00 - 1.05)	1.02 (1.01 - 1.04)
Severe hematological disorders (CC 44)	1.07 (1.05 - 1.09)	1.07 (1.05 - 1.09)	1.07 (1.05 - 1.09)	1.07 (1.06 - 1.08)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.03 (1.01 - 1.05)	1.02 (1.00 - 1.04)	1.02 (1.00 - 1.04)	1.02 (1.01 - 1.03)
Dementia or other specified brain disorders (CC 49-50)	1.08 (1.06 - 1.11)	1.10 (1.08 - 1.13)	1.13 (1.10 - 1.15)	1.10 (1.09 - 1.12)
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	1.04 (1.01 - 1.06)	1.04 (1.02 - 1.07)	1.06 (1.03 - 1.09)	1.05 (1.03 - 1.06)
Major psychiatric disorders (CC 54-56)	1.08 (1.05 - 1.12)	1.15 (1.11 - 1.19)	1.13 (1.09 - 1.17)	1.11 (1.09 - 1.14)
Depression (CC 58)	1.16 (1.11 - 1.22)	1.21 (1.15 - 1.27)	1.17 (1.11 - 1.23)	1.18 (1.15 - 1.21)
Other psychiatric disorders (CC 60)	1.14 (1.10 - 1.18)	1.07 (1.03 - 1.11)	1.12 (1.09 - 1.16)	1.11 (1.09 - 1.14)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.08 (1.05 - 1.10)	1.07 (1.04 - 1.09)	1.08 (1.06 - 1.11)	1.07 (1.06 - 1.09)
Stroke (CC 95-96)	1.13 (1.07 - 1.19)	1.17 (1.11 - 1.23)	1.19 (1.13 - 1.25)	1.16 (1.13 - 1.19)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.04 (1.01 - 1.07)	1.02 (0.99 - 1.04)	1.04 (1.01 - 1.07)	1.03 (1.01 - 1.05)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.00 (0.98 - 1.02)	1.01 (0.99 - 1.03)	1.01 (0.99 - 1.03)	1.01 (1.00 - 1.02)
Asthma (CC 110)	1.06 (1.04 - 1.08)	1.06 (1.04 - 1.08)	1.09 (1.07 - 1.11)	1.07 (1.06 - 1.08)
Pneumonia (CC 111-113)	1.03 (1.02 - 1.05)	1.03 (1.02 - 1.05)	1.03 (1.01 - 1.05)	1.03 (1.02 - 1.04)
Dialysis status (CC 130)	1.06 (1.04 - 1.09)	1.06 (1.03 - 1.08)	1.07 (1.05 - 1.09)	1.06 (1.05 - 1.07)
Renal failure (CC 131)	1.04 (1.01 - 1.07)	1.06 (1.03 - 1.09)	1.03 (1.00 - 1.06)	1.04 (1.03 - 1.06)
Nephritis (CC 132)	1.07 (1.04 - 1.10)	1.07 (1.04 - 1.09)	1.07 (1.05 - 1.10)	1.07 (1.06 - 1.09)
Other urinary tract disorders (CC 136)	1.08 (1.06 - 1.11)	1.08 (1.06 - 1.11)	1.10 (1.08 - 1.13)	1.09 (1.07 - 1.11)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.01 (0.99 - 1.03)	1.01 (0.99 - 1.03)	0.98 (0.96 - 1.00)	1.00 (0.99 - 1.01)

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	13.7 - 36.1	12.6 - 35.4	12.8 - 35.3	13.1 - 35.6
c-statistic	0.61	0.61	0.61	0.61

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,532	4,491	4,470	4,639
Mean number of admissions (SD)	87.0 (107.7)	84.6 (106.1)	86.8 (110.1)	250.5 (320.1)
Range (min. – max.)	1 - 1,133	1 - 1,188	1 - 1,300	1 - 3,621
25th percentile	14	13	13	37
50th percentile	44	41	42	116
75th percentile	123	120	123	356

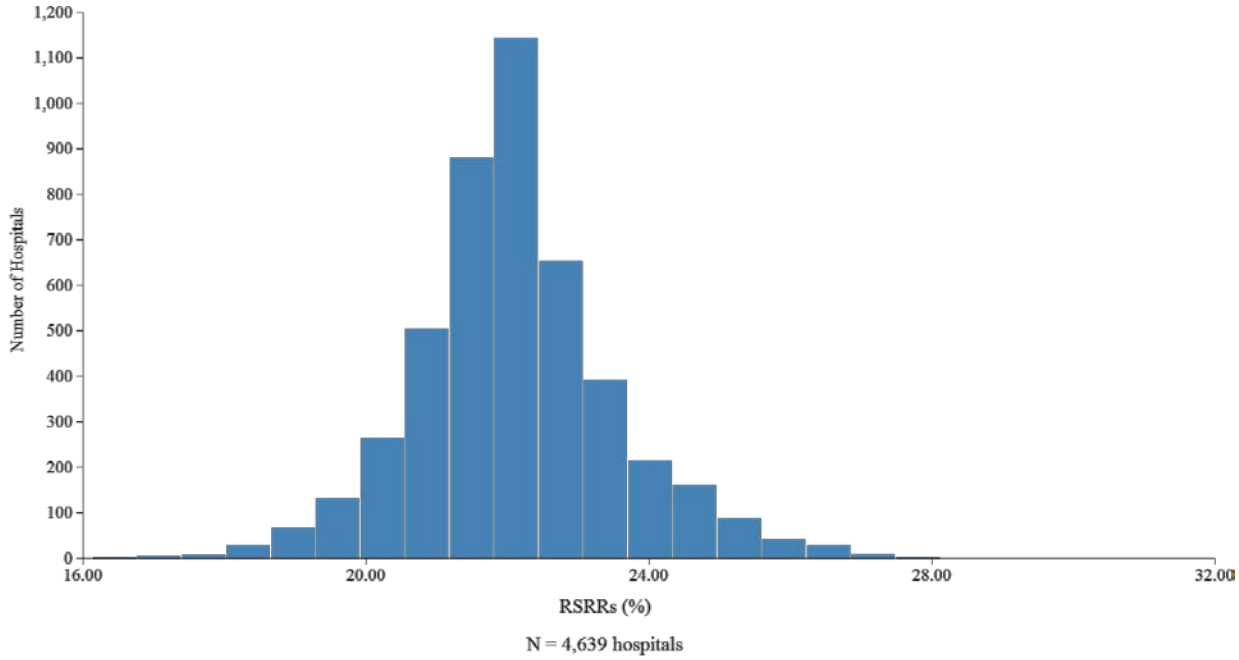
Table 4.4.6 – Distribution of Hospital HF RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,532	4,491	4,470	4,639
Mean (SD)	22.5 (1.0)	21.6 (1.0)	21.7 (0.8)	22.0 (1.4)
Range (min. – max.)	17.5 - 28.8	17.2 - 26.8	16.4 - 26.1	16.3 - 31.3
25th percentile	21.9	21.1	21.4	21.2
50th percentile	22.4	21.5	21.7	21.9
75th percentile	22.9	22.0	22.1	22.6

Table 4.4.7 – Between-Hospital Variance for HF

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.020 (0.002)	0.019 (0.002)	0.016 (0.002)	0.020 (0.001)

Figure 4.4.2 – Distribution of Hospital 30-Day HF RSRRs Between July 2012 and June 2015



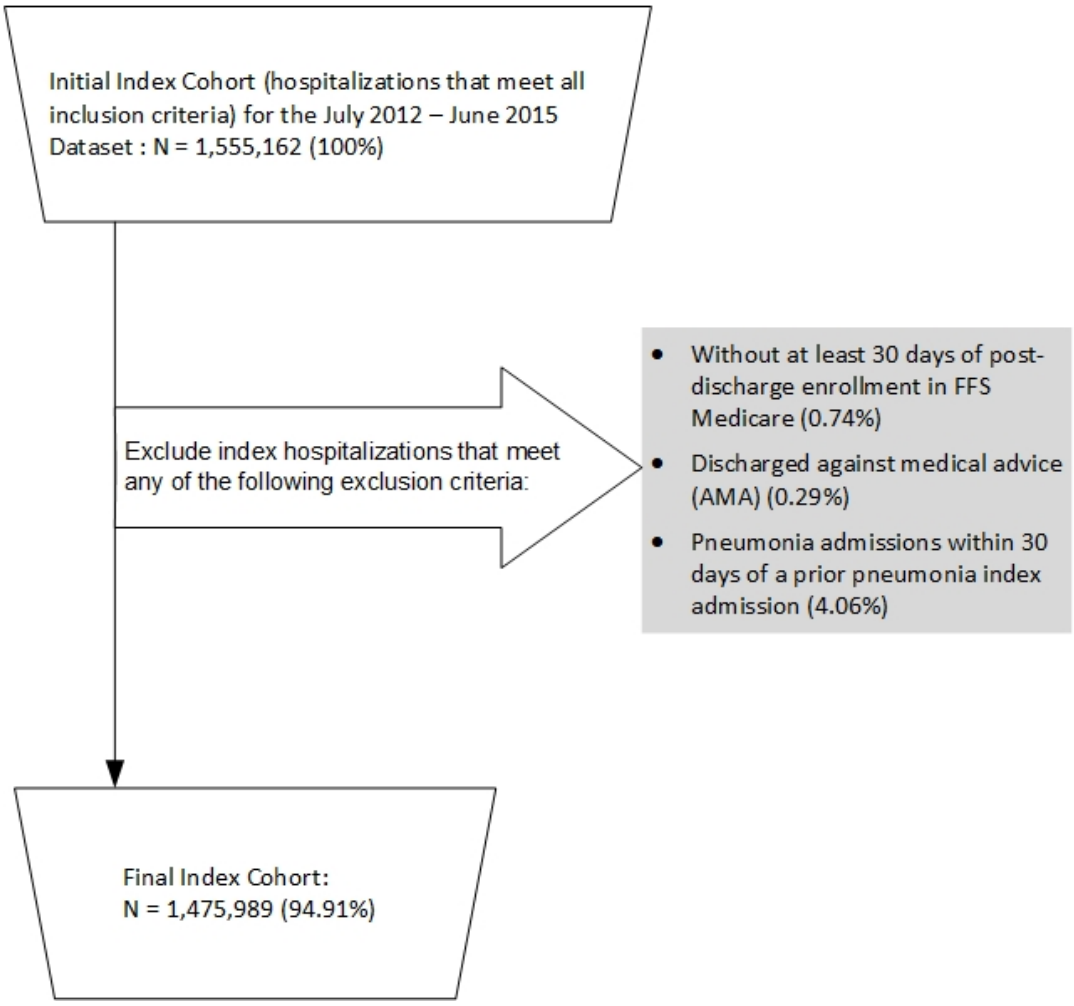
4.5 Pneumonia Readmission 2016 Model Results

4.5.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in Section 2.2.1. The percentage of pneumonia admissions meeting each exclusion criterion in the July 2012-June 2015 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 short-term acute care hospitalizations for Medicare patients aged 65 or over with either a principal discharge diagnosis of pneumonia (including aspiration pneumonia) OR a principal discharge diagnosis of sepsis (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA; enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and 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 – Pneumonia Cohort Exclusions in the July 2012-June 2015 Dataset



4.5.2 Frequency of Pneumonia Model Variables

We examined the change in both observed readmission rates and frequency of clinical and demographic variables. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 17.4% to 16.6%. Notable changes in the frequencies for model variables include:

- Decreases in Iron deficiency or other unspecified anemias and blood disease (60.0% to 58.7%), Dementia or other specified brain disorders (37.3% to 36.0%), Coronary atherosclerosis or angina (49.2% to 47.8%), Chronic Obstructive Pulmonary Disease (COPD) (52.8% to 51.8%), Fibrosis of lung or other chronic lung disorders (14.0% to 12.9%), Other lung disorders (45.1% to 43.3%), Urinary tract infection (31.6% to 30.6%), and Other urinary tract disorders (25.4% to 24.2%)
- Increases in Septicemia/shock (11.7% to 13.5%), Other psychiatric disorders (22.5% to 25.2%), Cardio-respiratory failure and shock; respiratory arrest (23.8% to 25.8%), Pneumonia (52.0% to 53.7%), Renal failure (31.3% to 33.0%), and Other injuries (40.8% to 41.8%)

Refer to Table 4.5.1 for more detail.

