

2024 Condition-Specific Readmission Measures Updates and Specifications Report

Acute Myocardial Infarction — Version 17.0
Chronic Obstructive Pulmonary Disease — Version 13.0
Heart Failure — Version 17.0
Pneumonia — Version 17.0

Submitted By:

Yale New Haven Health Services Corporation — Center for Outcomes Research and Evaluation
(YNHHSC/CORE)

Prepared For:

Centers for Medicare & Medicaid Services (CMS)

April 2024

Table of Contents

List of Tables	4
List of Figures.....	5
1. HOW TO USE THIS REPORT	7
2. BACKGROUND AND OVERVIEW OF MEASURE METHODOLOGY	9
2.1. Background on Readmission Measures	9
2.2. Overview of Measure Methodology	9
2.2.1 Cohort	9
2.2.2 Outcome	12
2.2.3 Planned Readmission Algorithm (Version 4.0 2024)	13
2.2.4 Risk-Adjustment Variables	14
2.2.5 Data Sources	15
2.2.6 Measure Calculation	16
2.2.7 Categorizing Hospital Performance	17
3. UPDATES TO MEASURES FOR 2024 PUBLIC REPORTING	18
3.1. Rationale for Measure Updates	18
3.2. Detailed Discussion of Measure Updates	18
3.2.1 Annual Updates to ICD-10 Code-Based Measure Specifications	18
3.2.2 COVID-19	20
3.2.3 Additional Notes	21
3.3. Changes to SAS Packs	21
4. RESULTS FOR 2024 PUBLIC REPORTING	22
4.1. Assessment of Updated Models	22
4.2. AMI Readmission 2024 Model Results	23
4.2.1 Index Cohort Exclusions	23
4.2.2 Frequency of AMI Model Variables	24
4.2.3 AMI Model Parameters and Performance	25
4.2.4 Distribution of Hospital Volumes and Readmission Rates for AMI	28
4.2.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset	30
4.3. COPD Readmission 2024 Model Results	31
4.3.1 Index Cohort Exclusions	31
4.3.2 Frequency of COPD Model Variables	32
4.3.3 COPD Model Parameters and Performance	33
4.3.4 Distribution of Hospital Volumes and Readmission Rates for COPD	37
4.3.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset	38
4.4. HF Readmission 2024 Model Results	40
4.4.1 Index Cohort Exclusions	40
4.4.2 Frequency of HF Model Variables	41
4.4.3 HF Model Parameters and Performance	42
4.4.4 Distribution of Hospital Volumes and Readmission Rates for HF	45
4.4.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset	47

4.5. Pneumonia Readmission 2024 Model Results.....	48
4.5.1 Index Cohort Exclusions.....	48
4.5.2 Frequency of Pneumonia Model Variables.....	49
4.5.3 Pneumonia Model Parameters and Performance	50
4.5.4 Distribution of Hospital Volumes and Readmission Rates for Pneumonia.....	54
4.5.5 Distribution of Hospitals by Performance Category in the Three-Year Dataset.....	56
5. GLOSSARY	57
6. REFERENCES	60
7. APPENDICES	62
Appendix A. Statistical Approach for AMI, COPD, HF, and Pneumonia Measures.....	62
Hierarchical Generalized Linear Model.....	62
Risk-Standardized Measure Score Calculation	62
Creating Interval Estimates	63
Bootstrapping Algorithm	63
Appendix B. Data QA	65
Phase I	65
Phase II	65
Phase III	65
Appendix C. Annual Updates	66
Appendix D. Measure Specifications	76
Appendix D.1 Hospital-Level 30-Day RSRR following AMI (CBE #0505)	76
Appendix D.2 Hospital-Level 30-Day RSRR following COPD (CBE #1891).....	78
Appendix D.3 Hospital-Level 30-Day RSRR following HF (CBE #0330).....	80
Appendix D.4 Hospital-Level 30-Day RSRR following Pneumonia (CBE #0506).....	82
Appendix E. Planned Readmission Algorithm	84

List of Tables

Table 4.2.2.1 — Frequency of AMI Model Variables over Different Time Periods.....	24
Table 4.2.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for AMI over Different Time Periods	25
Table 4.2.3.2 — Adjusted OR and 95% CIs for the AMI Hierarchical Logistic Regression Model over Different Time Periods	26
Table 4.2.3.3 — AMI Logistic Regression Model Performance over Different Time Periods	28
Table 4.2.4.1 — Distribution of Hospital AMI Admission Volumes over Different Time Periods.....	28
Table 4.2.4.2 — Distribution of Hospital AMI RSRRs over Different Time Periods.....	28
Table 4.2.4.3 — Between-Hospital Variance for AMI over Different Time Periods	29
Table 4.3.2.1 — Frequency of COPD Model Variables over Different Time Periods	32
Table 4.3.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for COPD over Different Time Periods	33
Table 4.3.3.2 — Adjusted OR and 95% CIs for the COPD Hierarchical Logistic Regression Model over Different Time Periods	35
Table 4.3.3.3 — COPD Logistic Regression Model Performance over Different Time Periods.....	37
Table 4.3.4.1 — Distribution of Hospital COPD Admission Volumes over Different Time Periods	37
Table 4.3.4.2 — Distribution of Hospital COPD RSRRs over Different Time Periods	37
Table 4.3.4.3 — Between-Hospital Variance for COPD over Different Time Periods.....	38
Table 4.4.2.1 — Frequency of HF Model Variables over Different Time Periods	41
Table 4.4.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for HF over Different Time Periods	42
Table 4.4.3.2 — Adjusted OR and 95% CIs for the HF Hierarchical Logistic Regression Model over Different Time Periods.....	43
Table 4.4.3.3 — HF Logistic Regression Model Performance over Different Time Periods	45
Table 4.4.4.1 — Distribution of Hospital HF Admission Volumes over Different Time Periods	46
Table 4.4.4.2 — Distribution of Hospital HF RSRRs over Different Time Periods	46
Table 4.4.4.3 — Between-Hospital Variance for HF over Different Time Periods.....	46
Table 4.5.2.1 — Frequency of Pneumonia Model Variables over Different Time Periods.....	49
Table 4.5.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for Pneumonia over Different Time Periods	50
Table 4.5.3.2 — Adjusted OR and 95% CIs for the Pneumonia Hierarchical Logistic Regression Model over Different Time Periods	52
Table 4.5.3.3 — Pneumonia Logistic Regression Model Performance over Different Time Periods	54
Table 4.5.4.1 — Distribution of Hospital Pneumonia Admission Volumes over Different Time Periods ...	54
Table 4.5.4.2 — Distribution of Hospital Pneumonia RSRRs over Different Time Periods.....	54
Table 4.5.4.3 — Between-Hospital Variance for Pneumonia over Different Time Periods.....	55

List of Figures

Figure 2.2.6.1 — Equation for RSRR Calculation	16
Figure 4.2.1.1 — AMI Cohort Exclusions in the July 2020 – June 2023 Dataset	23
Figure 4.2.4.1 — Distribution of Hospital 30-Day AMI RSRRs between July 2020 and June 2023	30
Figure 4.3.1.1 — COPD Cohort Exclusions in the July 2020 – June 2023 Dataset	31
Figure 4.3.4.1 — Distribution of Hospital 30-Day COPD RSRRs between July 2020 and June 2023	38
Figure 4.4.1.1 — HF Cohort Exclusions in the July 2020 – June 2023 Dataset	40
Figure 4.4.4.1 — Distribution of Hospital 30-Day HF RSRRs between July 2020 and June 2023	47
Figure 4.5.1.1 — Pneumonia Cohort Exclusions in the July 2020 – June 2023 Dataset	48
Figure 4.5.4.1 — Distribution of Hospital 30-Day Pneumonia RSRRs between July 2020 and June 2023	56

Center for Outcomes Research and Evaluation Project Team

Jo DeBuhr, R.N., B.S.N. — Technical Writer, Annual Updates Team Lead

Jacqueline N. Grady, M.S. — Division Director

Alana Lamasney Formoso, B.S. — Project Manager

Madeline L. Parisi, B.A. — Annual Updates Team Lead

Shelby Brewer, M.S. — Research Project Coordinator

Wanda Johnson, R.N., B.S. — Health Outcomes Researcher

Huihui Yu, Ph.D.* — Measure Lead Analyst

Rose Hu, M.S. — Measure Lead Analyst

Lisa G. Suter, M.D.* — Senior Director

Measure Reevaluation Team Contributors

Smitha Vellanky, M.Sc. — Content Expert for ICD-10, Division Lead

Ruihan Qin, M.S.* — Measure Analyst

Chien-Yu Huang, Ph.D.* — Measure Analyst

* Yale School of Medicine

Acknowledgements

This work is a collaborative effort, and the authors gratefully acknowledge the Veterans Health Administration (VHA); Bellese Technologies; Sharon-Lise Normand from Harvard Medical School, Department of Health Care Policy and Harvard School of Public Health, Department of Biostatistics; Jinghong Gao from YNNHSC/CORE; and Raquel Myers, Vinitha Meyyur, Melissa Hager, Ngozi Uzokwe, Julia Venanzi, and John Green at CMS for their contributions to this work.

1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) condition-specific readmission measures that are publicly reported [here](#) on Medicare.gov. The measures are used to calculate hospital-level 30-day risk-standardized readmission rates (RSRRs) following acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia admissions. This report serves as a single source of information about these measures for a wide range of readers. Reports describing other [outcome](#) measures can be found [here](#) on *QualityNet*.

Specifications that define [cohort](#) inclusions and exclusions, [risk-adjustment variables](#), and the planned readmission algorithm described in this report are detailed in the following supplemental files:

- 2024 AMI Readmission Measure Code Specifications
- 2024 COPD Readmission Measure Code Specifications
- 2024 HF Readmission Measure Code Specifications
- 2024 Pneumonia Readmission Measure Code Specifications

These supplemental files are posted [here](#) on *QualityNet*.

This report includes:

- **[Section 2](#) — An overview of the AMI, COPD, HF, and pneumonia readmission measures:**
 - Background
 - Cohort inclusions and exclusions
 - Included and excluded hospitalizations
 - How transferred patients are handled
 - Unplanned readmission outcome
 - Risk-adjustment variables
 - Data sources
 - Readmission rate calculation
 - Categorization of hospitals' performance scores
- **[Section 3](#) — 2024 measure updates**
- **[Section 4](#) — 2024 measure results**
- **[Section 5](#) — Glossary**

The appendices include:

- [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](#): Cohort inclusion/exclusion criteria and outcome criteria
- [Appendix E](#): Overview of the planned readmission algorithm

The original measure methodology reports and prior updates and specifications reports are available in the “Methodology” section and “Archived Measure Methodology” section (under “Resources”) on the readmission measures page [here](#) on *QualityNet*.

The AMI, HF, and pneumonia readmission measure methodologies are also described in the peer-reviewed medical literature.¹⁻⁷

For a list of the supporting resource files for the 2024 readmission measures that are available on *QualityNet* (including hyperlinks to the resources), or to review the 2024 Frequently Asked Questions document, refer to the “Resources” section on the readmission measures page [here](#) on *QualityNet*.

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 on the readmission measures page [here](#) on *QualityNet*.

If you have questions about the information in this report or the complementary supplemental files, please submit your inquiry using the QualityNet Q&A tool:

https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program: Inpatient Claims-Based Measures > Readmission > Understanding Measure Methodology. **Do NOT submit patient-identifiable information (for example, date of birth, Social Security number, Medicare Beneficiary Identifier, and encounter dates such as admission dates, discharge dates, procedure dates, and emergency department [ED]/observation dates) into this tool.**

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 Service hospitals) and critical access hospitals (CAHs). In 2011, CMS and the VHA collaborated to update the readmission measures to include AMI, HF, and pneumonia admissions in Veterans Administration (VA) hospitals. VA data were not included in the 2016 and 2017 results, but were reinstituted in 2018.

In 2014, CMS began publicly reporting the hospital 30-day COPD readmission measure for the nation's non-federal short-term acute care hospitals (including Indian Health Service hospitals) and CAHs. In 2020, CMS and the VHA collaborated to include COPD admissions in VA hospitals as well.

Results for all four of these readmission measures are posted and updated annually here on Medicare.gov.

CMS contracted with the Yale New Haven Health Services Corporation — Center for Outcomes Research and Evaluation (YNHHSC/CORE) to update the AMI, COPD, HF, and pneumonia readmission measures for 2024 public reporting through a process of measure reevaluation.

2.2. Overview of Measure Methodology

The 2024 risk-adjusted readmission measures use specifications from the original measure methodology reports posted here on *QualityNet*, with refinements to the measures as listed in Appendix C and described in the prior measures updates and specifications reports posted here on *QualityNet*. An overview of the methodology is presented in this section.

For more information on the CMS programs that use these measures for fiscal year (FY) 2025, as well as their use in future FYs, please refer to the FY 2024 Inpatient Prospective Payment System (IPPS) Final Rule posted here on the CMS website.

2.2.1 Cohort

Index Admissions Included in the Measures

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

- having a principal discharge diagnosis of AMI, COPD, HF, or pneumonia for each respective measure;
 - The COPD measure cohort also includes admissions with a principal discharge diagnosis of acute respiratory failure and a secondary diagnosis of COPD with exacerbation.

- The pneumonia measure cohort also includes admissions that meet ALL of the following criteria:
 - A principal discharge diagnosis of sepsis (that is not severe)
 - A secondary diagnosis of pneumonia coded as present on admission (POA)
 - No secondary diagnosis of sepsis that is both severe and coded as POA
- enrolled in Medicare Fee-For-Service (FFS) Part A and Part B for the 12 months prior to the date of the admission and Part A during the index admission (not applicable to VA hospitalizations);
- aged 65 or over;
- discharged alive from a non-federal short-term acute care hospital or VA hospital; and
- not transferred to another acute care facility.

The International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes used to define the cohort inclusions for each measure are listed in the 2024 supplemental files posted [here](#) on *QualityNet*.

Index Admissions Excluded from the Measures

The readmission measures exclude index admissions for patients:

- without at least 30 days of post-discharge enrollment in Medicare FFS (not applicable to VA hospitalizations);
- discharged against medical advice; or
- with a principal diagnosis code of COVID-19 (ICD-10-CM code U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim. These code specifications are outlined in the 2024 supplemental files [here](#) on *QualityNet*. [Of note, patients with a COVID-19 principal diagnosis code are inherently not included in these measures, by definition.]

Note that patients who do not have a full 30 days of post-discharge enrollment in Medicare FFS due to death are eligible for inclusion in the cohorts. Thus, if a patient had an unplanned readmission and later died, all within 30 days of discharge from the index admission, the case would be captured in the outcome, assuming they met inclusion/exclusion criteria.

An additional exclusion criterion for the AMI cohort is that patients admitted and discharged from a hospital on the same calendar day are excluded as index admissions because it is unlikely that these patients had clinically significant AMIs.

Additionally, for the HF cohort, patients with an International Classification of Diseases, Tenth Revision (ICD-10) code indicating left ventricular assist device (LVAD) implantation or heart transplantation either during the index admission or up to 12 months prior to the index admission are excluded as index admissions because these patients represent a clinically distinct group. Claims/VA data from January 1, 2020 through June 30, 2020 hospitalizations were not used due to the declared COVID-19 public health emergency (PHE), as discussed in [Section 3.2.2](#); as a result, the pre-index admission time frame would be less than 12 months for some patients, depending on their index admission

date. The ICD-10 codes used to identify LVAD and heart transplant cases in claims are provided in the 2024 HF Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.

Admissions for a condition within 30 days of discharge from an index admission for that same condition 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 for non-VA hospitalizations include removing claims with stays longer than one year, claims with overlapping dates, claims for patients not listed in the Medicare Enrollment Database, and records with ineligible provider IDs.

The percentage of admissions excluded based on each criterion is shown in [Section 4](#) in [Figure 4.2.1.1](#), [Figure 4.3.1.1](#), [Figure 4.4.1.1](#), and [Figure 4.5.1.1](#), for AMI, COPD, HF, and pneumonia, respectively.

Patients Transferred between Hospitals

The measures consider multiple hospitalizations that result from hospital-to-hospital transfers as a single acute episode of care. Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. To qualify as a transfer, the second inpatient admission must occur on the same day or the next calendar day following discharge from the first inpatient admission at a different short-term acute care hospital. Cases that meet this criterion are considered transfers regardless of whether the first institution indicates intent to transfer the patient in the discharge disposition code or whether the second inpatient admission is for the same condition.