4.5.3 Pneumonia 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 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 c-statistic decreased slightly from 0.64 to 0.63 (Table 4.5.4).

4.5.4 Distribution of Hospital Volumes and RSRRs for Pneumonia

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 17.4% between July 2012 and June 2013 to 16.7% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 17.0% (IQR 16.2% - 17.8%). 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 0.025 (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 SD above the national rate were 1.37 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0[21].

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

Of 4,692 hospitals in the study cohort, 79 performed "Better than the National Rate," 4,044 performed "No Different from the National Rate," and 186 performed "Worse than the National Rate." 383 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 Pneumonia Model Variables Over Different Time Periods

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	515,758	463,628	496,603	1,475,989
Observed readmission rate (%)	17.4	17.2	16.6	17.1
Mean age minus 65 (SD)	15.7 (8.4)	15.4 (8.5)	15.7 (8.6)	15.6 (8.5)
Male (%)	46.4	46.9	46.7	46.7
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	8.9	8.9	8.8	8.9
History of infection (CC 1, 3-6)	41.6	41.7	41.1	41.5
Septicemia/shock (CC 2)	11.7	12.9	13.5	12.6
Metastatic cancer or acute leukemia (CC 7)	4.9	5.2	5.0	5.0
Lung, upper digestive tract, and other severe cancers (CC 8)	6.4	6.9	6.6	6.7
Other major cancers (CC 9-10)	17.5	17.8	17.6	17.6
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	42.4	42.8	42.2	42.5
Protein-calorie malnutrition (CC 21)	16.7	16.9	16.6	16.8
Disorders of fluid/electrolyte/acid-base (CC 22-23)	43.8	44.6	43.8	44.1
Other gastrointestinal disorders (CC 36)	67.4	68.1	68.0	67.8
Severe hematological disorders (CC 44)	2.3	2.2	2.0	2.2
Iron deficiency or other unspecified anemias and blood disease (CC 47)	60.0	60.5	58.7	59.7
Dementia or other specified brain disorders (CC 49-50)	37.3	36.5	36.0	36.6
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	15.9	16.7	16.8	16.5
Major psychiatric disorders (CC 54-56)	15.8	16.0	16.0	15.9
Other psychiatric disorders (CC 60)	22.5	24.4	25.2	24.0
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	11.6	11.6	11.4	11.5
Respirator dependence/tracheostomy status (CC 77)	1.3	1.4	1.2	1.3
Cardio-respiratory failure and shock; respiratory arrest (CC 78-79)	23.8	25.5	25.8	25.0
Congestive heart failure (CC 80)	38.8	38.9	38.2	38.6
Acute coronary syndrome (CC 81-82)	7.7	7.8	7.6	7.7
Coronary atherosclerosis or angina (CC 83-84)	49.2	48.8	47.8	48.6
Valvular or rheumatic heart disease (CC 86)	25.6	25.9	26.0	25.8
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	45.4	46.0	45.9	45.7
Stroke (CC 95-96)	10.9	10.9	10.6	10.8
Vascular or circulatory disease (CC 104-106)	44.1	44.5	44.0	44.2
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	52.8	53.0	51.8	52.5
Fibrosis of lung or other chronic lung disorders (CC 109)	14.0	13.5	12.9	13.5
Asthma (CC 110)	11.1	11.2	11.3	11.2
Pneumonia (CC 111-113)	52.0	53.4	53.7	53.0
Pleural effusion/pneumothorax (CC 114)	17.4	18.0	17.5	17.6
Other lung disorders (CC 115)	45.1	44.1	43.3	44.2
Dialysis status (CC 130)	3.3	3.5	3.5	3.4

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Renal failure (CC 131)	31.3	32.6	33.0	32.3
Urinary tract infection (CC 135)	31.6	31.5	30.6	31.3
Other urinary tract disorders (CC 136)	25.4	25.0	24.2	24.9
Decubitus ulcer or chronic skin ulcer (CC 148-149)	13.7	13.9	13.4	13.7
Vertebral fractures (CC 157)	5.3	5.5	5.5	5.4
Other injuries (CC 162)	40.8	41.6	41.8	41.4

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

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.436	-2.420	-2.474	-2.447
Age minus 65 (years above 65, continuous)	-0.004	-0.004	-0.004	-0.004
Male	0.051	0.069	0.061	0.061
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	-0.039	-0.030	-0.029	-0.031
History of infection (CC 1, 3-6)	0.042	0.017	0.033	0.029
Septicemia/shock (CC 2)	0.042	0.062	0.050	0.047
Metastatic cancer or acute leukemia (CC 7)	0.161	0.177	0.207	0.179
Lung, upper digestive tract, and other severe cancers (CC 8)	0.154	0.162	0.153	0.154
Other major cancers (CC 9-10)	0.038	0.016	0.026	0.027
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.094	0.089	0.087	0.088
Protein-calorie malnutrition (CC 21)	0.111	0.123	0.112	0.116
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.136	0.116	0.115	0.122
Other gastrointestinal disorders (CC 36)	0.092	0.061	0.075	0.078
Severe hematological disorders (CC 44)	0.178	0.227	0.234	0.212
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.158	0.172	0.186	0.171
Dementia or other specified brain disorders (CC 49-50)	-0.015	0.005	-0.012	-0.011
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	0.076	0.096	0.103	0.091
Major psychiatric disorders (CC 54-56)	0.023	0.017	0.028	0.022
Other psychiatric disorders (CC 60)	0.053	0.058	0.057	0.055
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	0.072	0.083	0.080	0.078
Respirator dependence/tracheostomy status (CC 77)	0.128	0.155	0.141	0.135
Cardio-respiratory failure and shock; respiratory arrest (CC 78-79)	0.147	0.128	0.154	0.144
Congestive heart failure (CC 80)	0.144	0.145	0.142	0.144
Acute coronary syndrome (CC 81-82)	0.067	0.074	0.086	0.073
Coronary atherosclerosis or angina (CC 83-84)	0.039	0.047	0.055	0.045
Valvular or rheumatic heart disease (CC 86)	0.073	0.055	0.077	0.069

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	0.077	0.074	0.087	0.080
Stroke (CC 95-96)	0.042	0.008	0.025	0.024
Vascular or circulatory disease (CC 104-106)	0.055	0.057	0.043	0.050
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.185	0.155	0.155	0.165
Fibrosis of lung or other chronic lung disorders (CC 109)	0.104	0.097	0.104	0.104
Asthma (CC 110)	-0.009	-0.005	-0.014	-0.010
Pneumonia (CC 111-113)	0.047	0.040	0.040	0.042
Pleural effusion/pneumothorax (CC 114)	0.082	0.104	0.098	0.094
Other lung disorders (CC 115)	0.045	0.035	0.033	0.038
Dialysis status (CC 130)	0.204	0.182	0.208	0.194
Renal failure (CC 131)	0.126	0.122	0.122	0.123
Urinary tract infection (CC 135)	0.038	0.058	0.051	0.049
Other urinary tract disorders (CC 136)	0.053	0.047	0.042	0.048
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.108	0.104	0.077	0.094
Vertebral fractures (CC 157)	0.031	0.065	0.090	0.064
Other injuries (CC 162)	0.040	0.038	0.028	0.036

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

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 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	1.05 (1.04 - 1.07)	1.07 (1.05 - 1.09)	1.06 (1.05 - 1.08)	1.06 (1.05 - 1.07)
History of Coronary Artery Bypass Graft (CABG) surgery (ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10-36.16)	0.96 (0.94 - 0.99)	0.97 (0.94 - 1.00)	0.97 (0.95 - 1.00)	0.97 (0.95 - 0.99)
History of infection (CC 1, 3-6)	1.04 (1.03 - 1.06)	1.02 (1.00 - 1.04)	1.03 (1.02 - 1.05)	1.03 (1.02 - 1.04)
Septicemia/shock (CC 2)	1.04 (1.02 - 1.07)	1.06 (1.04 - 1.09)	1.05 (1.03 - 1.08)	1.05 (1.03 - 1.06)
Metastatic cancer or acute leukemia (CC 7)	1.18 (1.13 - 1.22)	1.19 (1.15 - 1.24)	1.23 (1.19 - 1.28)	1.20 (1.17 - 1.22)
Lung, upper digestive tract, and other severe cancers (CC 8)	1.17 (1.13 - 1.20)	1.18 (1.14 - 1.21)	1.17 (1.13 - 1.20)	1.17 (1.15 - 1.19)
Other major cancers (CC 9-10)	1.04 (1.02 - 1.06)	1.02 (1.00 - 1.04)	1.03 (1.01 - 1.05)	1.03 (1.02 - 1.04)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.10 (1.08 - 1.12)	1.09 (1.08 - 1.11)	1.09 (1.07 - 1.11)	1.09 (1.08 - 1.10)
Protein-calorie malnutrition (CC 21)	1.12 (1.10 - 1.14)	1.13 (1.11 - 1.16)	1.12 (1.10 - 1.14)	1.12 (1.11 - 1.14)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	1.15 (1.13 - 1.17)	1.12 (1.10 - 1.14)	1.12 (1.10 - 1.14)	1.13 (1.12 - 1.14)
Other gastrointestinal disorders (CC 36)	1.10 (1.08 - 1.12)	1.06 (1.04 - 1.08)	1.08 (1.06 - 1.10)	1.08 (1.07 - 1.09)
Severe hematological disorders (CC 44)	1.20 (1.14 - 1.25)	1.26 (1.20 - 1.32)	1.26 (1.21 - 1.33)	1.24 (1.20 - 1.27)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.17 (1.15 - 1.19)	1.19 (1.17 - 1.21)	1.20 (1.18 - 1.23)	1.19 (1.18 - 1.20)
Dementia or other specified brain disorders (CC 49-50)	0.99 (0.97 - 1.00)	1.01 (0.99 - 1.02)	0.99 (0.97 - 1.01)	0.99 (0.98 - 1.00)
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	1.08 (1.06 - 1.10)	1.10 (1.08 - 1.12)	1.11 (1.09 - 1.13)	1.10 (1.08 - 1.11)
Major psychiatric disorders (CC 54-56)	1.02 (1.00 - 1.04)	1.02 (1.00 - 1.04)	1.03 (1.01 - 1.05)	1.02 (1.01 - 1.04)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Other psychiatric disorders (CC 60)	1.06 (1.04 - 1.07)	1.06 (1.04 - 1.08)	1.06 (1.04 - 1.08)	1.06 (1.05 - 1.07)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.08 (1.05 - 1.10)	1.09 (1.06 - 1.11)	1.08 (1.06 - 1.11)	1.08 (1.07 - 1.10)
Respirator dependence/tracheostomy status (CC 77)	1.14 (1.08 - 1.20)	1.17 (1.10 - 1.24)	1.15 (1.09 - 1.22)	1.14 (1.11 - 1.18)
Cardio-respiratory failure and shock; respiratory arrest (CC 78-79)	1.16 (1.14 - 1.18)	1.14 (1.11 - 1.16)	1.17 (1.14 - 1.19)	1.16 (1.14 - 1.17)
Congestive heart failure (CC 80)	1.16 (1.13 - 1.18)	1.16 (1.14 - 1.18)	1.15 (1.13 - 1.18)	1.16 (1.14 - 1.17)
Acute coronary syndrome (CC 81-82)	1.07 (1.04 - 1.10)	1.08 (1.05 - 1.11)	1.09 (1.06 - 1.12)	1.08 (1.06 - 1.09)
Coronary atherosclerosis or angina (CC 83-84)	1.04 (1.02 - 1.06)	1.05 (1.03 - 1.07)	1.06 (1.04 - 1.08)	1.05 (1.04 - 1.06)
Valvular or rheumatic heart disease (CC 86)	1.08 (1.06 - 1.10)	1.06 (1.04 - 1.08)	1.08 (1.06 - 1.10)	1.07 (1.06 - 1.08)
Specified arrhythmias and other heart rhythm disorders (CC 92-93)	1.08 (1.06 - 1.10)	1.08 (1.06 - 1.10)	1.09 (1.07 - 1.11)	1.08 (1.07 - 1.09)
Stroke (CC 95-96)	1.04 (1.02 - 1.07)	1.01 (0.98 - 1.04)	1.03 (1.00 - 1.05)	1.02 (1.01 - 1.04)
Vascular or circulatory disease (CC 104-106)	1.06 (1.04 - 1.07)	1.06 (1.04 - 1.08)	1.04 (1.03 - 1.06)	1.05 (1.04 - 1.06)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.20 (1.18 - 1.22)	1.17 (1.15 - 1.19)	1.17 (1.15 - 1.19)	1.18 (1.17 - 1.19)
Fibrosis of lung or other chronic lung disorders (CC 109)	1.11 (1.09 - 1.13)	1.10 (1.08 - 1.13)	1.11 (1.09 - 1.14)	1.11 (1.10 - 1.12)
Asthma (CC 110)	0.99 (0.97 - 1.01)	1.00 (0.97 - 1.02)	0.99 (0.96 - 1.01)	0.99 (0.98 - 1.00)
Pneumonia (CC 111-113)	1.05 (1.03 - 1.07)	1.04 (1.02 - 1.06)	1.04 (1.02 - 1.06)	1.04 (1.03 - 1.05)
Pleural effusion/pneumothorax (CC 114)	1.09 (1.06 - 1.11)	1.11 (1.09 - 1.13)	1.10 (1.08 - 1.13)	1.10 (1.09 - 1.11)
Other lung disorders (CC 115)	1.05 (1.03 - 1.06)	1.04 (1.02 - 1.05)	1.03 (1.02 - 1.05)	1.04 (1.03 - 1.05)
Dialysis status (CC 130)	1.23 (1.18 - 1.27)	1.20 (1.15 - 1.25)	1.23 (1.19 - 1.28)	1.21 (1.19 - 1.24)
Renal failure (CC 131)	1.13 (1.11 - 1.15)	1.13 (1.11 - 1.15)	1.13 (1.11 - 1.15)	1.13 (1.12 - 1.14)
Urinary tract infection (CC 135)	1.04 (1.02 - 1.06)	1.06 (1.04 - 1.08)	1.05 (1.03 - 1.07)	1.05 (1.04 - 1.06)
Other urinary tract disorders (CC 136)	1.06 (1.04 - 1.07)	1.05 (1.03 - 1.07)	1.04 (1.02 - 1.06)	1.05 (1.04 - 1.06)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.11 (1.09 - 1.14)	1.11 (1.09 - 1.14)	1.08 (1.06 - 1.10)	1.10 (1.09 - 1.11)
Vertebral fractures (CC 157)	1.03 (1.00 - 1.07)	1.07 (1.03 - 1.10)	1.09 (1.06 - 1.13)	1.07 (1.05 - 1.09)
Other injuries (CC 162)	1.04 (1.03 - 1.06)	1.04 (1.02 - 1.06)	1.03 (1.01 - 1.05)	1.04 (1.03 - 1.05)

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	8.6 - 32.0	8.7 - 31.1	8.4 - 30.6	8.5 - 31.3
c-statistic	0.64	0.63	0.63	0.63

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,608	4,577	4,552	4,692
Mean number of admissions (SD)	111.9 (118.9)	101.3 (109.6)	109.1 (119.7)	314.6 (344.7)
Range (min. – max.)	1 - 1,131	1 - 1,109	1 - 1,212	1 - 3,452
25th percentile	28	24	25	72
50th percentile	69	62	66	188
75th percentile	159	145	155	450

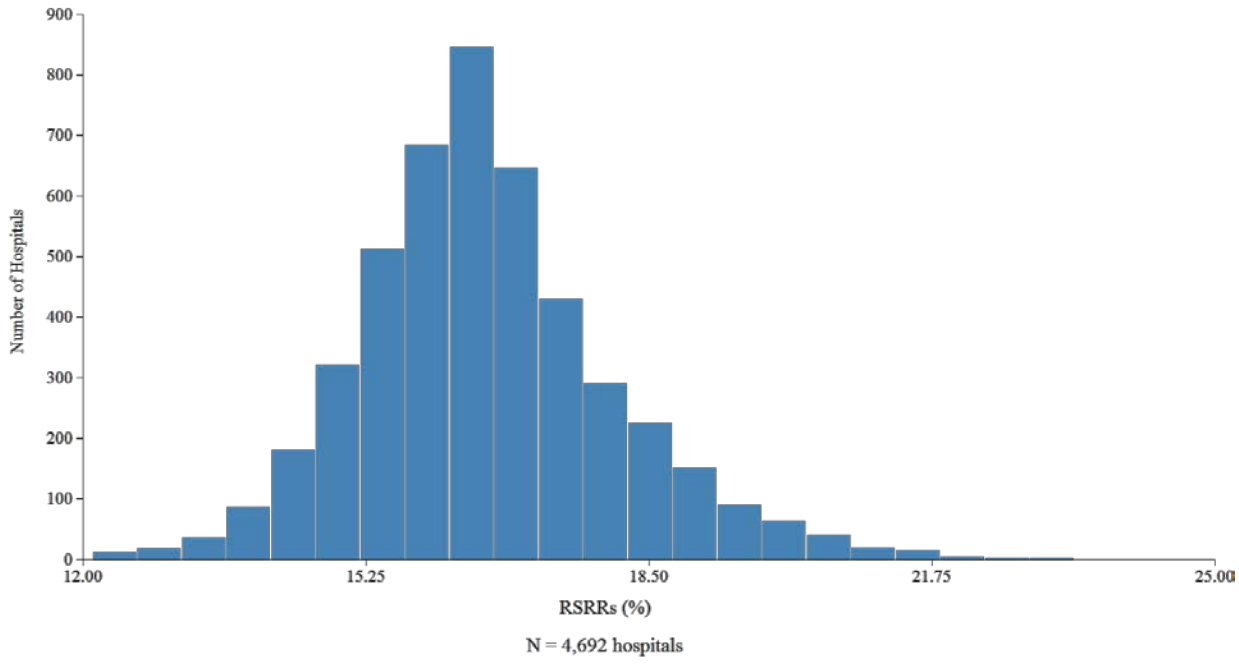
Table 4.5.6 – Distribution of Hospital Pneumonia RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,608	4,577	4,552	4,692
Mean (SD)	17.4 (1.1)	17.3 (1.0)	16.7 (0.9)	17.1 (1.4)
Range (min. – max.)	13.6 - 23.7	12.9 - 22.8	13.9 - 21.8	12.9 - 24.7
25th percentile	16.7	16.7	16.2	16.2
50th percentile	17.3	17.2	16.6	17.0
75th percentile	17.9	17.7	17.1	17.8

Table 4.5.7 – Between-Hospital Variance for Pneumonia

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.026 (0.002)	0.023 (0.002)	0.020 (0.002)	0.025 (0.001)

Figure 4.5.2 – Distribution of Hospital 30-Day Pneumonia RSRRs Between July 2012 and June 2015



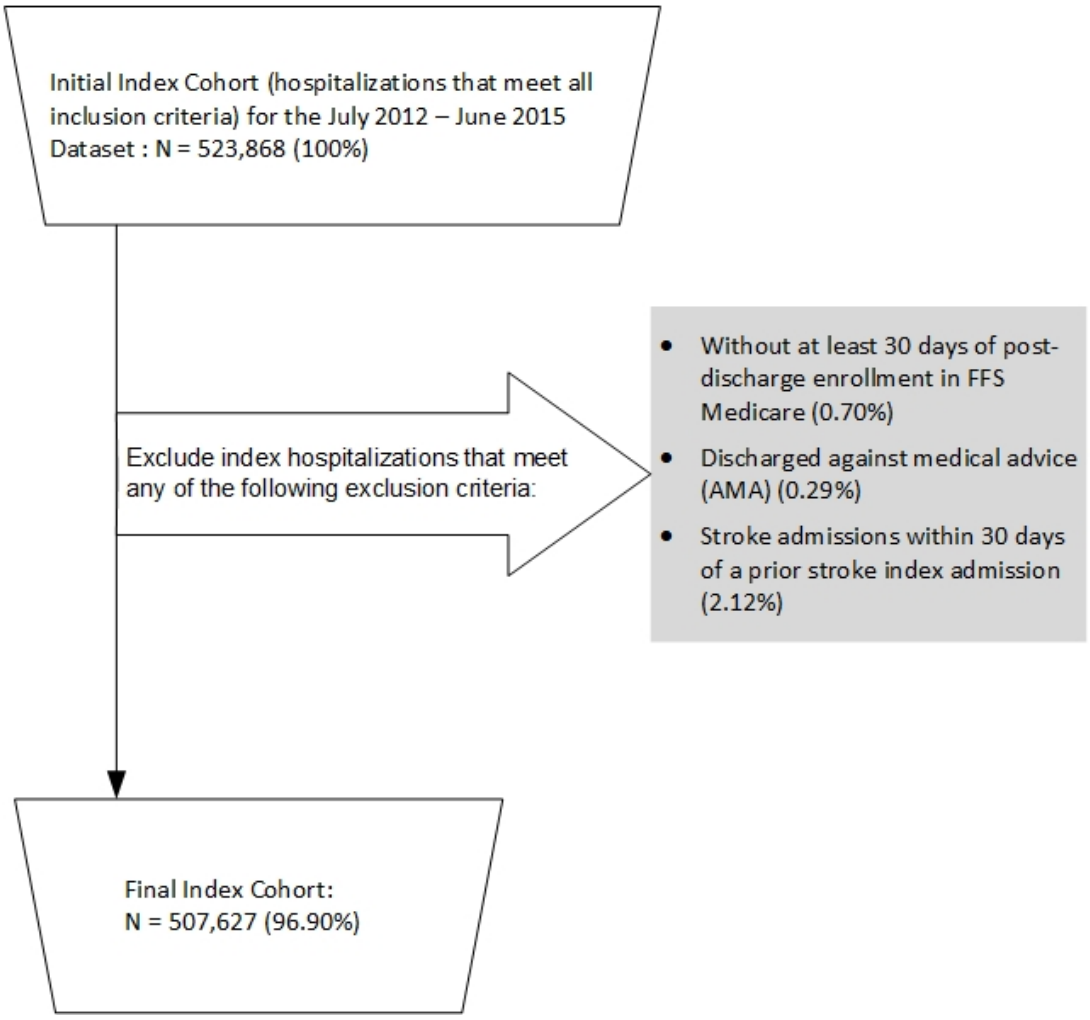
4.6 Stroke Readmission 2016 Model Results