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 series of transfers is eligible for inclusion in the cohort. The previous admissions are not included. For example, if a patient is admitted to Hospital A, transferred to Hospital B, and then discharged from Hospital B to a non-acute care setting, only the Hospital B admission would be included in the cohort, and an unplanned readmission within 30 days of discharge from the Hospital B admission would be captured in Hospital B's readmission outcome.

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's perspective, an unplanned readmission for any cause is an adverse event. In addition, making inferences about quality of care 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 that 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** calendar 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). This methodology is employed to assist hospitals who might bill two separate claims in such cases, instead of adjusting the original claim and combining both the original and subsequent stay onto a single claim, as directed by Medicare. In effect, this added step prevents the second stay from being captured as a readmission (if unplanned). If the condition is **different** from the index admission, this is considered a readmission in the measure, if unplanned. For complete details on the same hospital/day/condition methodology used by the measures, please refer to the SAS analytic packages (SAS packs). Guidance on how to request SAS packs is provided in [Section 3.3](#).

Readmissions with a principal diagnosis code of COVID-19 (U07.1) **or** with a secondary diagnosis code of COVID-19 coded as POA on the readmission claim are not eligible for the readmission outcome and are excluded. These code specifications are outlined in the 2024 supplemental files [here](#) on *QualityNet*.

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.⁸ 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.⁸⁻¹⁴

In determining whether an unplanned readmission occurred within 30 days of discharge from the index admission, the measures use the claim "FROM" date, which is the date

the subsequent admission episode started (that is, the date the patient first received care at that hospital within three days of the admission). Thus, in the case where (a) a patient began an unplanned readmission with an ED visit, observation stay, or care received in another outpatient location within the same facility (for example, outpatient diagnostic imaging), (b) the patient was admitted as an inpatient to that hospital within three days of that outpatient encounter, and (c) the care was combined into one claim, the date the outpatient care started would be used for the 30-day time frame.

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 regarding 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.

In the case where one of the multiple readmissions is a COVID-19 readmission (as described above and defined in the 2024 supplemental files [here](#) on *QualityNet*), the first readmission continues to drive the readmission outcome. If the first readmission is coded with COVID-19, any subsequent unplanned readmission is not considered in the outcome, and the readmission outcome is “no.” However, if the first readmission is not coded with COVID-19, it is considered an eligible readmission, regardless of whether a COVID-19 readmission follows, and the readmission outcome would be “yes” (if unplanned).

2.2.3 Planned Readmission Algorithm (Version 4.0 2024)

The planned readmission algorithm is a set of criteria for classifying readmissions as planned using Medicare claims and VA administrative 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:

- A few specific, limited types of care are always considered planned (transplant surgery, maintenance chemotherapy/immunotherapy, rehabilitation).
- A planned readmission is defined as a non-acute readmission for a scheduled procedure.
- 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 the condition-specific measures, teams of clinical and measure experts reviewed the algorithm to confirm it was appropriate for each measure's cohort.

The planned readmission algorithm uses a flowchart and four tables of specific Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Clinical Classification Software (CCS) procedure categories, AHRQ CCS diagnosis categories, and singular ICD-10 codes to classify readmissions as planned. As illustrated in Figure E.1 in Appendix E, readmissions are considered planned if ANY of the following occurs during readmission:

- A procedure is performed that is in one of the procedure categories that are always planned regardless of diagnosis.
- The principal diagnosis is in one of the diagnosis categories that are always planned.
- A procedure is performed that is one of the defined potentially planned procedures and the principal diagnosis is not in the list of defined acute discharge diagnoses.

The diagnoses and procedures referred to above can be found in Tables PR.1 through PR.4 in the 2024 supplemental files posted here on *QualityNet*.

Note that CCS mappings to ICD-10-CM and International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-PCS) codes are available here on *QualityNet*.

2.2.4 Risk-Adjustment Variables

To account for differences in case mix among hospitals, the measures include an adjustment for factors such as age, comorbid diseases, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome. For each patient, risk-adjustment variables are obtained from inpatient, outpatient, and physician Medicare administrative claims data extending up to 12 months prior to the index admission, and all claims data for the index admission itself. Risk-adjustment variables are also obtained from VA administrative data in the case of VA beneficiaries. Inpatient, outpatient, and physician claims/VA data from January 1, 2020 through June 30, 2020 encounters are not used due to the declared COVID-19 PHE (as discussed in Section 3.2.2); as a result, the pre-index admission time frame would be less than 12 months for some patients, depending on their index admission date.

The measures' adjustment for case mix differences among hospitals is based on the clinical status of the patient at the time of the index admission. Accordingly, only comorbidities that convey information about the patient at the time of the index admission, or any time within the preceding 12 months (or less), are included in risk adjustment. Complications that arise during the course of the hospitalization are not used in risk adjustment.

The process for determining patient comorbidities present at the time of the index admission from the index admission claim/VA data uses a POA algorithm. In brief, a

secondary diagnosis ICD-10-CM code on the index admission is used in risk adjustment if **one** of the following is true:

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

The POA algorithm applies only in the case of secondary diagnosis codes on the index admission that are assigned to a CC used in risk adjustment of a measure. ICD-10 code-defined risk variables, such as 'Sleep-disordered breathing' (used in the COPD readmission measure), do not use the algorithm.

Refer to the 2024 supplemental files posted [here](#) on *QualityNet* for the list of CC-defined risk-adjustment variables and the specifications for the ICD-10 code-defined risk-adjustment variables. The lists of potential complications referred to in Step 3 of the algorithm are also included in the 2024 supplemental files.

CC mappings to ICD-10-CM codes, as well as the "POA-Exempt Codes Considered Always POA for 2024" table (referred to in Step 2 of the algorithm), are available [here](#) on *QualityNet*.

The measures do not include an adjustment for social drivers of health because the association between social drivers of health and health outcomes can be due, in part, to differences in the quality of health care that these groups of patients receive. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important quality differences. The CMS consensus-based entity (CBE) re-endorsed the measures without adjustment for patient-level social drivers of health in the last endorsement maintenance submission prior to 2024.

2.2.5 Data Sources

The data sources for these analyses are Medicare administrative claims, VA administrative data, and enrollment information for patients having hospitalizations with discharge dates between July 1, 2020 and June 30, 2023. The datasets also contain associated inpatient, outpatient, and physician Medicare administrative claims and associated inpatient and outpatient VA administrative data from up to 12 months prior to the index admission (as discussed in [Section 2.2.4](#)) as well as inpatient Medicare and VA administrative data for the 30-day period after discharge from the index admission, for patients having hospitalizations with discharge dates in the aforementioned time period. Refer to the original methodology reports posted [here](#) on *QualityNet* for further descriptions of these data sources and an explanation of the three-year measurement period.

2.2.6 Measure Calculation

The hospital-level 30-day all-cause RSRR for each measure is estimated using a hierarchical logistic regression model. 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.¹⁵ 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.¹⁵ 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, as illustrated in Figure 2.2.6.1.

Figure 2.2.6.1 — Equation for RSRR Calculation

$$\text{RSRR} = \frac{\text{Predicted Readmissions}}{\text{Expected Readmissions}} \times \text{National Observed Readmission Rate}$$

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; 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 4.2.3.1, Table 4.3.3.1, Table 4.4.3.1, and Table 4.5.3.1, for the AMI, COPD, HF, and pneumonia 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 transformed using the inverse-link-function and summed over all patients attributed to a hospital to calculate a predicted value. The “expected” number of readmissions (the denominator) is obtained in the same manner, except that a common effect using all hospitals in our sample is added in place of the hospital-specific effect. These results are also transformed using the inverse-link-function and summed over all patients attributed to a hospital to calculate an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that time period.

Multiplying the predicted over expected ratio by the national observed readmission rate transforms the ratio into a rate that can be compared to the national observed readmission rate. The hierarchical logistic regression models are described fully in [Appendix A](#) and in the original methodology reports posted [here](#) on *QualityNet*.

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:

- “Better than the National Rate” if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed readmission rate
- “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

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 conclude how 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.

The distribution of hospitals by performance category in the U.S. for this reporting period is described in [Section 4.2.5](#), [Section 4.3.5](#), [Section 4.4.5](#), and [Section 4.5.5](#), for AMI, COPD, HF, and pneumonia, respectively.

3. UPDATES TO MEASURES FOR 2024 PUBLIC REPORTING

3.1. Rationale for Measure Updates

Annual 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. Modifications made to measure cohorts, risk models, and outcomes are informed by review of the most recent literature related to measure conditions or outcomes, feedback from various stakeholders, empirical analyses, and assessment of coding trends that reveal shifts in clinical practice or billing patterns. Input is solicited from a workgroup composed of up to 20 clinical and measure experts, inclusive of internal and external consultants and subcontractors. As this report describes, for 2024 public reporting, we made the following modifications to the measures:

- Updated the ICD-10 code-based specifications used in the measures. Specifically, we:
 - incorporated ICD-10-CM/PCS code changes into the cohort definitions and risk models that occurred in the following releases:
 - October 1, 2022 (FY 2023); and
 - April 1, 2023.
 - applied a YNHHS/CORE-modified v4.0 of the AHRQ HCUP's beta version 2019.1 CCS for ICD-10-CM/PCS to the planned readmission algorithm.
 - applied a modified version of the FY 2023 V24 CMS-Hierarchical Condition Category (HCC) crosswalk that is maintained by RTI International to the risk models.

As a part of annual reevaluation, we also undertook the following activities:

- Monitored code frequencies to identify any warranted specification changes due to possible changes in coding practices and patterns;
- Reviewed potentially clinically relevant codes that “neighbor” existing codes used in the measures to identify any warranted specification changes;
- Reviewed select pre-existing ICD-10 code-based specifications with our workgroup to confirm the appropriateness of specifications unaffected by the updates;
- Updated the measures' SAS packs and documentation;
- Evaluated and validated model performance for the three years combined (July 2020 – June 2023); and
- Evaluated the stability of the risk-adjustment models over the three-year measurement period by examining the model variable frequencies, model coefficients, and the performance of the models in each year (July 2020 – June 2021, July 2021 – June 2022, and July 2022 – June 2023).

3.2. Detailed Discussion of Measure Updates

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

Cohort Definitions

We examined the code sets from the two ICD-10-CM/PCS releases outlined above, with particular attention to newly added codes. We then solicited input from our workgroup

to determine which, if any, of the newly implemented ICD-10 codes in the code sets should be added to the cohort definitions. We reviewed approximately 1,218 new ICD-10-CM codes and 365 new ICD-10-PCS codes. These code totals reflect new code additions since 2023 public reporting.

No changes were made as a result of these processes and the surveillance and workgroup processes described above in the Rationale for Measure Updates section.

Readmission Outcome and the Planned Readmission Algorithm

In September 2019 and December 2020, the AHRQ HCUP released new versions of the CCS for ICD-10-CM and ICD-10-PCS codes, respectively, called the CCS Refined (CCSR). The magnitude of changes from the CCS beta versions to the CCSR is extensive. Until comprehensive testing can be completed on the CCSR, we will continue utilizing the existing beta version v2019.1 of the CCS for ICD-10-CM/PCS as the basis for the planned readmission algorithm specifications, updating it as appropriate with clinical expert input.

For 2024 public reporting, we examined the new ICD-10-CM and ICD-10-PCS codes in the two code set releases to determine the most appropriate CCS categorizations for the newly implemented ICD-10 codes, using the existing YNNHSC/CORE-modified v3.0 of the AHRQ HCUP's beta version 2019.1 CCS for ICD-10-CM/PCS that was utilized in 2023 public reporting. We then solicited input from our workgroup to confirm the clinical appropriateness of the CCS categorizations of the newly implemented ICD-10 codes in relation to the planned readmission algorithm, and whether any changes were warranted. Updates to the CCS mappings included the incorporation of the new ICD-10-CM codes and ICD-10-PCS codes into approximately 49 AHRQ CCS diagnosis categories and 31 AHRQ CCS procedure categories, respectively. Additionally, two ICD-10-PCS codes were remapped from one CCS procedure category to another.

The workgroup also reviewed the newly implemented ICD-10 codes in the two ICD-10-CM/PCS code set releases to determine which, if any, should be added to the singular ICD-10 code lists that are also used in the algorithm (conditions that are not captured by AHRQ CCS categories). The intent was to maintain the clinical integrity of the algorithm.

These processes, in addition to the surveillance and workgroup processes described above, led to the following changes:

- Potentially planned procedures:
 - added one ICD-10-PCS code (associated with AHRQ CCS procedure category 49) to the singular ICD-10-PCS code list
- Acute diagnoses:
 - added ICD-10-CM codes (associated with AHRQ CCS diagnosis categories 97, 101, 106, 115, 233, 238, 244, and 662) to the singular ICD-10-CM code lists

The YNNHSC/CORE-modified mappings that were used for 2024 public reporting are posted [here](#) on *QualityNet*. They show the assignment of ICD-10 codes to the AHRQ CCS diagnosis and procedure categories, and detail the changes made for 2024 public reporting.

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

Risk Adjustment

We reviewed RTI International's FY 2023 modified version of the V24 CMS-HCC crosswalk, examining how the newly implemented ICD-10 codes in the FY 2023 ICD-10-CM/PCS code set releases were classified and where there may be codes that RTI International reclassified from one HCC to another when they updated to the FY 2023 version. We then solicited input from our workgroup to confirm the clinical appropriateness of the HCC classifications of the newly implemented ICD-10 codes and any changes warranted due to code shifts. CC to ICD-10-CM code crosswalks were updated based on these processes, in addition to the surveillance and workgroup processes described above. The 2024 crosswalk files are available [here](#) on *QualityNet*.

The workgroup also reviewed the newly implemented ICD-10 codes in the two ICD-10-CM/PCS code set releases to determine which, if any, should be added to the singular ICD-10 code lists that are also used in risk adjustment (conditions that are not captured by CCs). This process, in addition to the surveillance and workgroup processes described above, led to the following change:

- added three ICD-10-PCS codes to the code list used to define the 'History of mechanical ventilation' risk-adjustment variable [This change only applies to the COPD readmission measure. For more details, refer to the 2024 COPD Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.]

Additionally, we reviewed the 1,218 new codes in the two ICD-10-CM releases and the changes made by CMS to the POA-exempt code list for FY 2023, to determine updates to the "POA-Exempt Codes Considered Always POA" table for 2024, as part of the risk-adjustment methodology used by the measures (discussed in [Section 2.2.4](#)). The resulting changes are detailed in the table posted [here](#) on *QualityNet*.

3.2.2 COVID-19

The following modifications made to the measures in prior public reporting years in response to the COVID-19 PHE will continue for 2024 public reporting:

- Claims data for January 1, 2020 through June 30, 2020 are excluded from use in the measures under CMS's Extraordinary Circumstances Exception (ECE) policy.¹⁶⁻¹⁹ As a result, the typical 12-month look-back period for use of claims/VA data in risk adjustment and in identifying patients with an ICD-10 code indicating LVAD implantation or heart transplantation prior to the index admission (an exclusion for the HF readmission measure cohort) totals less than 12 months for those patients whose 12-month period includes any portion of the January 1, 2020 through June 30, 2020 time frame.
- A 'History of COVID-19' risk variable is incorporated into the risk-adjustment models for the measures.

- COVID-19 index admissions are excluded from the cohorts. COVID-19 index admissions are defined by a principal diagnosis code of COVID-19 **or** a secondary diagnosis code of COVID-19 coded as POA on the index admission claim.
- COVID-19 readmissions are not eligible for the readmission outcome and are excluded. COVID-19 readmissions are defined by a principal diagnosis code of COVID-19 **or** a secondary diagnosis code of COVID-19 coded as POA on the readmission claim.

A brief summary of how COVID-19 is addressed in each measure, including code specifications, can be found in the 2024 supplemental files [here](#) on *QualityNet*.

3.2.3 Additional Notes

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

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

- 2024 AMI Readmission Measure Code Specifications
- 2024 COPD Readmission Measure Code Specifications
- 2024 HF Readmission Measure Code Specifications
- 2024 Pneumonia Readmission Measure Code Specifications

These supplemental files are posted [here](#) on *QualityNet*.

The ICD-10 code listings in this report and the 2024 supplemental files reflect the most current descriptions for each code.