4.6.1 Index Cohort Exclusions

The exclusion criteria for the measure are presented in Section 2.2.1. The percentage of stroke admissions meeting each exclusion criterion in the July 2012-June 2015 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 short-term acute care hospitalizations for Medicare patients aged 65 or over with a principal discharge diagnosis of ischemic stroke; enrolled in Medicare FFS Part A and Part B 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 2012-June 2015 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. Between July 2012-June 2013 and July 2014-June 2015, the observed readmission rate decreased from 12.9% to 12.4%. Notable changes in the frequencies for model variables include:

- Decreases in Hypertensive heart disease (5.3% to 4.3%), Ischemic or unspecified stroke (23.4% to 22.4%), Precerebral arterial occlusion and transient cerebral ischemia (23.3% to 22.3%), and Other lung disorders (21.7% to 20.4%)
- Increases in Other endocrine/metabolic/nutritional disorders (84.6% to 86.2%) and Renal failure (20.8% to 22.5%)

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 c-statistic remained constant at 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 12.9% between July 2012 and June 2013 to 12.4% between July 2014 and June 2015. The median hospital RSRR in the combined three-year dataset was 12.5% (IQR 12.1% - 12.8%). 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 0.030 (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 SD above the national rate were 1.42 times higher than the odds of all-cause readmission if treated at a hospital one SD below the national rate. If there were no systematic differences between hospitals, the OR would be 1.0[21].

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

Of 4,413 hospitals in the study cohort, 7 performed “Better than the National Rate,” 2,634 performed “No Different from the National Rate,” and 50 performed “Worse than the National Rate.” 1,722 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	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Total N	170,151	168,245	169,231	507,627
Observed readmission rate (%)	12.9	12.3	12.4	12.5
Mean age minus 65 (SD)	15.1 (8.2)	15.1 (8.3)	15.0 (8.4)	15.1 (8.3)
Male (%)	41.7	42.1	42.5	42.1
Congestive heart failure (CC 80)	24.1	23.9	23.2	23.8
Hypertensive heart disease (CC 90)	5.3	4.8	4.3	4.8
Cerebral hemorrhage (CC 95)	2.1	2.2	2.2	2.1
Ischemic or unspecified stroke (CC 96)	23.4	23.3	22.4	23.0
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	23.3	22.7	22.3	22.8
Hemiplegia, paralysis, functional disability (CC 100-102)	10.8	10.9	10.6	10.8
Metastatic cancer or acute leukemia (CC 7)	2.2	2.3	2.3	2.3
Cancer (CC 8-12)	18.7	18.4	18.5	18.5
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	42.6	42.8	43.2	42.9
Protein-calorie malnutrition (CC 21)	6.4	6.4	6.4	6.4
Disorders of fluid/electrolyte/acid-base (CC 22-23)	27.1	27.2	27.0	27.1
Other endocrine/metabolic/nutritional disorders (CC 24)	84.6	85.7	86.2	85.5
Severe hematological disorders (CC 44)	0.9	0.9	0.8	0.9
Iron deficiency or other unspecified anemias and blood disease (CC 47)	37.3	37.1	36.7	37.0
Dementia or other specified brain disorders (CC 49-50)	31.9	31.6	31.3	31.6
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	2.3	2.5	2.5	2.5
Seizure disorders and convulsions (CC 74)	7.5	7.7	7.6	7.6
Vascular or circulatory disease (CC 104-106)	32.6	32.4	32.0	32.3
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	22.5	22.0	21.7	22.1
Other lung disorders (CC 115)	21.7	20.9	20.4	21.0
Dialysis status (CC 130)	1.6	1.5	1.6	1.6
Renal failure (CC 131)	20.8	21.6	22.5	21.6
Other urinary tract disorders (CC 136)	18.6	18.1	17.7	18.1
Decubitus ulcer or chronic skin ulcer (CC 148-149)	6.8	6.9	6.7	6.8
Major symptoms, abnormalities (CC 166)	62.2	62.2	61.9	62.1

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

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Intercept	-2.449	-2.467	-2.466	-2.471
Age minus 65 (years above 65, continuous)	0.002	-0.001	-0.001	0.000
Male	0.040	0.029	0.038	0.036
Congestive heart failure (CC 80)	0.148	0.195	0.170	0.168
Hypertensive heart disease (CC 90)	0.106	0.065	0.068	0.069
Cerebral hemorrhage (CC 95)	-0.052	0.021	0.156	0.041
Ischemic or unspecified stroke (CC 96)	0.012	0.014	0.000	0.008
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	0.020	0.046	-0.003	0.022
Hemiplegia, paralysis, functional disability (CC 100-102)	0.023	-0.016	0.010	0.006

Variable	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Metastatic cancer or acute leukemia (CC 7)	0.382	0.366	0.294	0.346
Cancer (CC 8-12)	-0.004	0.017	0.038	0.016
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	0.160	0.148	0.192	0.162
Protein-calorie malnutrition (CC 21)	0.233	0.292	0.248	0.256
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.100	0.110	0.119	0.110
Other endocrine/metabolic/nutritional disorders (CC 24)	-0.008	-0.007	-0.038	-0.015
Severe hematological disorders (CC 44)	0.114	0.175	0.184	0.157
Iron deficiency or other unspecified anemias and blood disease (CC 47)	0.214	0.217	0.212	0.212
Dementia or other specified brain disorders (CC 49-50)	0.040	0.021	0.057	0.038
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	0.142	0.109	0.094	0.113
Seizure disorders and convulsions (CC 74)	0.120	0.123	0.133	0.121
Vascular or circulatory disease (CC 104-106)	0.054	0.055	0.090	0.063
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	0.137	0.165	0.163	0.156
Other lung disorders (CC 115)	0.087	0.037	0.052	0.060
Dialysis status (CC 130)	0.343	0.242	0.277	0.288
Renal failure (CC 131)	0.164	0.149	0.149	0.155
Other urinary tract disorders (CC 136)	0.105	0.140	0.086	0.111
Decubitus ulcer or chronic skin ulcer (CC 148-149)	0.053	0.056	0.049	0.052
Major symptoms, abnormalities (CC 166)	0.071	0.066	0.071	0.070

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

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 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)	1.03 (1.00 - 1.06)	1.04 (1.01 - 1.07)	1.04 (1.02 - 1.06)
Congestive heart failure (CC 80)	1.16 (1.12 - 1.20)	1.22 (1.17 - 1.26)	1.19 (1.14 - 1.23)	1.18 (1.16 - 1.21)
Hypertensive heart disease (CC 90)	1.11 (1.05 - 1.18)	1.07 (1.00 - 1.14)	1.07 (1.00 - 1.15)	1.07 (1.03 - 1.11)
Cerebral hemorrhage (CC 95)	0.95 (0.86 - 1.05)	1.02 (0.93 - 1.12)	1.17 (1.07 - 1.28)	1.04 (0.99 - 1.10)
Ischemic or unspecified stroke (CC 96)	1.01 (0.98 - 1.05)	1.01 (0.98 - 1.06)	1.00 (0.96 - 1.04)	1.01 (0.99 - 1.03)
Precerebral arterial occlusion and transient cerebral ischemia (CC 97)	1.02 (0.98 - 1.06)	1.05 (1.01 - 1.09)	1.00 (0.96 - 1.04)	1.02 (1.00 - 1.04)
Hemiplegia, paralysis, functional disability (CC 100-102)	1.02 (0.97 - 1.07)	0.98 (0.94 - 1.04)	1.01 (0.96 - 1.06)	1.01 (0.98 - 1.04)
Metastatic cancer or acute leukemia (CC 7)	1.11 (1.07 - 1.15)	1.15 (1.11 - 1.19)	1.09 (1.05 - 1.13)	1.12 (1.09 - 1.14)
Cancer (CC 8-12)	1.00 (0.96 - 1.04)	1.02 (0.98 - 1.06)	1.04 (1.00 - 1.08)	1.02 (0.99 - 1.04)
Diabetes mellitus (DM) or DM complications (CC 15-19, 119-120)	1.17 (1.14 - 1.21)	1.16 (1.13 - 1.20)	1.21 (1.18 - 1.25)	1.18 (1.16 - 1.20)
Protein-calorie malnutrition (CC 21)	1.26 (1.20 - 1.33)	1.34 (1.27 - 1.41)	1.28 (1.22 - 1.35)	1.29 (1.25 - 1.33)
Disorders of fluid/electrolyte/acid-base (CC 22-23)	0.99 (0.95 - 1.04)	0.99 (0.95 - 1.04)	0.96 (0.92 - 1.01)	0.99 (0.96 - 1.01)
Other endocrine/metabolic/nutritional disorders (CC 24)	1.18 (1.13 - 1.22)	1.16 (1.12 - 1.21)	1.16 (1.12 - 1.21)	1.17 (1.14 - 1.19)