3.3. Changes to SAS Packs

We revised the measure SAS packs to accommodate the specification updates discussed in [Section 3.1](#) and [Section 3.2](#) above. The new SAS packs and documentation are available upon request. Please submit your request using the QualityNet Q&A tool:

https://cmsqualitysupport.servicenowservices.com/qnet_qa?id=ask_a_question > Program: Inpatient Claims-Based Measures > Readmission > Understanding Measure Methodology. **Do NOT submit patient-identifiable information (for example, date of birth, Social Security number, Medicare Beneficiary Identifier, and encounter dates such as admission dates, discharge dates, procedure dates, and ED/observation dates) into this tool.**

The SAS packs include descriptions of the data files and data elements that feed the model software. Please be aware that CMS does not provide training or technical support for the software. CMS has made the SAS packs available to be completely transparent regarding the measure calculation methodology. However, note that even with the SAS packs, it is not possible to replicate the RSRR calculation without the data files, which contain the longitudinal patient data from the entire national sample of acute care hospitals that is used to estimate the individual hospital-specific effects, the average hospital-specific effect, and the risk-adjustment coefficients used in the equations.

4. RESULTS FOR 2024 PUBLIC REPORTING

4.1. Assessment of Updated Models

The hospital-level 30-day all-cause RSRRs for the measures are estimated using hierarchical logistic regression models. Refer to [Section 2](#) for a summary of the measure methodology and model risk-adjustment variables. Refer to prior methodology and updates and specifications reports on the readmission measures page [here](#) on *QualityNet* for further details.

We evaluated the performance of the models using the July 2020 to June 2023 data for the 2024 reporting period. We examined the differences in the frequencies of patient risk factors and the model parameter coefficients.

For each of the 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 curve ([c-statistic](#)). We also computed between-hospital variance for each year of data and for the three-year combined period. If there were no systematic differences between hospitals, the between-hospital variance would be zero.

The results of these analyses for each of the measures (AMI, COPD, HF, and pneumonia) are presented in [Section 4.2](#), [Section 4.3](#), [Section 4.4](#), and [Section 4.5](#).

Please note that, due to seasonal fluctuations and other factors, the statistics from one individual year within these sections may not be directly comparable to the other two years.

4.2. AMI Readmission 2024 Model Results

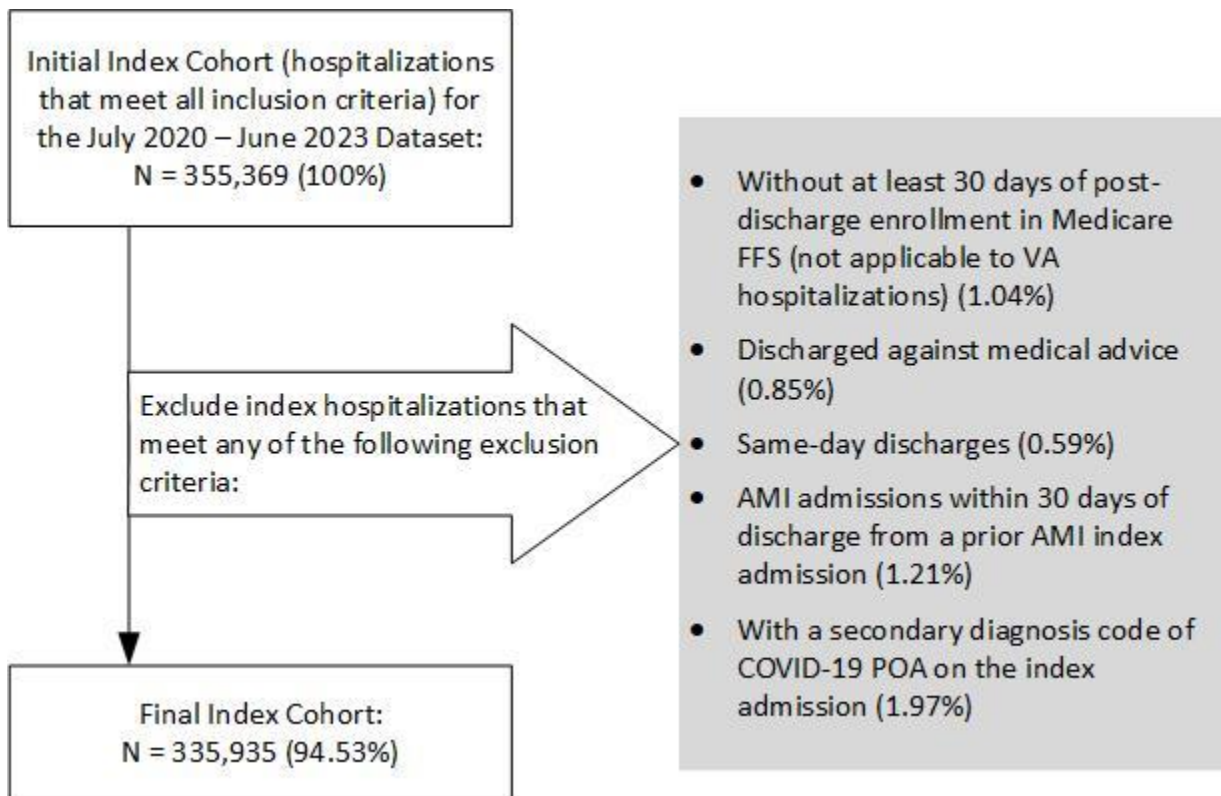
4.2.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of AMI admissions that met each exclusion criterion in the July 2020 – June 2023 dataset is presented in [Figure 4.2.1.1](#).

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 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 Part A during the index admission (not applicable to VA hospitalizations);
- who were not transferred to another acute care facility; and
- were alive at discharge.

Figure 4.2.1.1 — AMI Cohort Exclusions in the July 2020 – June 2023 Dataset



4.2.2 Frequency of AMI Model Variables

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

Refer to [Table 4.2.2.1](#) for more detail.

Table 4.2.2.1 — Frequency of AMI Model Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Total N	118,845	110,899	106,191	335,935
Mean age (SD)	77.3 (7.9)	77.5 (7.9)	77.5 (7.8)	77.4 (7.9)
Male	57.5	57.6	57.2	57.4
History of COVID-19	4.0	10.2	17.4	10.3
Anterior myocardial infarction	7.6	7.6	7.4	7.5
Non-anterior location of myocardial infarction	14.4	14.4	14.1	14.3
History of coronary artery bypass graft (CABG) surgery	15.6	15.4	14.8	15.3
History of percutaneous transluminal coronary angioplasty (PTCA)	25.2	26.5	26.5	26.0
Severe infection; other infectious diseases (CC 1, 3 – 7)	19.1	23.6	24.2	22.2
Metastatic cancer and acute leukemia (CC 8)	2.2	2.6	2.5	2.4
Cancer (CC 9 – 14)	16.5	20.3	20.7	19.1
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	46.6	47.5	47.2	47.1
Protein-calorie malnutrition (CC 21)	5.4	6.0	6.4	5.9
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	34.8	38.2	39.3	37.3
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	36.4	40.3	41.2	39.2
Dementia or other specified brain disorders (CC 51 – 53)	13.9	15.3	15.3	14.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	5.3	6.1	6.0	5.8
Congestive heart failure (CC 85)	48.3	49.9	50.5	49.5
Acute coronary syndrome (CC 86 – 87)	30.1	32.7	32.5	31.7
Angina pectoris (CC 88)	18.8	21.2	21.5	20.4
Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	79.6	80.2	80.4	80.0
Valvular and rheumatic heart disease (CC 91)	27.9	31.8	33.1	30.9
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	49.5	52.3	53.2	51.6
Stroke (CC 99 – 100)	4.8	6.2	6.3	5.7
Cerebrovascular disease (CC 101 – 102, 105)	15.9	19.6	19.8	18.4
Vascular or circulatory disease (CC 106 – 109)	36.2	41.0	41.1	39.3
Chronic obstructive pulmonary disease (COPD) (CC 111)	22.7	23.1	22.8	22.9
Asthma (CC 113)	6.8	7.9	8.2	7.6

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Pneumonia (CC 114 – 116)	13.2	15.4	15.9	14.8
Dialysis status (CC 134)	4.2	3.9	3.8	3.9
Renal failure (CC 135 – 140)	44.1	45.2	45.1	44.8
Other urinary tract disorders (CC 145)	11.5	15.1	15.0	13.8
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	5.6	6.8	6.8	6.4

4.2.3 AMI Model Parameters and Performance

Table 4.2.3.1 shows hierarchical logistic regression model parameter coefficients by individual year and for the combined three-year dataset.

Table 4.2.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for AMI over Different Time Periods

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Intercept	-2.840	-2.985	-2.971	-2.916
Years over 65 (continuous)	0.008	0.009	0.007	0.008
Male	-0.125	-0.133	-0.109	-0.124
History of COVID-19	-0.102	-0.004	-0.042	-0.059
Anterior myocardial infarction	0.270	0.269	0.239	0.262
Non-anterior location of myocardial infarction	0.064	0.071	0.074	0.068
History of coronary artery bypass graft (CABG) surgery	0.007	0.005	0.043	0.019
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.017	-0.014	-0.033	-0.022
Severe infection; other infectious diseases (CC 1, 3 – 7)	0.088	0.087	0.075	0.077
Metastatic cancer and acute leukemia (CC 8)	0.248	0.220	0.230	0.234
Cancer (CC 9 – 14)	0.037	0.055	0.049	0.042
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.213	0.205	0.124	0.181
Protein-calorie malnutrition (CC 21)	0.126	0.132	0.174	0.143
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	0.225	0.190	0.153	0.189
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.197	0.226	0.251	0.221
Dementia or other specified brain disorders (CC 51 – 53)	0.000	0.018	0.023	0.013
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.198	0.091	0.155	0.149
Congestive heart failure (CC 85)	0.342	0.325	0.351	0.340
Acute coronary syndrome (CC 86 – 87)	-0.004	0.048	0.039	0.027
Angina pectoris (CC 88)	0.027	0.044	0.018	0.027

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	0.074	0.068	0.160	0.100
Valvular and rheumatic heart disease (CC 91)	0.074	0.108	0.105	0.094
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.111	0.154	0.118	0.127
Stroke (CC 99 – 100)	0.028	0.066	0.020	0.033
Cerebrovascular disease (CC 101 – 102, 105)	0.057	0.052	0.053	0.051
Vascular or circulatory disease (CC 106 – 109)	0.108	0.069	0.121	0.098
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.239	0.222	0.197	0.221
Asthma (CC 113)	-0.024	0.058	-0.020	0.004
Pneumonia (CC 114 – 116)	0.206	0.160	0.146	0.168
Dialysis status (CC 134)	0.224	0.263	0.248	0.249
Renal failure (CC 135 – 140)	0.252	0.254	0.258	0.257
Other urinary tract disorders (CC 145)	0.104	0.053	0.076	0.072
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.145	0.120	0.097	0.119

Table 4.2.3.2 shows the risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the AMI readmission model by individual year and for the combined three-year dataset.

Table 4.2.3.2 — Adjusted OR and 95% CIs for the AMI Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Years over 65 (continuous)	1.01 (1.01 – 1.01)	1.01 (1.01 – 1.01)	1.01 (1.00 – 1.01)	1.01 (1.01 – 1.01)
Male	0.88 (0.85 – 0.91)	0.88 (0.84 – 0.91)	0.90 (0.86 – 0.93)	0.88 (0.86 – 0.90)
History of COVID-19	0.90 (0.83 – 0.98)	1.00 (0.94 – 1.05)	0.96 (0.92 – 1.00)	0.94 (0.91 – 0.97)
Anterior myocardial infarction	1.31 (1.23 – 1.40)	1.31 (1.22 – 1.40)	1.27 (1.18 – 1.36)	1.30 (1.25 – 1.35)
Non-anterior location of myocardial infarction	1.07 (1.01 – 1.12)	1.07 (1.02 – 1.13)	1.08 (1.02 – 1.14)	1.07 (1.04 – 1.10)
History of coronary artery bypass graft (CABG) surgery	1.01 (0.96 – 1.05)	1.00 (0.96 – 1.06)	1.04 (0.99 – 1.10)	1.02 (0.99 – 1.05)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.98 (0.94 – 1.02)	0.99 (0.94 – 1.03)	0.97 (0.93 – 1.01)	0.98 (0.96 – 1.00)
Severe infection; other infectious diseases (CC 1, 3 – 7)	1.09 (1.05 – 1.14)	1.09 (1.05 – 1.14)	1.08 (1.03 – 1.12)	1.08 (1.05 – 1.11)
Metastatic cancer and acute leukemia (CC 8)	1.28 (1.15 – 1.42)	1.25 (1.12 – 1.38)	1.26 (1.13 – 1.40)	1.26 (1.19 – 1.34)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Cancer (CC 9 – 14)	1.04 (0.99 – 1.09)	1.06 (1.01 – 1.11)	1.05 (1.00 – 1.10)	1.04 (1.02 – 1.07)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.24 (1.19 – 1.28)	1.23 (1.18 – 1.28)	1.13 (1.09 – 1.18)	1.20 (1.17 – 1.22)
Protein-calorie malnutrition (CC 21)	1.13 (1.06 – 1.21)	1.14 (1.07 – 1.22)	1.19 (1.12 – 1.27)	1.15 (1.11 – 1.20)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	1.25 (1.20 – 1.30)	1.21 (1.16 – 1.26)	1.17 (1.12 – 1.21)	1.21 (1.18 – 1.24)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.22 (1.17 – 1.27)	1.25 (1.20 – 1.31)	1.29 (1.23 – 1.34)	1.25 (1.22 – 1.28)
Dementia or other specified brain disorders (CC 51 – 53)	1.00 (0.95 – 1.05)	1.02 (0.97 – 1.07)	1.02 (0.97 – 1.07)	1.01 (0.98 – 1.04)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.22 (1.14 – 1.31)	1.10 (1.02 – 1.17)	1.17 (1.09 – 1.25)	1.16 (1.12 – 1.21)
Congestive heart failure (CC 85)	1.41 (1.35 – 1.46)	1.38 (1.33 – 1.44)	1.42 (1.36 – 1.48)	1.41 (1.37 – 1.44)
Acute coronary syndrome (CC 86 – 87)	1.00 (0.96 – 1.03)	1.05 (1.01 – 1.09)	1.04 (1.00 – 1.08)	1.03 (1.00 – 1.05)
Angina pectoris (CC 88)	1.03 (0.98 – 1.07)	1.04 (1.00 – 1.09)	1.02 (0.97 – 1.07)	1.03 (1.00 – 1.05)
Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	1.08 (1.03 – 1.13)	1.07 (1.02 – 1.13)	1.17 (1.11 – 1.24)	1.11 (1.07 – 1.14)
Valvular and rheumatic heart disease (CC 91)	1.08 (1.04 – 1.12)	1.11 (1.07 – 1.16)	1.11 (1.07 – 1.15)	1.10 (1.07 – 1.12)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.12 (1.08 – 1.16)	1.17 (1.12 – 1.21)	1.13 (1.08 – 1.17)	1.14 (1.11 – 1.16)
Stroke (CC 99 – 100)	1.03 (0.95 – 1.11)	1.07 (0.99 – 1.15)	1.02 (0.95 – 1.10)	1.03 (0.99 – 1.08)
Cerebrovascular disease (CC 101 – 102, 105)	1.06 (1.01 – 1.11)	1.05 (1.01 – 1.10)	1.05 (1.01 – 1.10)	1.05 (1.02 – 1.08)
Vascular or circulatory disease (CC 106 – 109)	1.11 (1.07 – 1.16)	1.07 (1.03 – 1.11)	1.13 (1.08 – 1.17)	1.10 (1.08 – 1.13)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.27 (1.22 – 1.32)	1.25 (1.20 – 1.30)	1.22 (1.17 – 1.27)	1.25 (1.22 – 1.28)
Asthma (CC 113)	0.98 (0.91 – 1.04)	1.06 (1.00 – 1.13)	0.98 (0.92 – 1.05)	1.00 (0.97 – 1.04)
Pneumonia (CC 114 – 116)	1.23 (1.17 – 1.29)	1.17 (1.12 – 1.23)	1.16 (1.10 – 1.21)	1.18 (1.15 – 1.21)
Dialysis status (CC 134)	1.25 (1.16 – 1.34)	1.30 (1.20 – 1.40)	1.28 (1.18 – 1.39)	1.28 (1.23 – 1.34)
Renal failure (CC 135 – 140)	1.29 (1.24 – 1.34)	1.29 (1.24 – 1.34)	1.29 (1.24 – 1.35)	1.29 (1.26 – 1.32)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Other urinary tract disorders (CC 145)	1.11 (1.06 – 1.16)	1.05 (1.01 – 1.11)	1.08 (1.03 – 1.13)	1.07 (1.05 – 1.10)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.16 (1.08 – 1.23)	1.13 (1.06 – 1.20)	1.10 (1.03 – 1.18)	1.13 (1.09 – 1.17)

Overall, model performance was stable over the three-year time period (Table 4.2.3.3).