Variable	07/2012-06/2013 OR (95% CI)	07/2013-06/2014 OR (95% CI)	07/2014-06/2015 OR (95% CI)	07/2012-06/2015 OR (95% CI)
Severe hematological disorders (CC 44)	1.12 (0.99 - 1.28)	1.19 (1.04 - 1.36)	1.20 (1.05 - 1.38)	1.17 (1.08 - 1.26)
Iron deficiency or other unspecified anemias and blood disease (CC 47)	1.24 (1.20 - 1.28)	1.24 (1.20 - 1.28)	1.24 (1.20 - 1.28)	1.24 (1.21 - 1.26)
Dementia or other specified brain disorders (CC 49-50)	1.04 (1.01 - 1.08)	1.02 (0.99 - 1.06)	1.06 (1.02 - 1.09)	1.04 (1.02 - 1.06)
Quadriplegia, paraplegia, functional disability (CC 67-69, 177-178)	1.15 (1.06 - 1.25)	1.12 (1.03 - 1.21)	1.10 (1.01 - 1.20)	1.12 (1.07 - 1.18)
Seizure disorders and convulsions (CC 74)	1.47 (1.34 - 1.60)	1.44 (1.32 - 1.57)	1.34 (1.23 - 1.47)	1.41 (1.34 - 1.49)
Vascular or circulatory disease (CC 104-106)	1.06 (1.02 - 1.09)	1.06 (1.02 - 1.09)	1.09 (1.06 - 1.13)	1.07 (1.05 - 1.09)
Chronic Obstructive Pulmonary Disease (COPD) (CC 108)	1.11 (1.07 - 1.15)	1.12 (1.08 - 1.16)	1.13 (1.09 - 1.17)	1.12 (1.09 - 1.14)
Other lung disorders (CC 115)	1.09 (1.05 - 1.13)	1.04 (1.00 - 1.08)	1.05 (1.02 - 1.09)	1.06 (1.04 - 1.08)
Dialysis status (CC 130)	1.13 (1.07 - 1.19)	1.13 (1.07 - 1.19)	1.14 (1.09 - 1.20)	1.13 (1.10 - 1.16)
Renal failure (CC 131)	1.15 (1.11 - 1.19)	1.18 (1.14 - 1.22)	1.18 (1.14 - 1.22)	1.17 (1.15 - 1.19)
Other urinary tract disorders (CC 136)	1.41 (1.28 - 1.55)	1.27 (1.16 - 1.40)	1.32 (1.20 - 1.45)	1.33 (1.26 - 1.41)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.05 (1.00 - 1.11)	1.06 (1.00 - 1.12)	1.05 (0.99 - 1.11)	1.05 (1.02 - 1.09)
Major symptoms, abnormalities (CC 166)	1.07 (1.04 - 1.11)	1.07 (1.03 - 1.11)	1.07 (1.04 - 1.11)	1.07 (1.05 - 1.10)

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Predictive ability, % (lowest decile – highest decile)	7.7 - 22.3	7.5 - 21.8	7.3 - 22.1	7.6 - 22.0
c-statistic	0.61	0.61	0.61	0.61

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

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,161	4,085	4,034	4,413
Mean number of admissions (SD)	40.9 (53.8)	41.2 (54.3)	42.0 (56.7)	115.0 (160.6)
Range (min. – max.)	1 - 495	1 - 481	1 - 558	1 - 1,448
25th percentile	5	5	5	11
50th percentile	18	18	18	43
75th percentile	57	59	59	161

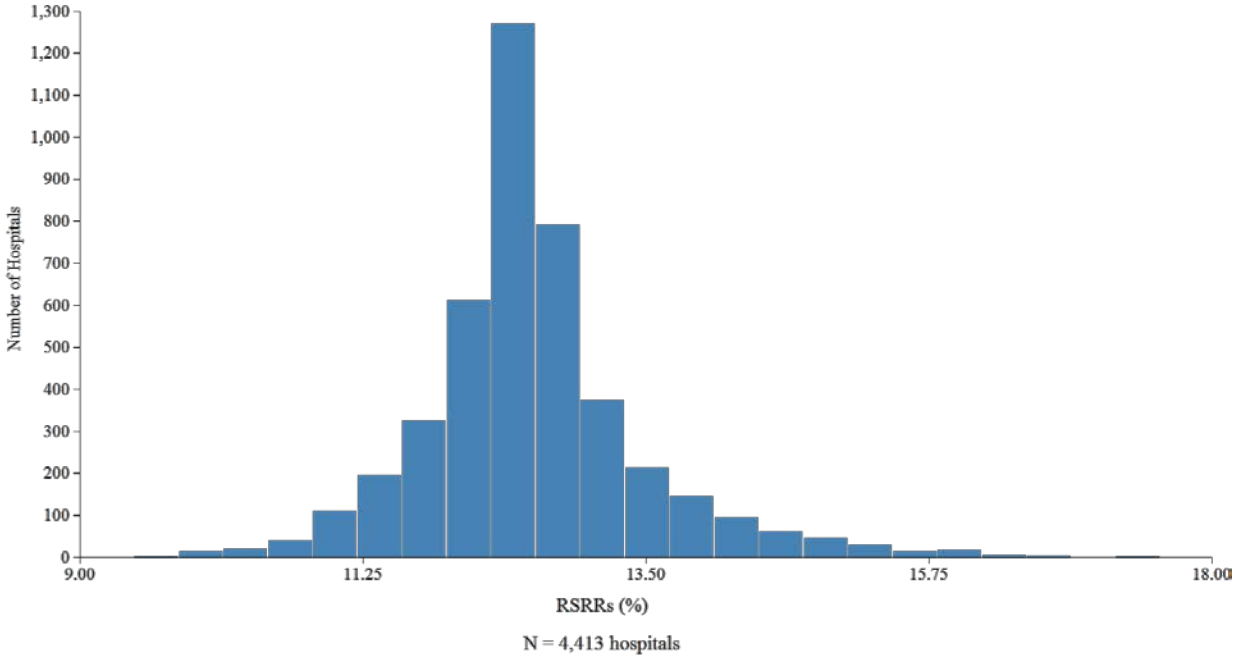
Table 4.6.6 – Distribution of Hospital Stroke RSRRs Over Different Time Periods

Characteristic	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Number of hospitals	4,161	4,085	4,034	4,413
Mean (SD)	12.9 (0.6)	12.3 (0.5)	12.4 (0.4)	12.5 (0.9)
Range (min. – max.)	10.2 - 16.5	10.5 - 16.0	10.5 - 15.0	9.1 - 17.7
25th percentile	12.6	12.1	12.2	12.1
50th percentile	12.9	12.2	12.3	12.5
75th percentile	13.1	12.5	12.5	12.8

Table 4.6.7 – Between-Hospital Variance for Stroke

	07/2012-06/2013	07/2013-06/2014	07/2014-06/2015	07/2012-06/2015
Between-hospital variance (SE)	0.027 (0.004)	0.026 (0.004)	0.021 (0.004)	0.030 (0.002)

Figure 4.6.2 – Distribution of Hospital 30-Day Stroke RSRRs Between July 2012 and June 2015



5. GLOSSARY

Case mix: The particular illness severity and age characteristics of patients with index admissions at a given hospital.

Clinical Classification Software (CCS): Software maintained by the AHRQ that groups thousands of individual procedure and diagnosis codes into clinically coherent, mutually exclusive procedure and diagnosis categories. CCS categories are used to determine if a readmission is planned. CCS procedure categories are used to define planned and potentially planned procedures. CCS diagnosis categories are used to define acute diagnoses and complications of care that are considered unplanned, as well as a few specific types of care that are always considered planned (for example, maintenance chemotherapy). Crosswalks which show the assignment of ICD codes to the CCS diagnosis and procedure categories are available on the AHRQ website.

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 values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the OR associated with protein-calorie malnutrition noted as "1.09 – 1.15" would indicate that there is 95% confidence that the OR lies between 1.09 and 1.15.

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 effect: A measure of the hospital quality of care that is calculated through hierarchical logistic regression, taking into consideration how many patients were eligible for the cohort, these patients' risk factors, and how many were readmitted. The hospital-specific effect is the calculated random effect intercept for each hospital. 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, COPD, HF, pneumonia, 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. 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 a short-term acute care hospital that is a scheduled part of the patient's plan of care. Planned readmissions are not considered in the outcomes of 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.

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 the outcomes of these measures.

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7. APPENDICES

Appendix A. Statistical Approach to RSRRs for AMI, COPD, HF, Pneumonia, 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 effect (that is, the average effect 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 effect. 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 effect. 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 effect.

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:

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

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

Where h(.) is a logit link, Y_{ij} is whether the j^{th} patient in the i^{th} hospital was readmitted (equal to 1 if readmitted within 30 days, zero otherwise); α_i represents the hospital-specific intercept, $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \ldots, Z_{pij})$ 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[25]. 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).

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Using the selected set of risk factors, we fit the hierarchical generalized linear model defined by Equations (1) – (2) and estimate the parameters, $\hat{\mu}$, $\{\hat{\alpha}_i, \hat{\alpha}_2, ..., \hat{\alpha}_I\}$, $\hat{\beta}$, 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

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

Expected $\hat{e}_{ij}(Z_{ij}) = h^{-1}(\hat{\mu} + \hat{\beta}\mathbf{Z}_{ij})$ (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 $RSRR_i$ 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 (for example, higher than expected, as expected, or lower than expected).

Creating Interval Estimates

Because the statistic described in Equation 5**,** that is, $\widehat{RSRR}_i$, 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)[26].

Appendix B. Data 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 pack 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 pack, 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 pack.