Table 4.2.3.3 — AMI Logistic Regression Model Performance over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Predictive ability% (lowest decile – highest decile)	4.5 – 27.8	4.5 – 27.1	4.7 – 27.2	4.6 – 27.3
c-statistic	0.66	0.67	0.66	0.66

4.2.4 Distribution of Hospital Volumes and Readmission Rates for AMI

The national *observed* readmission rate in the combined three-year dataset was 13.7%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 14.0%
- July 1, 2021 – June 30, 2022: 13.4%
- July 1, 2022 – June 30, 2023: 13.7%

Table 4.2.4.1 shows the distribution of hospital admission volumes.

Table 4.2.4.1 — Distribution of Hospital AMI Admission Volumes over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	3,189	3,244	3,121	3,770
Mean number of admissions (SD)	37.3 (49.5)	34.2 (45.9)	34.0 (44.1)	89.1 (132.6)
Range (min. – max.)	1– 347	1– 386	1– 401	1– 1,134
25 th percentile	2	2	3	3
50 th percentile	16	16	17	24
75 th percentile	54	50	51	131

Table 4.2.4.2 shows the distribution of hospital RSRRs.

Table 4.2.4.2 — Distribution of Hospital AMI RSRRs over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	3,189	3,244	3,121	3,770
Mean (SD)	14.0 (0.5)	13.4 (0.4)	13.7 (0.4)	13.7 (0.6)

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Range (min. – max.)	12.1 – 17.5	10.9 – 16.0	11.6 – 15.9	10.7 – 17.1
25 th percentile	13.8	13.2	13.6	13.5
50 th percentile	13.9	13.3	13.7	13.7
75 th percentile	14.2	13.6	13.9	13.9

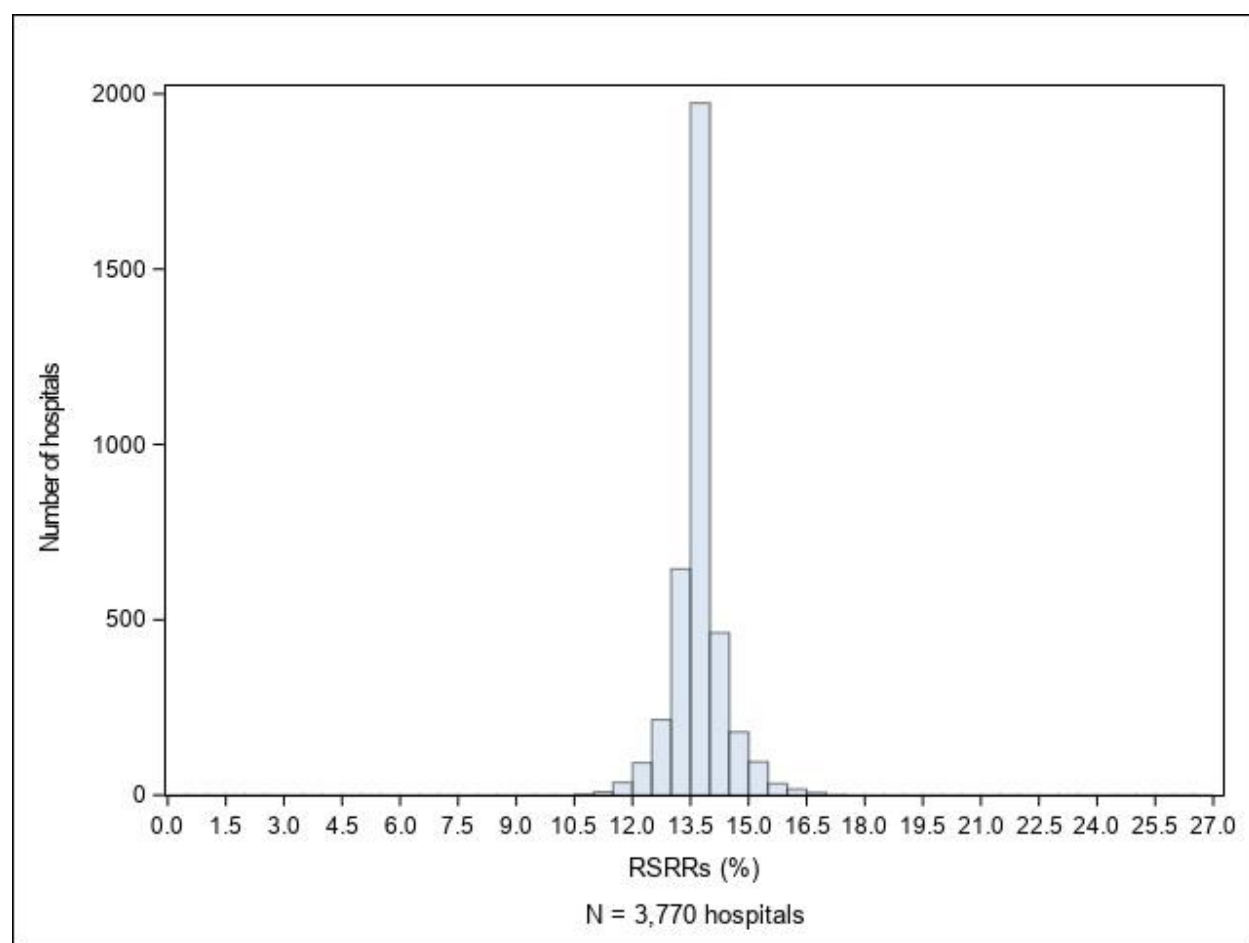
Table 4.2.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

Table 4.2.4.3 — Between-Hospital Variance for AMI over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Between-hospital variance (SE)	0.023 (0.005)	0.022 (0.005)	0.020 (0.005)	0.023 (0.002)

Figure 4.2.4.1 shows the overall distribution of the hospital RSRRs for the combined three-year dataset, which indicates that the hospital RSRRs are normally distributed. The odds of all-cause readmission if a patient is treated at a hospital one standard deviation (SD) above the national rate were 1.35 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 1.0.¹⁵

Figure 4.2.4.1 — Distribution of Hospital 30-Day AMI RSRRs between July 2020 and June 2023



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

Of 3,770 hospitals in the study cohort, 8 performed “Better than the National Rate,” 1,853 performed “No Different than the National Rate,” and 13 performed “Worse than the National Rate.” 1,896 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.3. COPD Readmission 2024 Model Results

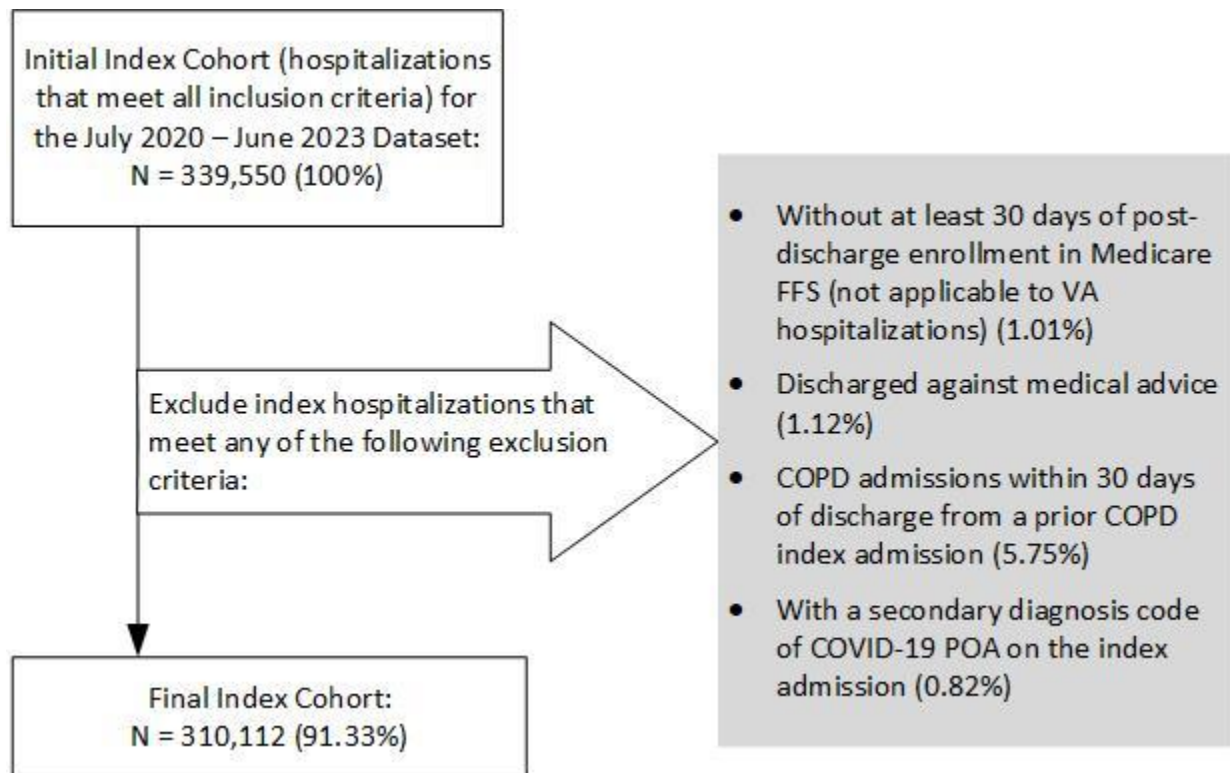
4.3.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of COPD admissions that met each exclusion criterion in the July 2020 – June 2023 dataset is presented in [Figure 4.3.1.1](#).

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 patients:

- aged 65 or over;
- with a principal discharge diagnosis of COPD or principal discharge diagnosis of acute 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 Part A during the index admission (not applicable to VA hospitalizations);
- who were not transferred to another acute care facility; and
- were alive at discharge.

Figure 4.3.1.1 — COPD Cohort Exclusions in the July 2020 – June 2023 Dataset



4.3.2 Frequency of COPD Model Variables

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

Refer to [Table 4.3.2.1](#) for more detail.

Table 4.3.2.1 — Frequency of COPD Model Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Total N	98,897	104,456	106,759	310,112
Mean age (SD)	75.8 (7.2)	76.2 (7.3)	76.5 (7.3)	76.2 (7.3)
History of COVID-19	6.8	16.1	25.9	16.5
History of mechanical ventilation	11.2	13.7	14.5	13.2
Sleep-disordered breathing	24.8	27.1	27.4	26.5
Severe infection; other infectious diseases (CC 1, 3 – 7)	28.5	35.7	37.7	34.1
Metastatic cancer and acute leukemia (CC 8)	3.8	3.9	3.9	3.9
Lung and other severe cancers (CC 9)	9.0	9.4	9.7	9.4
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	12.1	14.0	14.6	13.6
Other digestive and urinary neoplasms (CC 14)	4.7	7.0	7.2	6.3
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	38.8	39.8	39.8	39.4
Protein-calorie malnutrition (CC 21)	13.6	15.2	16.0	14.9
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	81.9	86.0	87.1	85.1
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	52.7	56.7	57.5	55.7
Chronic pancreatitis (CC 34)	0.5	0.6	0.6	0.6
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	10.9	13.7	13.5	12.7
Other gastrointestinal disorders (CC 38)	60.7	65.7	66.2	64.3
Severe hematological disorders (CC 46)	0.8	0.8	0.8	0.8
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	47.8	51.9	53.2	51.0
Dementia or other specified brain disorders (CC 51 – 53)	16.0	18.3	19.3	17.9
Drug/alcohol psychosis or dependence (CC 54 – 55)	7.4	8.2	8.3	8.0
Major psychiatric disorders (CC 57 – 59)	15.3	18.1	19.1	17.6
Depression (CC 61)	27.2	29.2	29.1	28.5
Anxiety disorders (CC 62)	12.3	14.3	15.1	13.9
Other psychiatric disorders (CC 63)	34.8	37.4	37.4	36.6
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	5.5	6.3	6.5	6.1

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Polyneuropathy; other neuropathies (CC 75, 81)	21.4	25.2	25.6	24.1
Respirator dependence/respiratory failure (CC 82 – 83)	1.6	1.5	1.4	1.5
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	72.5	76.2	76.9	75.3
Congestive heart failure (CC 85)	55.1	55.5	54.8	55.1
Acute coronary syndrome (CC 86 – 87)	13.4	16.2	17.1	15.6
Coronary atherosclerosis or angina (CC 88 – 89)	46.8	49.1	48.5	48.1
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	45.2	48.3	49.1	47.6
Other and unspecified heart disease (CC 98)	14.6	19.0	19.5	17.8
Stroke (CC 99 – 100)	4.4	5.7	6.0	5.4
Vascular or circulatory disease (CC 106 – 109)	41.7	48.3	49.1	46.5
Fibrosis of lung or other chronic lung disorders (CC 112)	11.5	13.5	13.8	12.9
Pneumonia (CC 114 – 116)	41.7	46.2	48.1	45.4
Renal failure (CC 135 – 140)	38.7	40.7	40.8	40.1
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	8.1	9.5	9.8	9.2
Cellulitis, local skin infection (CC 164)	9.7	12.3	12.1	11.4
Vertebral fractures without spinal cord injury (CC 169)	4.3	5.5	5.5	5.1

4.3.3 COPD Model Parameters and Performance

Table 4.3.3.1 shows hierarchical logistic regression model parameter coefficients by individual year and for the combined three-year dataset.

Table 4.3.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for COPD over Different Time Periods

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Intercept	-2.358	-2.598	-2.663	-2.508
Years over 65 (continuous)	-0.008	-0.003	-0.001	-0.005
History of COVID-19	-0.030	0.023	0.044	-0.020
History of mechanical ventilation	0.243	0.300	0.319	0.285
Sleep-disordered breathing	-0.014	-0.028	-0.028	-0.024
Severe infection; other infectious diseases (CC 1, 3 – 7)	0.078	0.018	0.063	0.044
Metastatic cancer and acute leukemia (CC 8)	0.216	0.151	0.206	0.195
Lung and other severe cancers (CC 9)	0.145	0.176	0.159	0.158
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	-0.002	0.006	0.014	0.001
Other digestive and urinary neoplasms (CC 14)	-0.075	-0.019	-0.034	-0.055
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.085	0.073	0.072	0.078

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Protein-calorie malnutrition (CC 21)	0.141	0.152	0.148	0.144
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	-0.013	-0.001	-0.015	-0.021
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	0.148	0.197	0.156	0.167
Chronic pancreatitis (CC 34)	0.006	0.055	0.169	0.076
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	0.119	0.092	0.050	0.084
Other gastrointestinal disorders (CC 38)	0.065	0.084	0.083	0.075
Severe hematological disorders (CC 46)	0.103	0.050	0.234	0.133
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.195	0.171	0.207	0.190
Dementia or other specified brain disorders (CC 51 – 53)	0.006	0.014	0.018	0.012
Drug/alcohol psychosis or dependence (CC 54 – 55)	0.207	0.149	0.193	0.177
Major psychiatric disorders (CC 57 – 59)	0.068	0.037	0.054	0.045
Depression (CC 61)	0.002	0.036	0.003	0.016
Anxiety disorders (CC 62)	0.045	0.104	0.075	0.071
Other psychiatric disorders (CC 63)	0.109	0.057	0.131	0.099
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.042	0.074	0.068	0.063
Polyneuropathy; other neuropathies (CC 75, 81)	0.015	0.027	0.056	0.030
Respirator dependence/respiratory failure (CC 82 – 83)	-0.009	0.040	-0.025	0.013
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	0.209	0.198	0.172	0.190
Congestive heart failure (CC 85)	0.202	0.246	0.237	0.237
Acute coronary syndrome (CC 86 – 87)	0.113	0.115	0.086	0.098
Coronary atherosclerosis or angina (CC 88 – 89)	0.070	0.051	0.030	0.052
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.155	0.170	0.166	0.163
Other and unspecified heart disease (CC 98)	0.060	0.110	0.046	0.067
Stroke (CC 99 – 100)	0.009	0.010	0.014	0.005
Vascular or circulatory disease (CC 106 – 109)	0.081	0.043	0.085	0.064
Fibrosis of lung or other chronic lung disorders (CC 112)	0.069	0.075	0.106	0.083
Pneumonia (CC 114 – 116)	0.099	0.059	0.110	0.087
Renal failure (CC 135 – 140)	0.170	0.153	0.133	0.155
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.121	0.036	0.058	0.072
Cellulitis, local skin infection (CC 164)	0.055	0.057	0.037	0.043
Vertebral fractures without spinal cord injury (CC 169)	0.051	0.063	0.130	0.081

Table 4.3.3.2 shows the risk-adjusted ORs and 95% CIs for the COPD readmission model by individual year and for the combined three-year dataset.

Table 4.3.3.2 — Adjusted OR and 95% CIs for the COPD Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Years over 65 (continuous)	0.99 (0.99 – 0.99)	1.00 (0.99 – 1.00)	1.00 (1.00 – 1.00)	1.00 (0.99 – 1.00)
History of COVID-19	0.97 (0.91 – 1.03)	1.02 (0.98 – 1.07)	1.05 (1.01 – 1.08)	0.98 (0.96 – 1.01)
History of mechanical ventilation	1.28 (1.21 – 1.34)	1.35 (1.29 – 1.41)	1.38 (1.32 – 1.44)	1.33 (1.29 – 1.37)
Sleep-disordered breathing	0.99 (0.95 – 1.02)	0.97 (0.94 – 1.01)	0.97 (0.94 – 1.01)	0.98 (0.95 – 1.00)
Severe infection; other infectious diseases (CC 1, 3 – 7)	1.08 (1.04 – 1.12)	1.02 (0.98 – 1.05)	1.06 (1.03 – 1.10)	1.04 (1.02 – 1.07)
Metastatic cancer and acute leukemia (CC 8)	1.24 (1.14 – 1.36)	1.16 (1.07 – 1.27)	1.23 (1.13 – 1.34)	1.22 (1.16 – 1.28)
Lung and other severe cancers (CC 9)	1.16 (1.09 – 1.23)	1.19 (1.13 – 1.26)	1.17 (1.11 – 1.24)	1.17 (1.13 – 1.21)
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	1.00 (0.95 – 1.05)	1.01 (0.96 – 1.06)	1.01 (0.97 – 1.06)	1.00 (0.97 – 1.03)
Other digestive and urinary neoplasms (CC 14)	0.93 (0.86 – 1.00)	0.98 (0.92 – 1.05)	0.97 (0.91 – 1.03)	0.95 (0.91 – 0.98)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.09 (1.05 – 1.13)	1.08 (1.04 – 1.11)	1.07 (1.04 – 1.11)	1.08 (1.06 – 1.10)
Protein-calorie malnutrition (CC 21)	1.15 (1.10 – 1.21)	1.16 (1.11 – 1.22)	1.16 (1.11 – 1.21)	1.16 (1.13 – 1.19)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	0.99 (0.94 – 1.03)	1.00 (0.95 – 1.05)	0.99 (0.93 – 1.04)	0.98 (0.95 – 1.01)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	1.16 (1.12 – 1.20)	1.22 (1.17 – 1.26)	1.17 (1.13 – 1.21)	1.18 (1.16 – 1.21)
Chronic pancreatitis (CC 34)	1.01 (0.82 – 1.24)	1.06 (0.88 – 1.27)	1.18 (0.99 – 1.42)	1.08 (0.97 – 1.20)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	1.13 (1.07 – 1.18)	1.10 (1.05 – 1.15)	1.05 (1.00 – 1.10)	1.09 (1.06 – 1.12)
Other gastrointestinal disorders (CC 38)	1.07 (1.03 – 1.11)	1.09 (1.05 – 1.13)	1.09 (1.05 – 1.13)	1.08 (1.06 – 1.10)
Severe hematological disorders (CC 46)	1.11 (0.94 – 1.31)	1.05 (0.90 – 1.23)	1.26 (1.08 – 1.48)	1.14 (1.04 – 1.25)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.22 (1.17 – 1.26)	1.19 (1.14 – 1.23)	1.23 (1.19 – 1.27)	1.21 (1.18 – 1.23)
Dementia or other specified brain disorders (CC 51 – 53)	1.01 (0.96 – 1.05)	1.01 (0.97 – 1.06)	1.02 (0.98 – 1.06)	1.01 (0.99 – 1.04)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Drug/alcohol psychosis or dependence (CC 54 – 55)	1.23 (1.16 – 1.30)	1.16 (1.10 – 1.23)	1.21 (1.15 – 1.28)	1.19 (1.16 – 1.23)
Major psychiatric disorders (CC 57 – 59)	1.07 (1.02 – 1.12)	1.04 (0.99 – 1.08)	1.06 (1.01 – 1.10)	1.05 (1.02 – 1.07)
Depression (CC 61)	1.00 (0.96 – 1.04)	1.04 (1.00 – 1.08)	1.00 (0.96 – 1.04)	1.02 (0.99 – 1.04)
Anxiety disorders (CC 62)	1.05 (1.00 – 1.10)	1.11 (1.06 – 1.16)	1.08 (1.03 – 1.13)	1.07 (1.04 – 1.10)
Other psychiatric disorders (CC 63)	1.11 (1.07 – 1.16)	1.06 (1.02 – 1.10)	1.14 (1.10 – 1.18)	1.10 (1.08 – 1.13)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.04 (0.97 – 1.12)	1.08 (1.01 – 1.15)	1.07 (1.01 – 1.14)	1.06 (1.03 – 1.11)
Polyneuropathy; other neuropathies (CC 75, 81)	1.01 (0.98 – 1.06)	1.03 (0.99 – 1.07)	1.06 (1.02 – 1.10)	1.03 (1.01 – 1.05)
Respirator dependence/respiratory failure (CC 82 – 83)	0.99 (0.88 – 1.11)	1.04 (0.93 – 1.17)	0.98 (0.87 – 1.10)	1.01 (0.95 – 1.08)
Cardio-respiratory failure and shock (CC 84), plus ICD- 10-CM codes R09.01 and R09.02	1.23 (1.18 – 1.28)	1.22 (1.17 – 1.27)	1.19 (1.14 – 1.24)	1.21 (1.18 – 1.24)
Congestive heart failure (CC 85)	1.22 (1.18 – 1.27)	1.28 (1.23 – 1.33)	1.27 (1.22 – 1.32)	1.27 (1.24 – 1.30)
Acute coronary syndrome (CC 86 – 87)	1.12 (1.07 – 1.17)	1.12 (1.08 – 1.17)	1.09 (1.05 – 1.14)	1.10 (1.08 – 1.13)
Coronary atherosclerosis or angina (CC 88 – 89)	1.07 (1.04 – 1.11)	1.05 (1.02 – 1.09)	1.03 (1.00 – 1.07)	1.05 (1.03 – 1.07)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.17 (1.13 – 1.21)	1.19 (1.14 – 1.23)	1.18 (1.14 – 1.22)	1.18 (1.15 – 1.20)
Other and unspecified heart disease (CC 98)	1.06 (1.02 – 1.11)	1.12 (1.07 – 1.16)	1.05 (1.01 – 1.09)	1.07 (1.04 – 1.10)
Stroke (CC 99 – 100)	1.01 (0.93 – 1.09)	1.01 (0.94 – 1.08)	1.01 (0.95 – 1.08)	1.01 (0.97 – 1.05)
Vascular or circulatory disease (CC 106 – 109)	1.08 (1.05 – 1.12)	1.04 (1.01 – 1.08)	1.09 (1.05 – 1.13)	1.07 (1.04 – 1.09)
Fibrosis of lung or other chronic lung disorders (CC 112)	1.07 (1.02 – 1.13)	1.08 (1.03 – 1.13)	1.11 (1.06 – 1.16)	1.09 (1.06 – 1.12)
Pneumonia (CC 114 – 116)	1.10 (1.07 – 1.14)	1.06 (1.02 – 1.10)	1.12 (1.08 – 1.16)	1.09 (1.07 – 1.11)
Renal failure (CC 135 – 140)	1.19 (1.14 – 1.23)	1.16 (1.12 – 1.21)	1.14 (1.10 – 1.18)	1.17 (1.14 – 1.19)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.13 (1.07 – 1.19)	1.04 (0.98 – 1.09)	1.06 (1.01 – 1.12)	1.08 (1.04 – 1.11)
Cellulitis, local skin infection (CC 164)	1.06 (1.00 – 1.11)	1.06 (1.01 – 1.11)	1.04 (0.99 – 1.09)	1.04 (1.01 – 1.08)
Vertebral fractures without spinal cord injury (CC 169)	1.05 (0.98 – 1.13)	1.07 (1.00 – 1.14)	1.14 (1.07 – 1.21)	1.08 (1.04 – 1.13)

Overall, model performance was stable over the three-year time period (Table 4.3.3.3).

Table 4.3.3.3 — COPD Logistic Regression Model Performance over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Predictive ability% (lowest decile – highest decile)	9.8 – 35.8	8.6 – 34.5	7.9 – 34.6	8.8 – 34.7
c-statistic	0.64	0.64	0.65	0.64

4.3.4 Distribution of Hospital Volumes and Readmission Rates for COPD

The national *observed* readmission rate in the combined three-year dataset was 18.5%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 19.6%
- July 1, 2021 – June 30, 2022: 18.0%
- July 1, 2022 – June 30, 2023: 18.0%

Table 4.3.4.1 shows the distribution of hospital admission volumes.

Table 4.3.4.1 — Distribution of Hospital COPD Admission Volumes over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,204	4,243	4,223	4,473
Mean number of admissions (SD)	23.5 (26.8)	24.6 (28.6)	25.3 (29.8)	69.3 (82.9)
Range (min. – max.)	1 – 229	1 – 255	1 – 256	1 – 730
25 th percentile	5	5	5	13
50 th percentile	14	14	14	38
75 th percentile	33	34	35	98

Table 4.3.4.2 shows the distribution of hospital RSRRs.

Table 4.3.4.2 — Distribution of Hospital COPD RSRRs over Different Time Periods

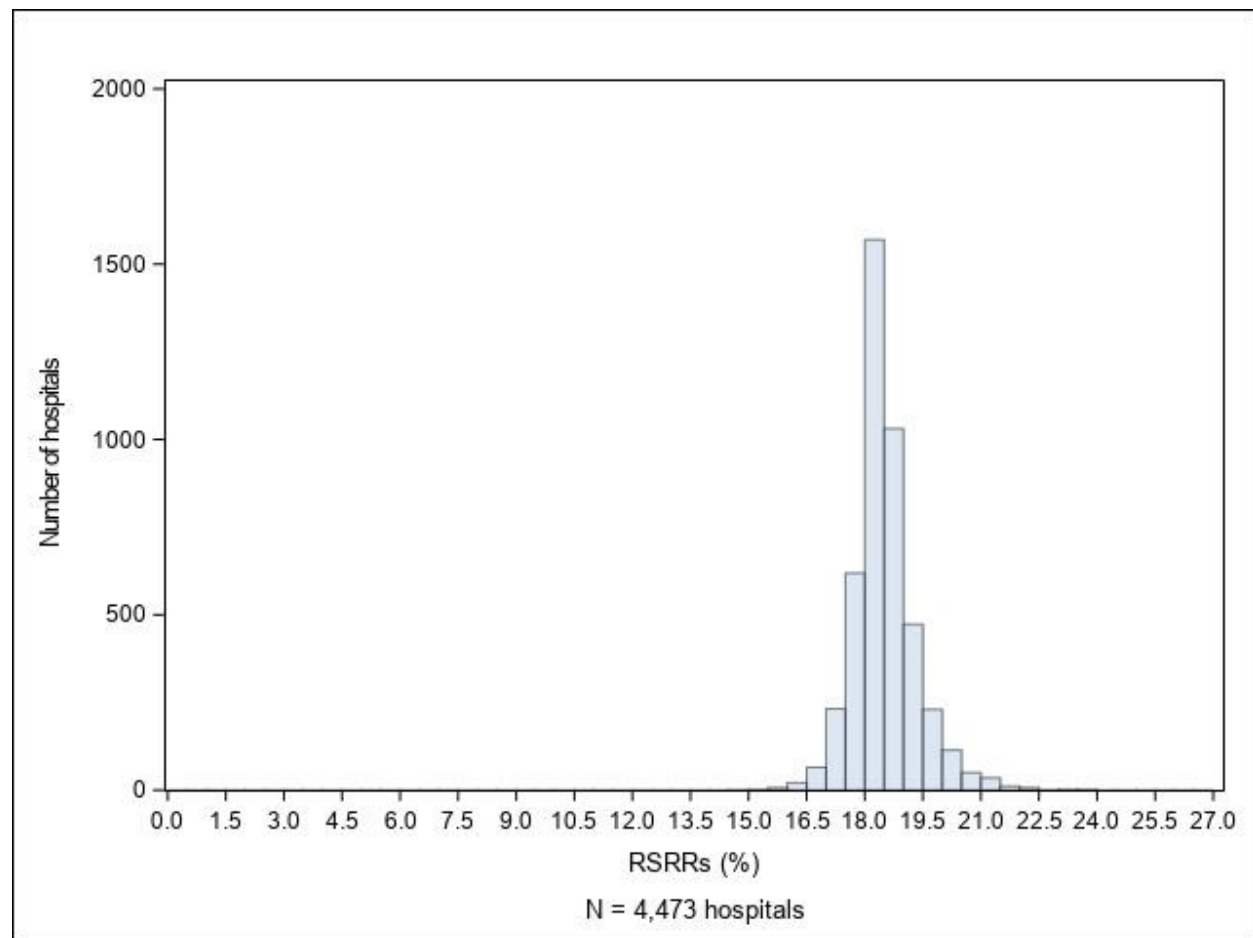
Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,204	4,243	4,223	4,473
Mean (SD)	19.6 (0.7)	18.0 (0.5)	18.0 (0.4)	18.5 (0.8)
Range (min. – max.)	16.2 – 24.7	15.9 – 22.2	16.5 – 20.6	14.9 – 23.7
25 th percentile	19.2	17.8	17.8	18.1
50 th percentile	19.5	18.0	17.9	18.4
75 th percentile	19.9	18.3	18.2	18.9

Table 4.3.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

Table 4.3.4.3 — Between-Hospital Variance for COPD over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Between-hospital variance (SE)	0.028 (0.005)	0.021 (0.005)	0.017 (0.005)	0.021 (0.002)

Figure 4.3.4.1 shows the overall distribution of the hospital RSRRs for the combined three-year dataset, which indicates that the hospital RSRRs are normally distributed. The odds of all-cause readmission if a patient is treated at a hospital one SD above the national rate were 1.34 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 1.0.¹⁵

Figure 4.3.4.1 — Distribution of Hospital 30-Day COPD RSRRs between July 2020 and June 2023

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

Of 4,473 hospitals in the study cohort, 1 performed “Better than the National Rate,” 2,721 performed “No Different than the National Rate,” and 17 performed “Worse than

the National Rate.” 1,734 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.4. HF Readmission 2024 Model Results

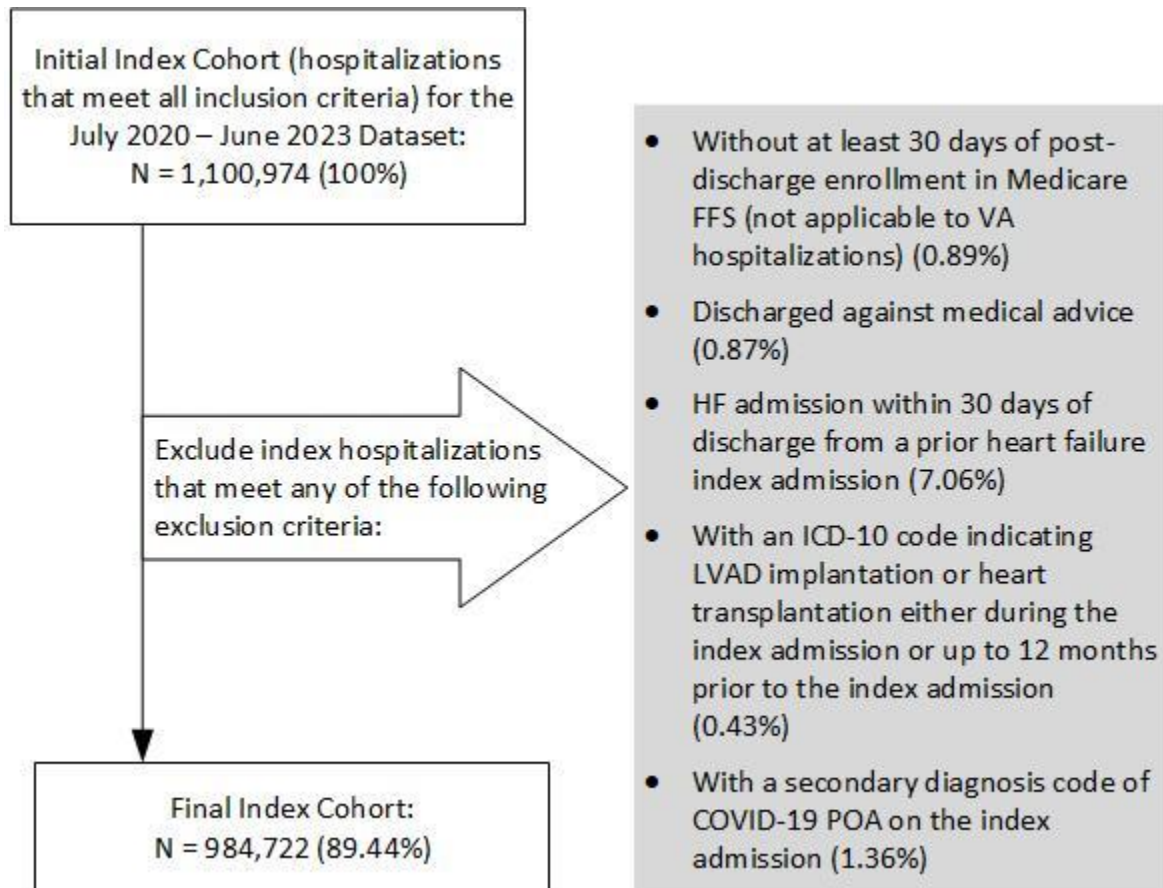
4.4.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of HF admissions that met each exclusion criterion in the July 2020 – June 2023 dataset is presented in [Figure 4.4.1.1](#).