Figure B.1 – CORE QA Phase I

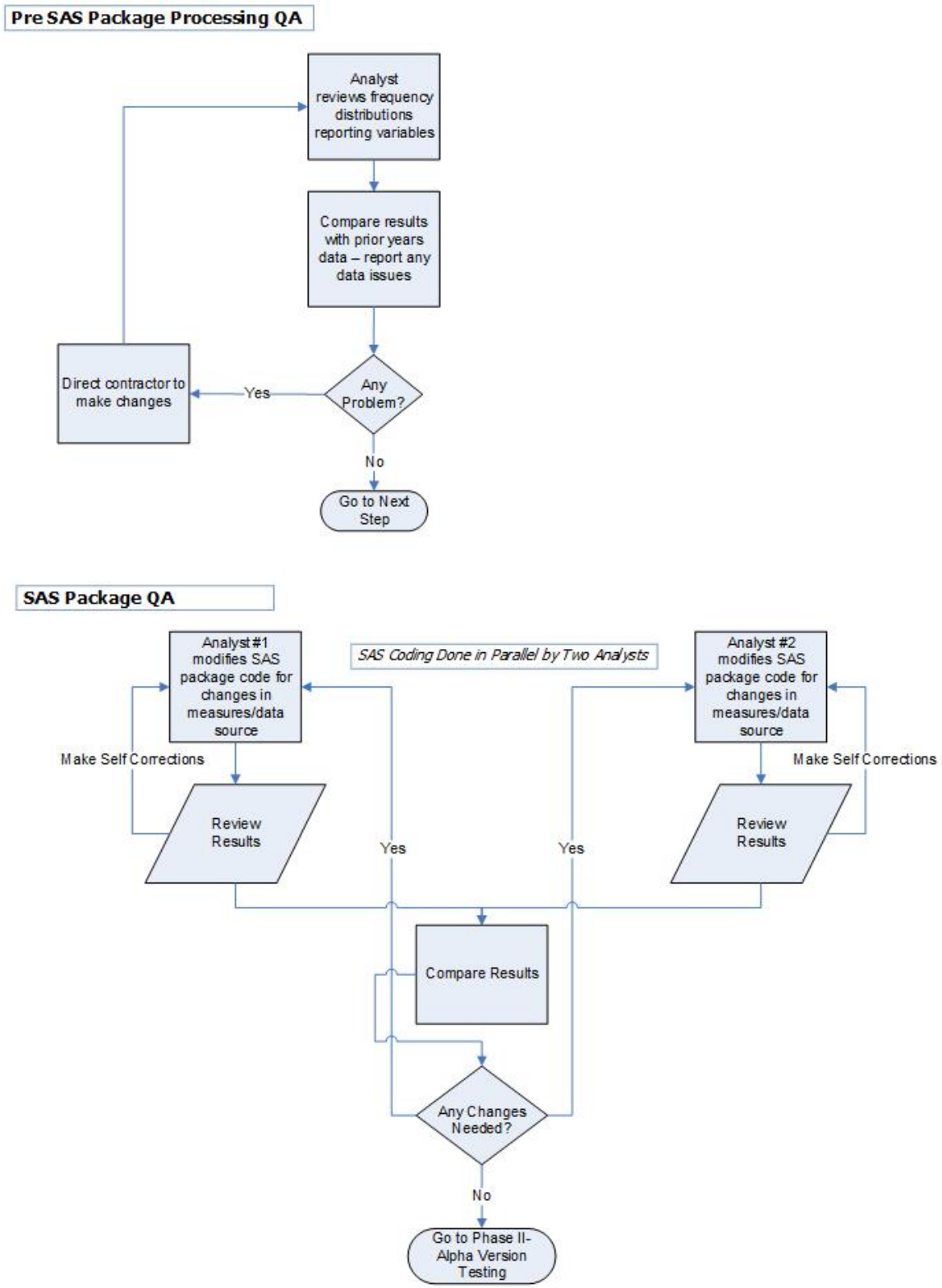
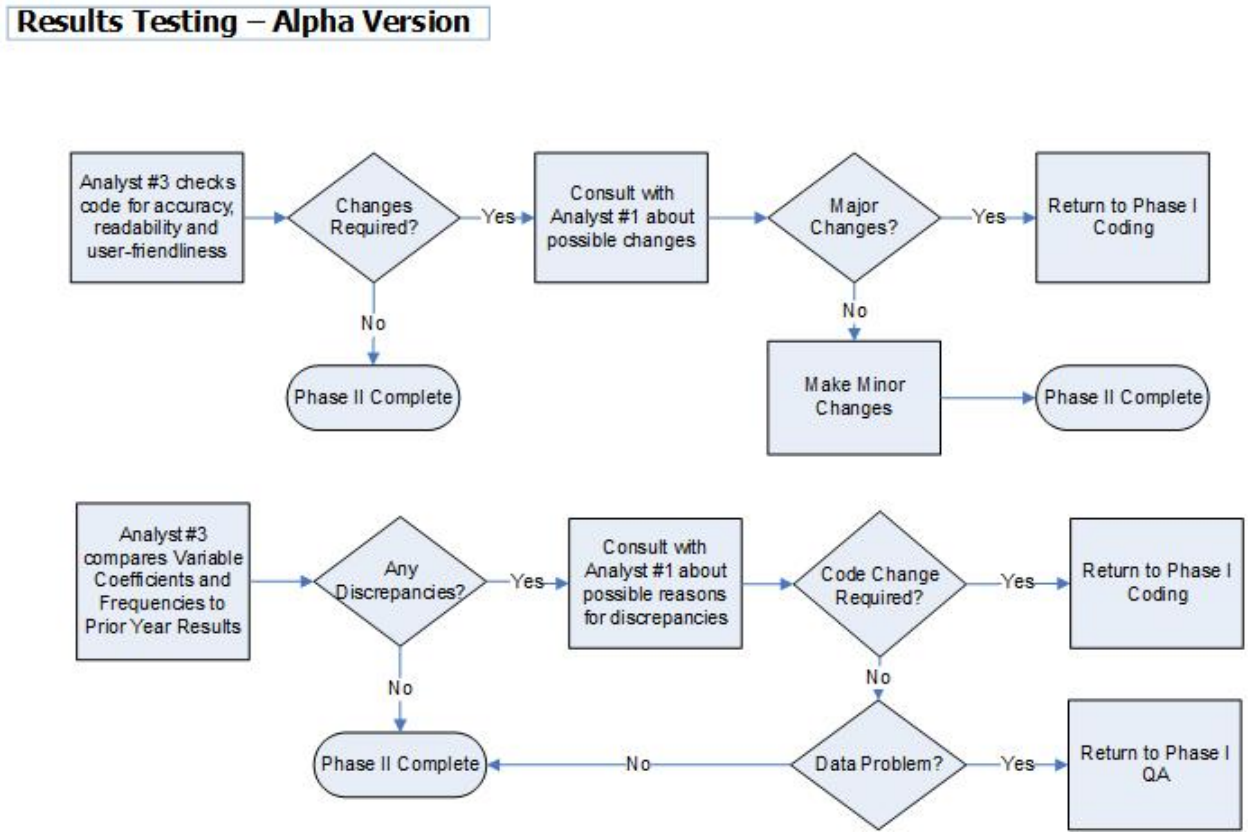


Figure B.2 – CORE QA Phase II



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.

2016

2016 Measures Updates and Specifications Report (Version 9.0 - AMI, HF, and Pneumonia) (Version 5.0 - COPD and Stroke)

1. Updated the pneumonia measure specifications:
    - ICD-9 cohort codes include aspiration pneumonia admissions as well as sepsis admissions (not including severe sepsis) that have a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA.
        - Rationale: This expansion of the cohort allows the measure to capture a broader population of patients admitted for pneumonia and a more consistent clinical cohort across hospitals. This update was made in response to changes in coding practice leading to more pneumonia patients being coded with a principal discharge diagnosis of sepsis, which led to bias in hospital comparisons.
    - Updated the risk variable list in concordance with the expanded cohort (CC 77 and CC 78 added).
        - Rationale: Presence of Respiratory dependence/tracheostomy status (CC 77) and presence of Respiratory arrest (CC 78) in the 12 months prior to the index admission had strong associations with readmission in the expanded pneumonia cohort and had high levels of face validity in terms of the clinical expectation that these conditions would be associated with worse outcomes if occurred during the 12-month timeframe.
2. Respecified the measures by updating to CMS planned readmission algorithm version 4.0.
    - Rationale: Version 4.0 incorporates improvements made following a validation study of the algorithm using data from a medical record review and input from clinical experts. These changes improve the accuracy of the algorithm by decreasing the number of readmissions that the algorithm mistakenly designates as planned/unplanned by removing five procedure categories and adding one procedure category.
3. Updated HF cohort to exclude patients with an LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission.
    - Rationale: The use of LVADs, in particular, has increased dramatically since the time of measure development. These patients represent a clinically distinct, highly-selected group.
4. Added one ischemic stroke code (436 Acute, but ill-defined, cerebrovascular disease).
    - Rationale: Although ICD-9 code 436 is not specific and could, in theory, include intracerebral hemorrhage, these codes are most commonly ischemic strokes coded as 436. This code may be used either because there is insufficient documentation to use a more specific code, or because some hospitals use older coding terminology to assign diagnoses of cerebrovascular accidents. Admissions coded with ICD-9 code 436 as the principal discharge diagnosis are appropriate inclusions for the stroke measure. Addition

of this code will allow for a more comprehensive cohort of true ischemic stroke patients, across all hospitals.

5. Applied the 2015 version of the AHRQ CCS to the planned readmission algorithm.
    - Rationale: A 2015 version of the AHRQ CCS was released.

2015

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

1. Applied updated AHRQ CCS version to the planned readmission algorithm.
    - Rationale: An updated version of the AHRQ CCS 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. Applied updated AHRQ CCS version to the planned readmission algorithm.
    - Rationale: An updated version of the AHRQ CCS 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 planned readmission algorithm handling of admissions to psychiatric and rehabilitation hospitals.
    - Rationale: Psychiatric and rehabilitation 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 Hospital-Level 30-Day RSRR Following AMI (NQF #0505)

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 Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure.
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 short-term acute care hospital**
   Rationale: It is only possible for patients to be readmitted if they are discharged alive.
5. **Not transferred to another acute care facility**
   Rationale: Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure's focus is on admissions that result in discharge to a non-acute care setting (for example, to home or a skilled nursing facility).

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.
4. **AMI admissions within 30 days of a prior AMI index admission**
   Rationale: Additional AMI admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.

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

ICD-9-CM Diagnosis 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
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

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
History of Percutaneous Transluminal Coronary Angioplasty (PTCA)	ICD-9 diagnosis code V45.82; ICD-9 procedure codes 00.66, 36.06, 36.07	
History of Coronary Artery Bypass Graft (CABG) surgery	ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10–36.16	
Anterior myocardial infarction	ICD-9 diagnosis codes 410.00-410.12	
Other location of myocardial infarction	ICD-9 diagnosis codes 410.20-410.62	
History of infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
	CC 6 Other infectious diseases	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Cancer	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Dementia and other specified brain disorders	CC 49 Dementia	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Congestive heart failure	CC 80 Congestive heart failure	X
Acute coronary syndrome	CC 81 Acute myocardial infarction	X
	CC 82 Other acute/subacute forms of ischemic heart disease	X
Angina pectoris/old myocardial infarction	CC 83 Angina pectoris/old myocardial infarction	
Coronary atherosclerosis/other chronic ischemic heart disease	CC 84 Coronary atherosclerosis/other chronic ischemic heart disease	
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Cerebrovascular disease	CC 97 Precerebral arterial occlusion and transient cerebral ischemia	X
	CC 98 Cerebral atherosclerosis and aneurysm	
	CC 99 Cerebrovascular disease, unspecified	
	CC 103 Cerebrovascular disease late effects, unspecified	
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Asthma	CC 110 Asthma	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	
Dialysis status	CC 130 Dialysis status	X

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Renal failure	CC 131 Renal failure	X
Other urinary tract disorders	CC 136 Other urinary tract disorders	
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	

Outcome

Outcome Criteria for AMI Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

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. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix D.2 Hospital-Level 30-Day RSRR Following COPD (NQF #1891)

Cohort

Inclusion Criteria for COPD Measure

1. **Principal discharge diagnosis of COPD or principal discharge diagnosis of respiratory failure with a secondary diagnosis of COPD with exacerbation**
   Rationale: COPD is the condition targeted for measurement. Respiratory failure admissions 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.2.1).
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.
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 short-term acute care hospital**
   Rationale: It is only possible for patients to be readmitted if they are discharged alive.
5. **Not transferred to another acute care facility**
   Rationale: Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure's focus is on admissions that result in discharge to a non-acute care setting (for example, to home or a skilled nursing facility).

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.
3. **COPD admissions within 30 days of a prior COPD index admission**
   Rationale: Additional COPD admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.