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 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 Part A during the index admission (not applicable to VA hospitalizations);
- who were not transferred to another acute care facility; and
- were alive at discharge.

Figure 4.4.1.1 — HF Cohort Exclusions in the July 2020 – June 2023 Dataset



4.4.2 Frequency of HF Model Variables

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

Refer to [Table 4.4.2.1](#) for more detail.

Table 4.4.2.1 — Frequency of HF Model Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Total N	335,118	324,693	324,911	984,722
Mean age (SD)	80.2 (8.5)	80.6 (8.4)	80.9 (8.4)	80.6 (8.4)
Male	49.1	48.3	48.2	48.5
History of COVID-19	6.9	14.9	24.0	15.2
History of coronary artery bypass graft (CABG) surgery	19.3	18.8	18.0	18.7
Metastatic cancer and acute leukemia (CC 8)	2.7	3.0	3.1	2.9
Cancer (CC 9 – 14)	19.5	22.8	23.5	21.9
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	54.6	55.2	54.7	54.8
Protein-calorie malnutrition (CC 21)	10.4	12.0	12.8	11.7
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	58.6	64.0	65.0	62.5
Liver or biliary disease (CC 27 – 32)	13.0	15.5	16.2	14.9
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	14.4	17.8	17.8	16.7
Other gastrointestinal disorders (CC 38)	59.7	66.2	66.6	64.1
Severe hematological disorders (CC 46)	1.7	1.9	1.9	1.8
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	60.5	64.9	66.0	63.8
Dementia or other specified brain disorders (CC 51 – 53)	19.9	22.8	23.3	22.0
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	15.3	16.6	16.7	16.2
Major psychiatric disorders (CC 57 – 59)	9.7	12.0	12.7	11.4
Depression (CC 61)	20.1	22.0	21.8	21.3
Other psychiatric disorders (CC 63)	22.5	25.9	26.1	24.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	7.2	8.4	8.4	8.0
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	56.5	61.3	62.5	60.1
Congestive heart failure (CC 85)	77.8	81.2	81.7	80.2
Acute coronary syndrome (CC 86 – 87)	26.3	30.9	32.3	29.8
Coronary atherosclerosis or angina (CC 88 – 89)	66.0	67.3	67.2	66.8
Valvular and rheumatic heart disease (CC 91)	49.3	56.2	57.9	54.4
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	76.8	80.2	81.1	79.4
Other and unspecified heart disease (CC 98)	23.3	30.6	32.0	28.6

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Stroke (CC 99 – 100)	6.3	8.4	8.6	7.8
Vascular or circulatory disease (CC 106 – 109)	51.8	59.0	59.9	56.9
Chronic obstructive pulmonary disease (COPD) (CC 111)	42.1	42.8	41.9	42.3
Fibrosis of lung or other chronic lung disorders (CC 112)	7.3	9.0	9.3	8.5
Asthma (CC 113)	9.6	11.3	11.7	10.8
Pneumonia (CC 114 – 116)	32.7	36.4	37.3	35.4
Dialysis status (CC 134)	6.3	6.0	5.9	6.1
Renal failure (CC 135 – 140)	70.6	71.1	70.9	70.9
Nephritis (CC 141)	1.5	1.8	1.7	1.7
Other urinary tract disorders (CC 145)	18.1	23.1	23.2	21.4
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	14.4	16.7	17.1	16.0

4.4.3 HF Model Parameters and Performance

Table 4.4.3.1 shows hierarchical logistic regression model parameter coefficients by individual year and for the combined three-year dataset.

Table 4.4.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for HF over Different Time Periods

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Intercept	-2.365	-2.493	-2.474	-2.417
Years over 65 (continuous)	-0.006	-0.005	-0.005	-0.006
Male	-0.039	-0.035	-0.028	-0.033
History of COVID-19	-0.069	0.024	0.035	-0.010
History of coronary artery bypass graft (CABG) surgery	0.019	0.012	0.025	0.021
Metastatic cancer and acute leukemia (CC 8)	0.121	0.178	0.164	0.158
Cancer (CC 9 – 14)	0.018	0.015	0.020	0.014
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.096	0.102	0.094	0.095
Protein-calorie malnutrition (CC 21)	0.097	0.069	0.091	0.087
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	0.164	0.171	0.163	0.163
Liver or biliary disease (CC 27 – 32)	0.109	0.063	0.091	0.086
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	0.053	0.079	0.087	0.073
Other gastrointestinal disorders (CC 38)	0.056	0.044	0.084	0.059
Severe hematological disorders (CC 46)	0.262	0.181	0.264	0.239
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.152	0.132	0.159	0.146
Dementia or other specified brain disorders (CC 51 – 53)	0.006	0.016	0.018	0.012
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	0.099	0.099	0.088	0.092

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Major psychiatric disorders (CC 57 – 59)	0.031	0.013	0.063	0.032
Depression (CC 61)	0.033	0.007	0.008	0.020
Other psychiatric disorders (CC 63)	0.068	0.094	0.039	0.065
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.068	0.057	0.087	0.070
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	0.037	0.059	0.080	0.057
Congestive heart failure (CC 85)	0.097	0.114	0.107	0.106
Acute coronary syndrome (CC 86 – 87)	0.097	0.101	0.113	0.100
Coronary atherosclerosis or angina (CC 88 – 89)	0.080	0.071	0.039	0.064
Valvular and rheumatic heart disease (CC 91)	0.060	0.076	0.094	0.073
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.114	0.088	0.082	0.095
Other and unspecified heart disease (CC 98)	0.029	0.041	0.039	0.033
Stroke (CC 99 – 100)	0.040	0.060	-0.006	0.026
Vascular or circulatory disease (CC 106 – 109)	0.077	0.078	0.081	0.074
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.165	0.153	0.147	0.155
Fibrosis of lung or other chronic lung disorders (CC 112)	0.070	0.060	0.044	0.056
Asthma (CC 113)	-0.001	0.012	0.018	0.006
Pneumonia (CC 114 – 116)	0.142	0.130	0.094	0.119
Dialysis status (CC 134)	0.155	0.129	0.146	0.145
Renal failure (CC 135 – 140)	0.271	0.253	0.222	0.254
Nephritis (CC 141)	-0.004	0.060	0.103	0.056
Other urinary tract disorders (CC 145)	0.051	0.039	0.060	0.045
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.107	0.118	0.117	0.113

Table 4.4.3.2 shows the risk-adjusted ORs and 95% CIs for the HF readmission model by individual year and for the combined three-year dataset.

Table 4.4.3.2 — Adjusted OR and 95% CIs for the HF Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Years over 65 (continuous)	0.99 (0.99-1.00)	1.00 (0.99-1.00)	0.99 (0.99-1.00)	0.99 (0.99-1.00)
Male	0.96 (0.94-0.98)	0.97 (0.95-0.98)	0.97 (0.95-0.99)	0.97 (0.96-0.98)
History of COVID-19	0.93 (0.90-0.97)	1.02 (1.00-1.05)	1.04 (1.01-1.06)	0.99 (0.98-1.00)
History of coronary artery bypass graft (CABG) surgery	1.02 (1.00-1.04)	1.01 (0.99-1.04)	1.03 (1.00-1.05)	1.02 (1.01-1.04)
Metastatic cancer and acute leukemia (CC 8)	1.13 (1.07-1.19)	1.19 (1.14-1.26)	1.18 (1.12-1.24)	1.17 (1.14-1.21)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Cancer (CC 9 – 14)	1.02 (0.99-1.04)	1.01 (0.99-1.04)	1.02 (1.00-1.04)	1.01 (1.00-1.03)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.10 (1.08-1.12)	1.11 (1.09-1.13)	1.10 (1.08-1.12)	1.10 (1.09-1.11)
Protein-calorie malnutrition (CC 21)	1.10 (1.07-1.13)	1.07 (1.04-1.10)	1.10 (1.07-1.12)	1.09 (1.07-1.11)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	1.18 (1.16-1.20)	1.19 (1.16-1.21)	1.18 (1.15-1.20)	1.18 (1.16-1.19)
Liver or biliary disease (CC 27 – 32)	1.12 (1.09-1.14)	1.07 (1.04-1.09)	1.09 (1.07-1.12)	1.09 (1.07-1.10)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	1.05 (1.03-1.08)	1.08 (1.06-1.11)	1.09 (1.07-1.12)	1.08 (1.06-1.09)
Other gastrointestinal disorders (CC 38)	1.06 (1.04-1.08)	1.04 (1.02-1.07)	1.09 (1.07-1.11)	1.06 (1.05-1.07)
Severe hematological disorders (CC 46)	1.30 (1.22-1.38)	1.20 (1.13-1.27)	1.30 (1.23-1.38)	1.27 (1.23-1.31)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.16 (1.14-1.19)	1.14 (1.12-1.17)	1.17 (1.15-1.20)	1.16 (1.14-1.17)
Dementia or other specified brain disorders (CC 51 – 53)	1.01 (0.98-1.03)	1.02 (0.99-1.04)	1.02 (1.00-1.04)	1.01 (1.00-1.02)
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	1.10 (1.08-1.13)	1.10 (1.08-1.13)	1.09 (1.07-1.12)	1.10 (1.08-1.11)
Major psychiatric disorders (CC 57 – 59)	1.03 (1.00-1.06)	1.01 (0.98-1.04)	1.07 (1.04-1.09)	1.03 (1.02-1.05)
Depression (CC 61)	1.03 (1.01-1.06)	1.01 (0.98-1.03)	1.01 (0.99-1.03)	1.02 (1.01-1.03)
Other psychiatric disorders (CC 63)	1.07 (1.05-1.09)	1.10 (1.08-1.12)	1.04 (1.02-1.06)	1.07 (1.05-1.08)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.07 (1.04-1.11)	1.06 (1.03-1.09)	1.09 (1.06-1.13)	1.07 (1.05-1.09)
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	1.04 (1.02-1.06)	1.06 (1.04-1.08)	1.08 (1.06-1.10)	1.06 (1.05-1.07)
Congestive heart failure (CC 85)	1.10 (1.08-1.13)	1.12 (1.09-1.15)	1.11 (1.08-1.14)	1.11 (1.10-1.13)
Acute coronary syndrome (CC 86 – 87)	1.10 (1.08-1.12)	1.11 (1.08-1.13)	1.12 (1.10-1.14)	1.10 (1.09-1.12)
Coronary atherosclerosis or angina (CC 88 – 89)	1.08 (1.06-1.11)	1.07 (1.05-1.10)	1.04 (1.02-1.06)	1.07 (1.05-1.08)
Valvular and rheumatic heart disease (CC 91)	1.06 (1.04-1.08)	1.08 (1.06-1.10)	1.10 (1.08-1.12)	1.08 (1.06-1.09)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.12 (1.10-1.15)	1.09 (1.07-1.12)	1.09 (1.06-1.11)	1.10 (1.09-1.12)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Other and unspecified heart disease (CC 98)	1.03 (1.01-1.05)	1.04 (1.02-1.06)	1.04 (1.02-1.06)	1.03 (1.02-1.05)
Stroke (CC 99 – 100)	1.04 (1.01-1.08)	1.06 (1.03-1.10)	0.99 (0.96-1.03)	1.03 (1.01-1.05)
Vascular or circulatory disease (CC 106 – 109)	1.08 (1.06-1.10)	1.08 (1.06-1.10)	1.08 (1.06-1.11)	1.08 (1.07-1.09)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.18 (1.16-1.20)	1.16 (1.14-1.19)	1.16 (1.14-1.18)	1.17 (1.16-1.18)
Fibrosis of lung or other chronic lung disorders (CC 112)	1.07 (1.04-1.11)	1.06 (1.03-1.09)	1.04 (1.01-1.08)	1.06 (1.04-1.08)
Asthma (CC 113)	1.00 (0.97-1.03)	1.01 (0.98-1.04)	1.02 (0.99-1.05)	1.01 (0.99-1.02)
Pneumonia (CC 114 – 116)	1.15 (1.13-1.18)	1.14 (1.12-1.16)	1.10 (1.08-1.12)	1.13 (1.11-1.14)
Dialysis status (CC 134)	1.17 (1.13-1.21)	1.14 (1.10-1.18)	1.16 (1.12-1.20)	1.16 (1.13-1.18)
Renal failure (CC 135 – 140)	1.31 (1.28-1.34)	1.29 (1.26-1.32)	1.25 (1.22-1.28)	1.29 (1.27-1.31)
Nephritis (CC 141)	1.00 (0.93-1.06)	1.06 (1.00-1.13)	1.11 (1.04-1.18)	1.06 (1.02-1.10)
Other urinary tract disorders (CC 145)	1.05 (1.03-1.08)	1.04 (1.02-1.06)	1.06 (1.04-1.08)	1.05 (1.03-1.06)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.11 (1.09-1.14)	1.13 (1.10-1.15)	1.12 (1.10-1.15)	1.12 (1.10-1.14)

Overall, model performance was stable over the three-year time period ([Table 4.4.3.3](#)).

Table 4.4.3.3 — HF Logistic Regression Model Performance over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Predictive ability% (lowest decile – highest decile)	11.0 – 33.2	10.4 – 32.2	10.7 – 33.0	10.8 – 32.7
c-statistic	0.61	0.61	0.62	0.61

4.4.4 Distribution of Hospital Volumes and Readmission Rates for HF

The national *observed* readmission rate in the combined three-year dataset was 19.8%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 20.2%
- July 1, 2021 – June 30, 2022: 19.3%
- July 1, 2022 – June 30, 2023: 19.8%

[Table 4.4.4.1](#) shows the distribution of hospital admission volumes.

Table 4.4.4.1 — Distribution of Hospital HF Admission Volumes over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,354	4,340	4,317	4,511
Mean number of admissions (SD)	77.0 (101.9)	74.8 (100.0)	75.3 (101.6)	218.3 (298.9)
Range (min. – max.)	1 – 1,172	1 – 1,124	1 – 1,194	1 – 3,490
25 th percentile	8	8	8	21
50 th percentile	34	33	33	88
75 th percentile	110	108	109	312

Table 4.4.4.2 shows the distribution of hospital RSRRs.

Table 4.4.4.2 — Distribution of Hospital HF RSRRs over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,354	4,340	4,317	4,511
Mean (SD)	20.2 (0.7)	19.3 (0.7)	19.8 (0.6)	19.8 (1.1)
Range (min. – max.)	16.3 – 23.8	15.7 – 23.8	16.9 – 23.4	14.8 – 25.7
25 th percentile	19.9	19.0	19.5	19.3
50 th percentile	20.1	19.3	19.8	19.7
75 th percentile	20.5	19.6	20.1	20.3

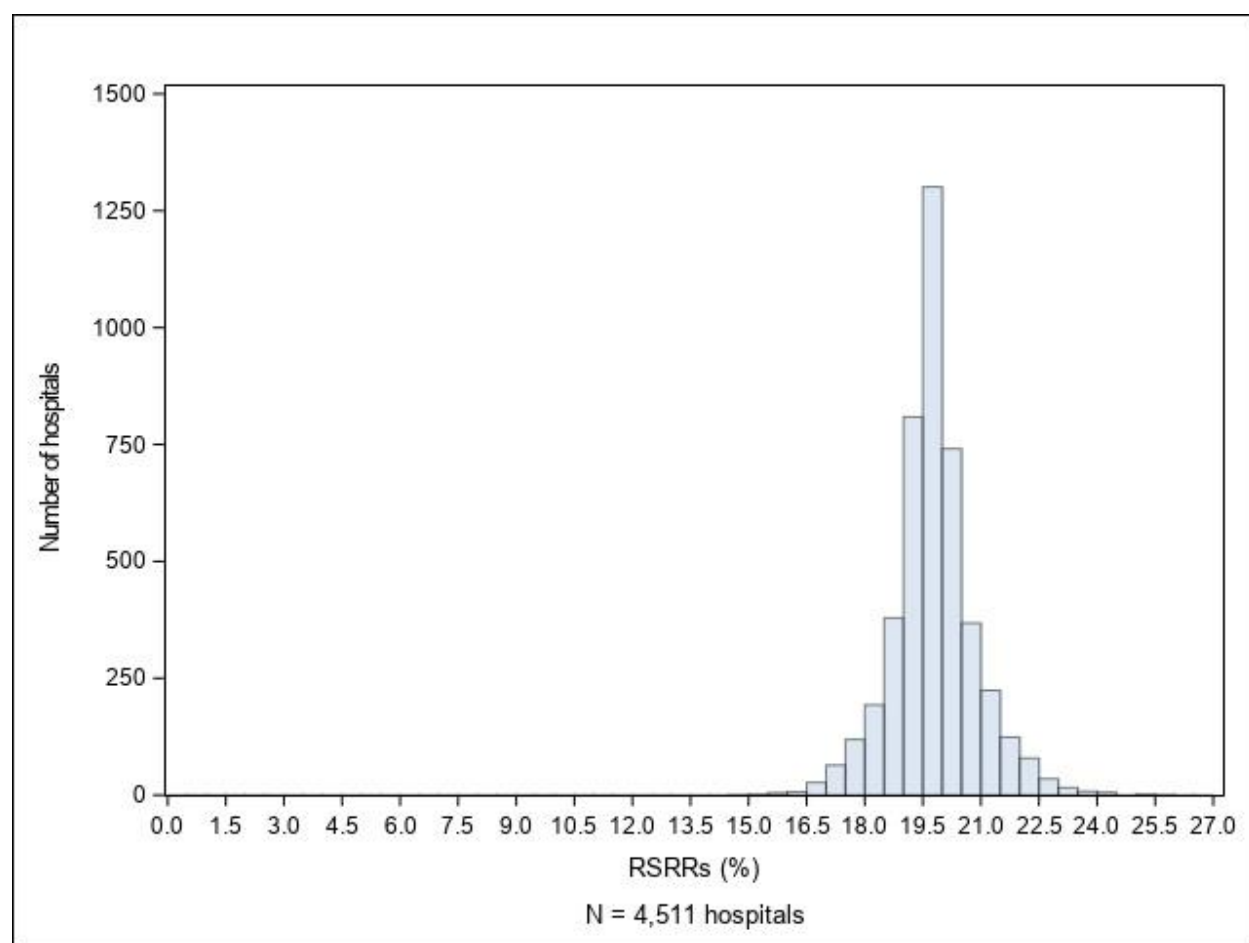
Table 4.4.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

Table 4.4.4.3 — Between-Hospital Variance for HF over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Between-hospital variance (SE)	0.016 (0.002)	0.017 (0.002)	0.014 (0.002)	0.018 (0.001)

Figure 4.4.4.1 shows the overall distribution of the hospital RSRRs for the combined three-year dataset, which indicates that the hospital RSRRs are normally distributed. The odds of all-cause readmission if a patient is treated at a hospital one SD above the national rate were 1.31 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 1.0.¹⁵

Figure 4.4.4.1 — Distribution of Hospital 30-Day HF RSRRs between July 2020 and June 2023



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

Of 4,511 hospitals in the study cohort, 63 performed “Better than the National Rate,” 3,158 performed “No Different than the National Rate,” and 56 performed “Worse than the National Rate.” 1,234 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.5. Pneumonia Readmission 2024 Model Results

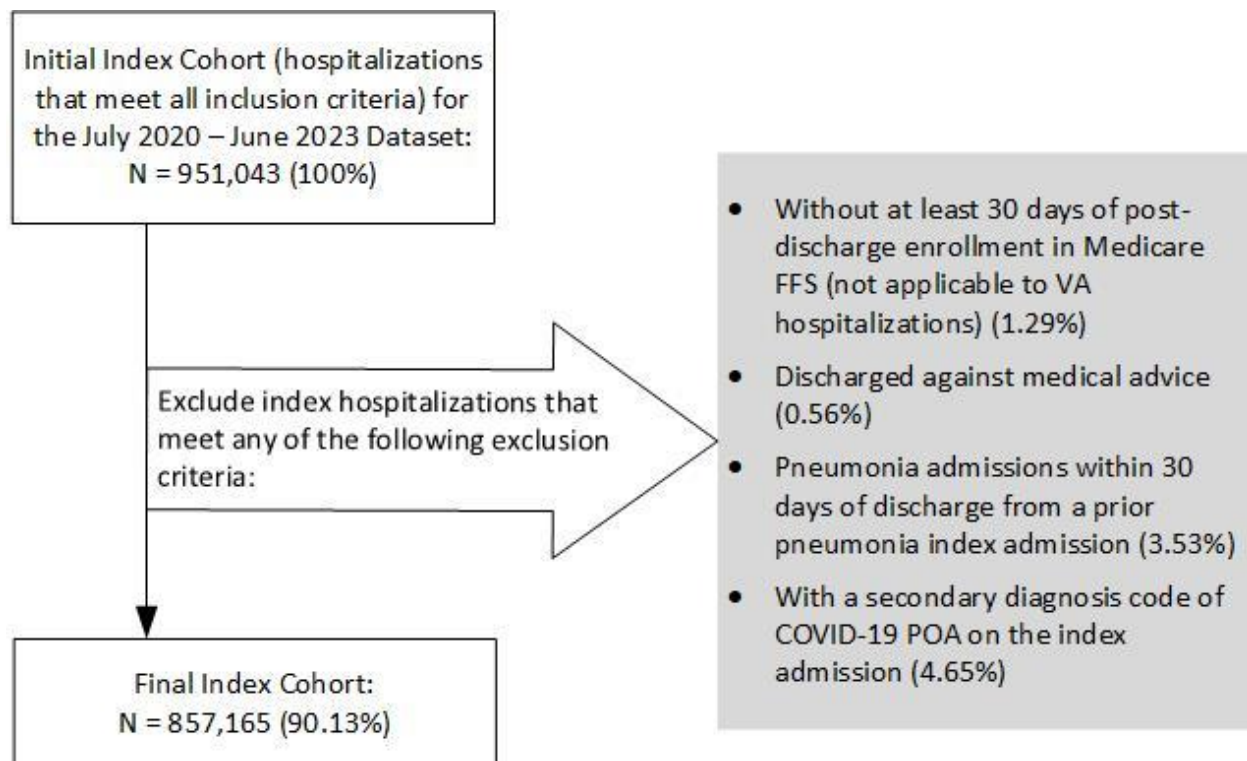
4.5.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in [Section 2.2.1](#). The percentage of pneumonia admissions that met each exclusion criterion in the July 2020 – June 2023 dataset is presented in [Figure 4.5.1.1](#).

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 patients:

- aged 65 or over;
- with one of the following:
 1. A principal discharge diagnosis of pneumonia; or
 2. a. A principal discharge diagnosis of sepsis (that is not severe); and
b. A secondary diagnosis of pneumonia coded as POA; and
c. No secondary diagnosis of sepsis that is both severe and coded as POA
- enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations);
- who were not transferred to another acute care facility; and
- were alive at discharge.

Figure 4.5.1.1 — Pneumonia Cohort Exclusions in the July 2020 – June 2023 Dataset



4.5.2 Frequency of Pneumonia Model Variables

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

Refer to [Table 4.5.2.1](#) for more detail.

Table 4.5.2.1 — Frequency of Pneumonia Model Variables over Different Time Periods

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Total N	251,679	281,047	324,439	857,165
Mean Age (SD)	79.5 (8.5)	79.8 (8.5)	79.9 (8.4)	79.7 (8.5)
Male	52.2	50.2	48.6	50.2
History of COVID-19	9.5	17.9	26.7	18.8
History of coronary artery bypass graft (CABG) surgery	9.3	9.2	8.6	9.0
Severe infection; other infectious diseases (CC 1, 3 – 7)	38.3	43.8	44.3	42.4
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	15.7	18.7	18.9	17.9
Metastatic cancer and acute leukemia (CC 8)	7.5	7.3	7.0	7.2
Lung and other severe cancers (CC 9)	9.6	9.6	9.5	9.6
Lymphoma; other cancers (CC 10 – 12)	16.9	18.9	19.2	18.4
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	42.3	43.4	43.1	43.0
Protein-calorie malnutrition (CC 21)	19.8	20.5	20.6	20.4
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	61.9	65.1	65.6	64.3
Other gastrointestinal disorders (CC 38)	64.6	69.8	69.4	68.1
Severe hematological disorders (CC 46)	1.9	2.0	1.9	2.0
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	55.0	58.8	59.1	57.8
Dementia or other specified brain disorders (CC 51 – 53)	32.7	33.5	32.6	32.9
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	17.7	19.1	19.3	18.8
Major psychiatric disorders (CC 57 – 59)	14.9	16.9	17.4	16.5
Other psychiatric disorders (CC 63)	25.5	29.0	28.7	27.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	11.7	11.9	11.3	11.6
Respirator dependence/tracheostomy status (CC 82)	2.0	2.0	1.7	1.9
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	60.7	66.9	69.7	66.1
Congestive heart failure (CC 85)	47.4	50.7	51.5	50.1
Acute coronary syndrome (CC 86 – 87)	15.0	17.7	18.4	17.1
Coronary atherosclerosis or angina (CC 88 – 89)	43.6	45.9	45.8	45.2
Valvular and rheumatic heart disease (CC 91)	22.7	28.8	30.1	27.5

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	50.7	54.9	55.5	53.9
Stroke (CC 99 – 100)	8.6	10.2	9.8	9.6
Vascular or circulatory disease (CC 106 – 109)	45.1	51.6	51.8	49.8
Chronic obstructive pulmonary disease (COPD) (CC 111)	45.7	47.7	48.1	47.3
Fibrosis of lung or other chronic lung disorders (CC 112)	10.6	12.9	13.6	12.5
Asthma (CC 113)	9.3	11.9	13.1	11.6
Pneumonia (CC 114 – 116)	32.9	37.6	37.7	36.3
Pleural effusion/pneumothorax (CC 117)	20.2	22.7	23.1	22.1
Other respiratory disorders (CC 118)	39.3	46.3	49.6	45.5
Dialysis status (CC 134)	4.3	3.9	3.7	3.9
Renal failure (CC 135 – 140)	51.3	52.7	52.1	52.0
Urinary tract infection (CC 144)	32.3	34.9	34.1	33.8
Other urinary tract disorders (CC 145)	16.5	20.5	20.2	19.2
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	15.4	16.9	16.3	16.2
Vertebral fractures without spinal cord injury (CC 169)	4.6	6.0	6.0	5.6
Other injuries (CC 174)	29.2	37.7	38.2	35.4

4.5.3 Pneumonia Model Parameters and Performance

Table 4.5.3.1 shows hierarchical logistic regression model parameter coefficients by individual year and for the combined three-year dataset.

Table 4.5.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for Pneumonia over Different Time Periods

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Intercept	-2.305	-2.587	-2.697	-2.513
Years over 65 (continuous)	-0.009	-0.009	-0.007	-0.009
Male	-0.011	0.030	0.045	0.028
History of COVID-19	-0.102	-0.030	-0.026	-0.075
History of coronary artery bypass graft (CABG) surgery	-0.019	-0.048	-0.030	-0.029
Severe infection; other infectious diseases (CC 1, 3 – 7)	0.043	0.036	0.026	0.028
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	0.098	0.122	0.116	0.112
Metastatic cancer and acute leukemia (CC 8)	0.147	0.194	0.189	0.182
Lung and other severe cancers (CC 9)	0.133	0.122	0.123	0.126
Lymphoma; other cancers (CC 10 – 12)	0.045	0.034	0.024	0.028
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.090	0.098	0.097	0.093
Protein-calorie malnutrition (CC 21)	0.098	0.126	0.165	0.131

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	0.082	0.121	0.130	0.108
Other gastrointestinal disorders (CC 38)	0.053	0.062	0.071	0.061
Severe hematological disorders (CC 46)	0.359	0.200	0.228	0.263
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.177	0.182	0.185	0.181
Dementia or other specified brain disorders (CC 51 – 53)	-0.034	-0.008	0.012	-0.006
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	0.067	0.061	0.061	0.059
Major psychiatric disorders (CC 57 – 59)	0.007	0.038	0.021	0.019
Other psychiatric disorders (CC 63)	0.059	0.035	0.065	0.054
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.108	0.118	0.104	0.111
Respirator dependence/tracheostomy status (CC 82)	0.139	0.173	0.198	0.177
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	0.071	0.056	0.051	0.051
Congestive heart failure (CC 85)	0.180	0.171	0.204	0.188
Acute coronary syndrome (CC 86 – 87)	0.088	0.080	0.075	0.075
Coronary atherosclerosis or angina (CC 88 – 89)	0.032	0.038	0.026	0.032
Valvular and rheumatic heart disease (CC 91)	0.051	0.073	0.048	0.051
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.093	0.108	0.103	0.100
Stroke (CC 99 – 100)	0.029	0.036	0.024	0.028
Vascular or circulatory disease (CC 106 – 109)	0.057	0.052	0.057	0.051
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.142	0.137	0.119	0.134
Fibrosis of lung or other chronic lung disorders (CC 112)	0.099	0.110	0.124	0.110
Asthma (CC 113)	0.012	0.001	-0.021	-0.014
Pneumonia (CC 114 – 116)	0.091	0.110	0.114	0.107
Pleural effusion/pneumothorax (CC 117)	0.144	0.170	0.180	0.166
Other respiratory disorders (CC 118)	0.025	0.029	0.034	0.021
Dialysis status (CC 134)	0.278	0.188	0.232	0.240
Renal failure (CC 135 – 140)	0.116	0.116	0.134	0.126
Urinary tract infection (CC 144)	0.032	0.058	0.065	0.055
Other urinary tract disorders (CC 145)	0.041	0.055	0.036	0.039
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.113	0.096	0.122	0.113
Vertebral fractures without spinal cord injury (CC 169)	0.043	0.004	0.077	0.043
Other injuries (CC 174)	0.016	0.037	0.016	0.014

Table 4.5.3.2 shows the risk-adjusted ORs and 95% CIs for the pneumonia readmission model by individual year and for the combined three-year dataset.