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

ICD-9-CM Diagnosis Codes	Description
491.21	Obstructive chronic bronchitis with (acute) exacerbation
491.22	Obstructive chronic bronchitis with acute bronchitis
491.8	Other chronic bronchitis

ICD-9-CM Diagnosis Codes	Description
491.9	Unspecified chronic bronchitis
492.8	Other emphysema
493.20	Chronic obstructive asthma, unspecified
493.21	Chronic obstructive asthma with status asthmaticus
493.22	Chronic obstructive asthma with (acute) exacerbation
496	Chronic airway obstruction, not elsewhere classified
Principal discharge diagnosis codes included in cohort if combined with a secondary diagnosis of COPD with exacerbation (491.21, 491.22, 493.21, or 493.22)	
518.81	Acute respiratory failure
518.82	Other pulmonary insufficiency, not elsewhere classified
518.84	Acute and chronic respiratory failure
799.1	Respiratory arrest

Risk Adjustment

Table D.2.2 – Risk Variables for COPD Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	n/a	
History of mechanical ventilation	ICD-9 procedure codes 93.90, 96.70, 96.71, 96.72	
Sleep apnea	ICD-9 diagnosis codes 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57	
History of infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
	CC 6 Other infectious diseases	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Lung, upper digestive tract, and other severe cancers	CC 8 Lung, upper digestive tract, and other severe cancers	
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
Other digestive and urinary neoplasms	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	
Pancreatic disease	CC 32 Pancreatic disease	
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders	CC 34 Peptic ulcer, hemorrhage, other specified gastrointestinal disorders	X
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Dementia and other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Drug/alcohol psychosis or dependence	CC 51 Drug/alcohol psychosis	
	CC 52 Drug/alcohol dependence	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Depression	CC 58 Depression	
Anxiety disorders	CC 59 Anxiety disorders	
Other psychiatric disorders	CC 60 Other psychiatric disorders	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Polyneuropathy	CC 71 Polyneuropathy	
Respirator dependence/respiratory failure	CC 77 Respirator dependence/tracheostomy status	X

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 78 Respiratory arrest	X
Cardio-respiratory failure and shock	CC 79 Cardio-respiratory failure and shock	X
Congestive heart failure	CC 80 Congestive heart failure	X
Acute coronary syndrome	CC 81 Acute myocardial infarction	X
	CC 82 Other acute/subacute forms of ischemic heart disease	X
Chronic atherosclerosis or angina	CC 83 Angina pectoris/old myocardial infarction	
	CC 84 Coronary atherosclerosis/other chronic ischemic heart disease	
Hypertensive heart and renal disease or encephalopathy	CC 89 Hypertensive heart and renal disease or encephalopathy	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Other or unspecified heart disease	CC 94 Other or unspecified heart disease	
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Fibrosis of lung or other chronic lung disorders	CC 109 Fibrosis of lung or other chronic lung disorders	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	
Renal failure	CC 131 Renal failure	X
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	
Cellulitis, local skin infection	CC 152 Cellulitis, local skin infection	X
Vertebral fractures	CC 157 Vertebral fractures	

Outcome

Outcome Criteria for COPD Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

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. From a

patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix D.3 Hospital-Level 30-Day RSRR Following HF (NQF #0330)

Cohort

Inclusion Criteria for HF Measure

1. **Principal discharge diagnosis of HF**
   Rationale: HF is the condition targeted for measurement (Table D.3.1).
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure.
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 short-term acute care hospital**
   Rationale: It is only possible for patients to be readmitted if they are discharged alive.
5. **Not transferred to another acute care facility**
   Rationale: Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure's focus is on admissions that result in discharge to a non-acute care setting (for example, to home or a skilled nursing facility).

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.
3. **HF admissions within 30 days of a prior HF index admission**
   Rationale: Additional HF admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.
4. **With a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission**
   Rationale: These patients represent a clinically distinct, highly-selected group (Table D.3.x).

Table D.3.1 – ICD-9-CM Codes for Inclusion in HF Cohort

ICD-9-CM Diagnosis 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
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

Table D.3.2 – ICD-9-CM LVAD and Heart Transplant Codes Which Exclude an Admission from HF Cohort

ICD-9-CM Procedure Codes	Description
33.6	Combined heart-lung transplantation
37.51	Heart transplantation
37.60	Implantation or insertion of biventricular external heart assist system
37.62	Insertion of temporary non-implantable extracorporeal circulatory assist device
37.65	Implant of single ventricular (extracorporeal) external heart assist system
37.66	Insertion of implantable heart assist system
37.68	Insertion of percutaneous external heart assist device

Risk Adjustment

Table D.3.3 – Risk Variables for HF Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
History of Coronary Artery Bypass Graft (CABG) surgery	ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10–36.16	
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Cancer	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Liver or biliary disease	CC 25 End-stage liver disease	
	CC 26 Cirrhosis of liver	
	CC 27 Chronic hepatitis	
	CC 28 Acute liver failure/disease	X
	CC 29 Other hepatitis and liver disease	
	CC 30 Gallbladder and biliary tract disorders	
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders	CC 34 Peptic ulcer, hemorrhage, other specified gastrointestinal disorders	X
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Dementia and other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Drug/alcohol psychosis or dependence	CC 51 Drug/alcohol psychosis	
	CC 52 Drug/alcohol dependence	
	CC 53 Drug/alcohol abuse, without dependence	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Depression	CC 58 Depression	
Other psychiatric disorders	CC 60 Other psychiatric disorders	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Cardio-respiratory failure and shock	CC 79 Cardio-respiratory failure and shock	X
Congestive heart failure	CC 80 Congestive heart failure	X
Acute coronary syndrome	CC 81 Acute myocardial infarction	X
	CC 82 Other acute/subacute forms of ischemic heart disease	X
Coronary atherosclerosis or angina	CC 83 Angina pectoris/old myocardial infarction	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 84 Coronary atherosclerosis/other chronic ischemic heart disease	
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Other or unspecified heart disease	CC 94 Other or unspecified heart disease	
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Fibrosis of lung or other chronic lung disorders	CC 109 Fibrosis of lung or other chronic lung disorders	
Asthma	CC 110 Asthma	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Nephritis	CC 132 Nephritis	X
Other urinary tract disorders	CC 136 Other urinary tract disorders	
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	

Outcome

Outcome Criteria for HF Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

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. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix D.4 Hospital-Level 30-Day RSRR Following Pneumonia (NQF #0506)

Cohort

Inclusion Criteria for Pneumonia Measure

1. **Principal discharge diagnosis of:**
   - **Pneumonia (including aspiration pneumonia); or,**
   - **Sepsis (not including severe sepsis) with a secondary diagnosis of pneumonia (including aspiration pneumonia) coded as POA and no secondary diagnosis of severe sepsis coded as POA**

   Rationale: Pneumonia is the condition targeted for measurement. Sepsis admissions with a secondary diagnosis of pneumonia, as described above, are also included in order for the measure to more fully reflect the population of Medicare FFS beneficiaries being treated for pneumonia (Table D.4.1).
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: Claims data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure that no Medicare Advantage patients are included in the measure.
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 short-term acute care hospital**
   Rationale: It is only possible for patients to be readmitted if they are discharged alive.
5. **Not transferred to another acute care facility**
   Rationale: Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure's focus is on admissions that result in discharge to a non-acute care setting (for example, to home or a skilled nursing facility).

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.
3. **Pneumonia admissions within 30 days of a prior pneumonia index admission**
   Rationale: Additional pneumonia admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.

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

ICD-9-CM Diagnosis 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 [Streptococcus pneumoniae pneumonia]
482.0	Pneumonia due to Klebsiella pneumoniae
482.1	Pneumonia due to Pseudomonas
482.2	Pneumonia due to Hemophilus influenzae [H. influenzae]
482.30	Pneumonia due to Streptococcus, unspecified
482.31	Pneumonia due to Streptococcus, group A
482.32	Pneumonia due to Streptococcus, group B
482.39	Pneumonia due to other Streptococcus
482.40	Pneumonia due to Staphylococcus, unspecified
482.41	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
507.0	Pneumonitis due to inhalation of food or vomitus
Principal discharge diagnosis codes included in cohort if combined with a secondary diagnosis of pneumonia coded as POA AND no secondary diagnosis of severe sepsis (995.92 Severe sepsis or 785.52 Septic shock) coded as POA is present	
038.0	Streptococcal septicemia
038.10	Staphylococcal septicemia, unspecified
038.11	Methicillin susceptible Staphylococcus aureus septicemia
038.12	Methicillin resistant Staphylococcus aureus septicemia

ICD-9-CM Diagnosis Codes	Description
038.19	Other staphylococcal septicemia
038.2	Pneumococcal septicemia [Streptococcus pneumoniae septicemia]
038.3	Septicemia due to anaerobes
038.40	Septicemia due to gram-negative organism, unspecified
038.41	Septicemia due to hemophilus Influenzae [H. influenzae]
038.42	Septicemia due to escherichia coli [E. coli]
038.43	Septicemia due to pseudomonas
038.44	Septicemia due to serratia
038.49	Other septicemia due to gram-negative organisms
038.8	Other specified septicemias
038.9	Unspecified septicemia
995.91	Sepsis

Risk Adjustment

Table D.4.2 – Risk Variables for Pneumonia Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
History of Coronary Artery Bypass Graft (CABG) surgery	ICD-9 diagnosis code V45.81; ICD-9 procedure codes 36.10–36.16	
History of infection	CC 1 HIV/AIDS	
	CC 3 Central nervous system infection	
	CC 4 Tuberculosis	
	CC 5 Opportunistic infections	
	CC 6 Other infectious diseases	X
Septicemia/shock	CC 2 Septicemia/shock	X
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Lung, upper digestive tract, and other severe cancers	CC 8 Lung, upper digestive tract, and other severe cancers	
Other major cancers	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Dementia and other specified brain disorders	CC 49 Dementia/cerebral degeneration	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Drug/alcohol psychosis or dependence	CC 51 Drug/alcohol psychosis	
	CC 52 Drug/alcohol dependence	
	CC 53 Drug/alcohol abuse, without dependence	
Major psychiatric disorders	CC 54 Schizophrenia	
	CC 55 Major depressive, bipolar, and paranoid disorders	
	CC 56 Reactive and unspecified psychosis	
Other psychiatric disorders	CC 60 Other psychiatric disorders	
Hemiplegia, paraplegia, paralysis, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Respirator dependence/tracheostomy status	CC 77 Respirator dependence/tracheostomy status	X
Cardio-respiratory failure and shock; respiratory arrest	CC 78 Respiratory arrest	X
	CC 79 Cardio-respiratory failure and shock	X
Congestive heart failure	CC 80 Congestive heart failure	X
Acute coronary syndrome	CC 81 Acute myocardial infarction	X
	CC 82 Other acute/subacute forms of ischemic heart disease	X
Chronic atherosclerosis or angina	CC 83 Angina pectoris/old myocardial infarction	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 84 Coronary atherosclerosis/other chronic ischemic heart disease	
Valvular or rheumatic heart disease	CC 86 Valvular or rheumatic heart disease	
Specified arrhythmias and other heart rhythm disorders	CC 92 Specified arrhythmias	X
	CC 93 Other heart rhythm and conduction disorders	X
Stroke	CC 95 Cerebral hemorrhage	X
	CC 96 Ischemic or unspecified stroke	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Fibrosis of lung or other chronic lung disorders	CC 109 Fibrosis of lung or other chronic lung disorders	
Asthma	CC 110 Asthma	
Pneumonia	CC 111 Aspiration and specified bacterial pneumonias	X
	CC 112 Pneumococcal pneumonia, emphysema, lung abscess	X
	CC 113 Viral and unspecified pneumonia, pleurisy	
Pleural effusion/pneumothorax	CC 114 Pleural effusion/pneumothorax	X
Other lung disorders	CC 115 Other lung disorders	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Urinary tract infection	CC 135 Urinary tract infection	X
Other urinary tract disorders	CC 136 Other urinary tract disorders	
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X
	CC 149 Chronic ulcer of skin, except decubitus	
Vertebral fractures	CC 157 Vertebral fractures	
Other injuries	CC 162 Other injuries	

Outcome

Outcome Criteria for Pneumonia Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.

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. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to

the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix D.5 Hospital-Level 30-Day RSRR Following Ischemic 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). Hemorrhagic strokes are not included in the cohort. Ischemic strokes are the most common type of stroke, accounting for the vast majority of stroke hospitalizations. Additionally, the causes, prognosis, and treatment of ischemic stroke are quite different than those of hemorrhagic stroke. Combining ischemic and hemorrhagic stroke patients could make it more difficult to account for a hospital's patient case mix.
2. **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission, and enrolled in Part A during the index admission**
   Rationale: Currently claims-data are consistently available only for Medicare FFS beneficiaries. The 12-month prior enrollment criterion ensures that patients were Medicare FFS beneficiaries and that their comorbidities are captured from claims for risk adjustment. Medicare Part A is required at the time of admission to ensure no Medicare Advantage patients are included in the measure.
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 short-term acute care hospital**
   Rationale: It is only possible for patients to be readmitted if they are discharged alive.
5. **Not transferred to another acute care facility**
   Rationale: Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure's focus is on admissions that result in discharge to a non-acute care setting (for example, to home or a skilled nursing facility).

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.
3. **Stroke admissions within 30 days of a prior stroke index admission**
   Rationale: Additional stroke admissions within 30 days are excluded as index admissions because they are part of the outcome. A single admission does not count as both an index admission and a readmission for another index admission.

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

ICD-9-CM Diagnosis 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
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
436	Acute, but ill-defined, cerebrovascular disease

Risk Adjustment

Table D.5.2 – Risk Variables for Stroke Measure

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
Age minus 65 (years above 65, continuous)	n/a	
Male	n/a	
Metastatic cancer or acute leukemia	CC 7 Metastatic cancer or acute leukemia	
Cancer	CC 8 Lung, upper digestive tract, and other severe cancers	
	CC 9 Lymphatic, head and neck, brain, and other major cancers	
	CC 10 Breast, prostate, colorectal and other cancers and tumors	
	CC 11 Other respiratory and heart neoplasms	
	CC 12 Other digestive and urinary neoplasms	
Diabetes mellitus (DM) or DM complications	CC 15 Diabetes with renal manifestation	
	CC 16 Diabetes with neurologic or peripheral circulatory manifestation	
	CC 17 Diabetes with acute complications	X
	CC 18 Diabetes with ophthalmologic manifestation	
	CC 19 Diabetes with no or unspecified complications	
	CC 119 Proliferative diabetic retinopathy and vitreous hemorrhage	

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 120 Diabetic and other vascular retinopathies	
Protein-calorie malnutrition	CC 21 Protein-calorie malnutrition	
Disorders of fluid/electrolyte/acid-base	CC 22 Other significant endocrine and metabolic disorders	
	CC 23 Disorders of fluid/electrolyte/acid-base balance	X
Other endocrine/metabolic/nutritional disorders	CC 24 Other endocrine/metabolic/nutritional disorders	
Other gastrointestinal disorders	CC 36 Other gastrointestinal disorders	
Severe hematological disorders	CC 44 Severe hematological disorders	
Iron deficiency or other unspecified anemias and blood disease	CC 47 Iron deficiency or other unspecified anemias and blood disease	
Dementia and other specified brain disorders	CC 49 Dementia	
	CC 50 Senility, nonpsychotic organic brain syndromes/conditions	
Quadriplegia, paraplegia, functional disability	CC 67 Quadriplegia, other extensive paralysis	
	CC 68 Paraplegia	
	CC 69 Spinal cord disorders/injuries	
	CC 177 Amputation status, lower limb/amputation complications	X
	CC 178 Amputation status, upper limb	X
Seizure disorders and convulsions	CC 74 Seizure disorders and convulsions	
Congestive heart failure	CC 80 Congestive heart failure	X
Hypertensive heart disease	CC 90 Hypertensive heart disease	
Cerebral hemorrhage	CC 95 Cerebral hemorrhage	X
Ischemic or unspecified stroke	CC 96 Ischemic or unspecified stroke	X
Precerebral arterial occlusion and transient cerebral ischemia	CC 97 Precerebral arterial occlusion and transient cerebral ischemia	X
Hemiplegia, paralysis, functional disability	CC 100 Hemiplegia/hemiparesis	X
	CC 101 Diplegia (upper), monoplegia, and other paralytic syndromes	X
	CC 102 Speech, language, cognitive, perceptual deficits	X
Vascular or circulatory disease	CC 104 Vascular disease with complications	X
	CC 105 Vascular disease	X
	CC 106 Other circulatory disease	X
Chronic Obstructive Pulmonary Disease (COPD)	CC 108 Chronic Obstructive Pulmonary Disease (COPD)	
Other lung disorders	CC 115 Other lung disorders	
Dialysis status	CC 130 Dialysis status	X
Renal failure	CC 131 Renal failure	X
Other urinary tract disorders	CC 136 Other urinary tract disorders	
Decubitus ulcer or chronic skin ulcer	CC 148 Decubitus ulcer of skin	X

Description	Variable	Variables Not Used in Risk Adjustment if Occurred Only During Index Admission (indicated by "X")
	CC 149 Chronic ulcer of skin, except decubitus	
Major symptoms, abnormalities	CC 166 Major symptoms, abnormalities	

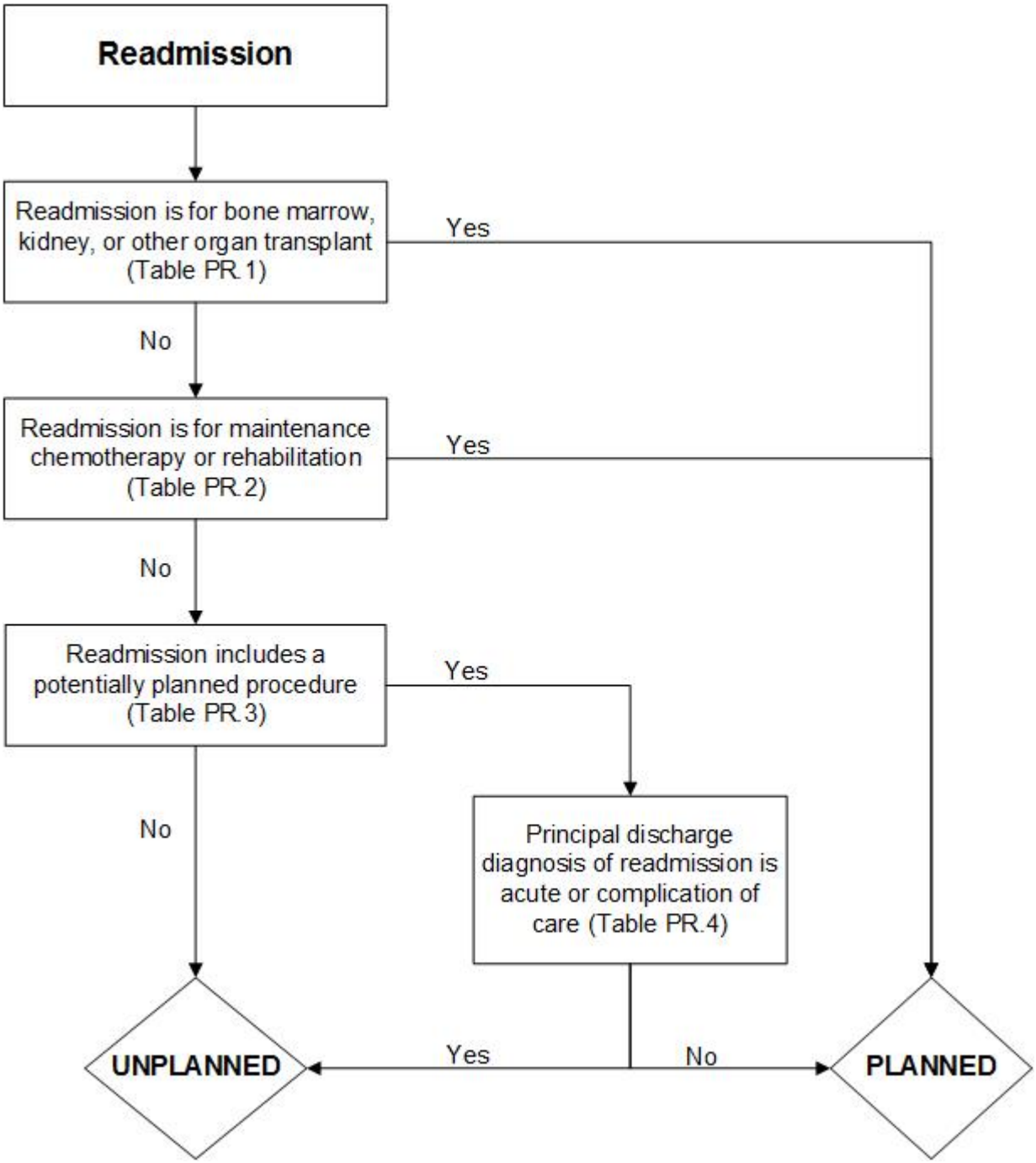
Outcome

Outcome Criteria for Stroke Measure

Unplanned readmission, from any cause, within 30 days from the date of discharge from an index admission.
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. From a patient perspective, an unplanned readmission from any cause is an adverse event. Outcomes occurring within 30 days of discharge can be influenced by hospital care and the early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce readmissions.

Appendix E. Planned Readmission Algorithm

Figure PR.1 – Planned Readmission Algorithm Version 4.0 Flowchart



Planned Readmission Algorithm Version 4.0 Tables – AMI, COPD, HF, Pneumonia, and Stroke Measures

Table PR.1 – Procedure Categories That are Always Planned (Version 4.0)

AHRQ CCS Procedure	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 4.0)

AHRQ CCS Diagnosis	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 4.0)

AHRQ CCS Procedure	Description
1	Incision and excision of CNS
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)
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
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
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal

AHRQ CCS Procedure	Description
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
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
170	Excision of skin lesion
172	Skin graft
ICD-9 Procedure Codes	**Description**
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from AHRQ CCS Procedure category 42- Other OR Rx procedures on respiratory system and mediastinum)
38.18	Endarterectomy leg vessel (from AHRQ CCS Procedure category 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from AHRQ CCS Procedure category 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from AHRQ CCS Procedure category 218- Psychological and psychiatric evaluation and therapy)

Table PR.4 – Acute Diagnosis Categories (Version 4.0)

AHRQ CCS Diagnosis	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 diagnosis 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

AHRQ CCS Diagnosis	Description
125	Acute bronchitis
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

AHRQ CCS Diagnosis	Description
243	Poisoning by nonmedicinal substances
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 Diagnosis Codes	**Description**
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 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

AHRQ CCS Diagnosis	Description
130.3	Myocarditis due to toxoplasmosis
391.0	Acute rheumatic pericarditis
391.1	Acute rheumatic endocarditis
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 diagnosis codes within AHRQ CCS Diagnosis category 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

AHRQ CCS Diagnosis	Description
426.54	Trifascicular block
426.6	Other heart block
426.7	Anomalous atrioventricular excitation
426.81	Lown-Ganong-Levine syndrome
426.82	Long QT syndrome
426.9	Conduction disorder, unspecified
Acute ICD-9 diagnosis codes within AHRQ CCS Diagnosis category 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 diagnosis codes within AHRQ CCS Diagnosis category 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 diagnosis codes within AHRQ CCS Diagnosis category 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 diagnosis codes within AHRQ CCS Diagnosis category 152: Pancreatic disorders	
577.0	Acute pancreatitis