Table 4.5.3.2 — Adjusted OR and 95% CIs for the Pneumonia Hierarchical Logistic Regression Model over Different Time Periods

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Years over 65 (continuous)	0.99 (0.99-0.99)	0.99 (0.99-0.99)	0.99 (0.99-0.99)	0.99 (0.99-0.99)
Male	0.99 (0.97-1.01)	1.03 (1.01-1.05)	1.05 (1.02-1.07)	1.03 (1.02-1.04)
History of COVID-19	0.90 (0.87-0.94)	0.97 (0.94-1.00)	0.97 (0.95-1.00)	0.93 (0.91-0.94)
History of coronary artery bypass graft (CABG) surgery	0.98 (0.94-1.02)	0.95 (0.92-0.99)	0.97 (0.94-1.01)	0.97 (0.95-0.99)
Severe infection; other infectious diseases (CC 1, 3 – 7)	1.04 (1.02-1.07)	1.04 (1.01-1.06)	1.03 (1.01-1.05)	1.03 (1.02-1.04)
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	1.10 (1.07-1.14)	1.13 (1.10-1.16)	1.12 (1.09-1.15)	1.12 (1.10-1.14)
Metastatic cancer and acute leukemia (CC 8)	1.16 (1.11-1.21)	1.21 (1.16-1.27)	1.21 (1.16-1.26)	1.20 (1.17-1.23)
Lung and other severe cancers (CC 9)	1.14 (1.10-1.19)	1.13 (1.09-1.17)	1.13 (1.09-1.17)	1.13 (1.11-1.16)
Lymphoma; other cancers (CC 10 – 12)	1.05 (1.02-1.08)	1.03 (1.01-1.06)	1.02 (1.00-1.05)	1.03 (1.01-1.05)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	1.09 (1.07-1.12)	1.10 (1.08-1.13)	1.10 (1.08-1.12)	1.10 (1.08-1.11)
Protein-calorie malnutrition (CC 21)	1.10 (1.07-1.13)	1.13 (1.11-1.16)	1.18 (1.15-1.21)	1.14 (1.12-1.16)
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	1.09 (1.06-1.11)	1.13 (1.10-1.16)	1.14 (1.11-1.17)	1.11 (1.10-1.13)
Other gastrointestinal disorders (CC 38)	1.05 (1.03-1.08)	1.06 (1.04-1.09)	1.07 (1.05-1.10)	1.06 (1.05-1.08)
Severe hematological disorders (CC 46)	1.43 (1.34-1.53)	1.22 (1.14-1.30)	1.26 (1.18-1.34)	1.30 (1.25-1.35)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.19 (1.17-1.22)	1.20 (1.17-1.23)	1.20 (1.18-1.23)	1.20 (1.18-1.21)
Dementia or other specified brain disorders (CC 51 – 53)	0.97 (0.94-0.99)	0.99 (0.97-1.02)	1.01 (0.99-1.03)	0.99 (0.98-1.01)
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56, 202 – 203)	1.07 (1.04-1.10)	1.06 (1.03-1.09)	1.06 (1.04-1.09)	1.06 (1.04-1.08)
Major psychiatric disorders (CC 57 – 59)	1.01 (0.98-1.04)	1.04 (1.01-1.07)	1.02 (0.99-1.05)	1.02 (1.00-1.04)
Other psychiatric disorders (CC 63)	1.06 (1.03-1.09)	1.04 (1.01-1.06)	1.07 (1.04-1.09)	1.05 (1.04-1.07)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.11 (1.08-1.15)	1.13 (1.09-1.16)	1.11 (1.08-1.14)	1.12 (1.10-1.14)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Respirator dependence/tracheostomy status (CC 82)	1.15 (1.08-1.23)	1.19 (1.12-1.27)	1.22 (1.14-1.30)	1.19 (1.15-1.24)
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	1.07 (1.05-1.10)	1.06 (1.03-1.08)	1.05 (1.03-1.08)	1.05 (1.04-1.07)
Congestive heart failure (CC 85)	1.20 (1.17-1.23)	1.19 (1.16-1.22)	1.23 (1.20-1.26)	1.21 (1.19-1.22)
Acute coronary syndrome (CC 86 – 87)	1.09 (1.06-1.12)	1.08 (1.05-1.11)	1.08 (1.05-1.11)	1.08 (1.06-1.10)
Coronary atherosclerosis or angina (CC 88 – 89)	1.03 (1.01-1.06)	1.04 (1.02-1.06)	1.03 (1.00-1.05)	1.03 (1.02-1.05)
Valvular and rheumatic heart disease (CC 91)	1.05 (1.03-1.08)	1.08 (1.05-1.10)	1.05 (1.03-1.07)	1.05 (1.04-1.07)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.10 (1.07-1.12)	1.11 (1.09-1.14)	1.11 (1.08-1.13)	1.11 (1.09-1.12)
Stroke (CC 99 – 100)	1.03 (0.99-1.07)	1.04 (1.00-1.07)	1.02 (0.99-1.06)	1.03 (1.01-1.05)
Vascular or circulatory disease (CC 106 – 109)	1.06 (1.04-1.08)	1.05 (1.03-1.08)	1.06 (1.04-1.08)	1.05 (1.04-1.07)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.15 (1.13-1.18)	1.15 (1.12-1.17)	1.13 (1.10-1.15)	1.14 (1.13-1.16)
Fibrosis of lung or other chronic lung disorders (CC 112)	1.10 (1.07-1.14)	1.12 (1.08-1.15)	1.13 (1.10-1.16)	1.12 (1.10-1.14)
Asthma (CC 113)	1.01 (0.98-1.05)	1.00 (0.97-1.03)	0.98 (0.95-1.01)	0.99 (0.97-1.00)
Pneumonia (CC 114 – 116)	1.10 (1.07-1.12)	1.12 (1.09-1.14)	1.12 (1.10-1.15)	1.11 (1.10-1.13)
Pleural effusion/pneumothorax (CC 117)	1.16 (1.13-1.19)	1.18 (1.16-1.21)	1.20 (1.17-1.22)	1.18 (1.16-1.20)
Other respiratory disorders (CC 118)	1.03 (1.00-1.05)	1.03 (1.01-1.05)	1.03 (1.01-1.06)	1.02 (1.01-1.03)
Dialysis status (CC 134)	1.32 (1.26-1.38)	1.21 (1.15-1.27)	1.26 (1.21-1.32)	1.27 (1.24-1.31)
Renal failure (CC 135 – 140)	1.12 (1.10-1.15)	1.12 (1.10-1.15)	1.14 (1.12-1.17)	1.13 (1.12-1.15)
Urinary tract infection (CC 144)	1.03 (1.01-1.06)	1.06 (1.04-1.09)	1.07 (1.04-1.09)	1.06 (1.04-1.07)
Other urinary tract disorders (CC 145)	1.04 (1.01-1.07)	1.06 (1.03-1.08)	1.04 (1.01-1.06)	1.04 (1.02-1.05)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.12 (1.09-1.15)	1.10 (1.07-1.13)	1.13 (1.10-1.16)	1.12 (1.10-1.14)
Vertebral fractures without spinal cord injury (CC 169)	1.04 (0.99-1.10)	1.00 (0.96-1.05)	1.08 (1.04-1.12)	1.04 (1.02-1.07)

Variable	07/2020 – 06/2021 OR (95% CI)	07/2021 – 06/2022 OR (95% CI)	07/2022 – 06/2023 OR (95% CI)	07/2020 – 06/2023 OR (95% CI)
Other injuries (CC 174)	1.02 (0.99-1.04)	1.04 (1.01-1.06)	1.02 (1.00-1.04)	1.01 (1.00-1.03)

Overall, model performance was stable over the three-year time period (Table 4.5.3.3).

Table 4.5.3.3 — Pneumonia Logistic Regression Model Performance over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Predictive ability% (lowest decile – highest decile)	9.2 – 30.6	7.5 – 29.8	6.9 – 29.1	7.9 – 29.6
c-statistic	0.62	0.63	0.64	0.63

4.5.4 Distribution of Hospital Volumes and Readmission Rates for Pneumonia

The national *observed* readmission rate in the combined three-year dataset was 16.4%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 17.5%
- July 1, 2021 – June 30, 2022: 16.2%
- July 1, 2022 – June 30, 2023: 15.7%

Table 4.5.4.1 shows the distribution of hospital admission volumes.

Table 4.5.4.1 — Distribution of Hospital Pneumonia Admission Volumes over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,454	4,457	4,447	4,568
Mean number of admissions (SD)	56.5 (67.5)	63.1 (75.6)	73.0 (90.2)	187.6 (229.9)
Range (min. – max.)	1 – 899	1 – 1,070	1 – 1,286	1 – 3,255
25 th percentile	11	13	13	34
50 th percentile	30	34	40	100
75 th percentile	80	88	104	266

Table 4.5.4.2 shows the distribution of hospital RSRRs.

Table 4.5.4.2 — Distribution of Hospital Pneumonia RSRRs over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,454	4,457	4,447	4,568
Mean (SD)	17.5 (0.5)	16.2 (0.8)	15.7 (0.6)	16.4 (0.9)
Range (min. – max.)	15.4 – 21.5	12.7 – 21.7	13.1 – 20.2	12.7 – 24.3

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
25 th percentile	17.2	15.8	15.4	15.9
50 th percentile	17.4	16.1	15.6	16.3
75 th percentile	17.7	16.5	15.9	16.8

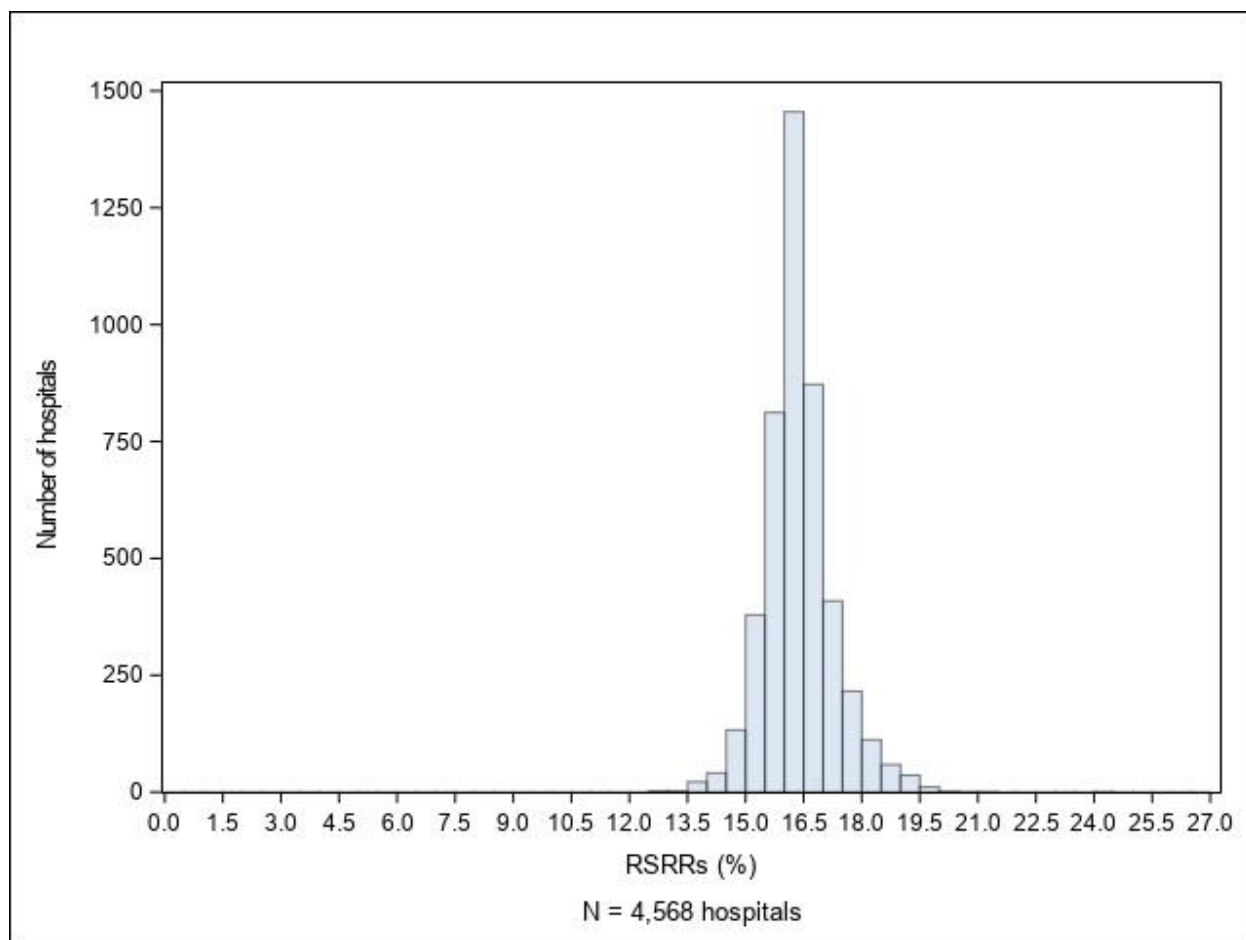
Table 4.5.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

Table 4.5.4.3 — Between-Hospital Variance for Pneumonia over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Between-hospital variance (SE)	0.013 (0.002)	0.025 (0.003)	0.017 (0.002)	0.018 (0.001)

Figure 4.5.4.1 shows the overall distribution of the hospital RSRRs for the combined three-year dataset, which indicates that the hospital RSRRs are normally distributed. The odds of all-cause readmission if a patient is treated at a hospital one SD above the national rate were 1.31 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 1.0.¹⁵

Figure 4.5.4.1 — Distribution of Hospital 30-Day Pneumonia RSRRs between July 2020 and June 2023



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

Of 4,568 hospitals in the study cohort, 23 performed “Better than the National Rate,” 3,665 performed “No Different than the National Rate,” and 55 performed “Worse than the National Rate.” 825 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

5. GLOSSARY

Acute care hospital: A hospital that provides inpatient medical care for surgery and acute medical conditions or injuries. Short-term acute care hospitals provide care for short-term illnesses and conditions. In contrast, long-term acute care hospitals generally treat medically complex patients who require long-stay hospital-level care, which is generally defined as an inpatient length of stay more than 25 days.

Bootstrapping: The bootstrap is a computer-based method for estimating the standard error of an estimate when the estimate is based on a sample with an unknown probability distribution. Bootstrap methods depend on the bootstrap sample, which is a random sample of size n drawn with replacement from the population of n objects. The bootstrap algorithm works by drawing many independent bootstrap samples, evaluating the corresponding bootstrap replications, and estimating the standard error of the statistic by the empirical SD of the replications.

C-statistic: An indicator of the model's discriminant ability or ability to correctly classify those patients 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 that patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in their patients' outcomes.

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

Clinical Classification Software (CCS): Software maintained by the AHRQ HCUP that groups thousands of individual procedure and diagnosis codes into clinically coherent, mutually exclusive procedure and diagnosis categories. AHRQ CCS categories are used to determine if a readmission is planned. AHRQ CCS procedure categories are used to define planned and potentially planned procedures. AHRQ 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). Mappings which show the assignment of ICD-10 codes to the AHRQ CCS diagnosis and procedure categories for 2024 public reporting are posted [here](#) on *QualityNet*.

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

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

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

Condition Categories (CCs): Groupings of ICD-10-CM diagnosis codes into clinically relevant categories, from the HCC system.^{20, 21} CMS uses modified groupings, but not the hierarchical logic of the system, to create risk factor variables. Mappings which show the assignment of ICD-10 codes to the CCs are available [here](#) on *QualityNet*.

Confidence interval (CI): A CI is a range of values that describes the uncertainty surrounding an estimate. It is indicated by its endpoints; for example, a 95% CI for the OR associated with 'Protein-

calorie malnutrition' noted as "1.09 – 1.15" means that we are confident that 95 out of 100 times the estimated 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 Generalized Linear Model (HGLM): A widely accepted statistical method that enables evaluation of relative hospital performance by accounting for patient risk factors. This statistical model accounts for the hierarchical structure of the data (patients clustered within hospitals are assumed to be correlated) and accommodates modeling of the association between outcomes and patient characteristics. Based on the hierarchical model, we can evaluate:

- how much variation in hospital readmission rates overall is accounted for by patients' individual risk factors (such as age and other medical conditions); and
- how much variation is accounted for by hospital contribution to readmission risk.

A hierarchical logistic regression model is a type of HGLM used for binary outcomes.

Hospital-specific effect: A measure of a hospital's quality of care that is calculated using hierarchical logistic regression, taking into consideration the number of patients who are eligible for the cohort, these patients' risk factors, and the number who are readmitted. The hospital-specific effect is the calculated random effect intercept for each hospital. A hospital-specific effect less than the average hospital-specific effect indicates the hospital performed better on the measure than the average hospital with the same case mix, a hospital-specific effect greater than the average hospital-specific effect indicates the hospital performed worse than average, and a hospital-specific effect near the average hospital-specific effect indicates about average performance. 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, or pneumonia 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 there is 95% confidence 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 directly from Medicare for each individual service provided. Patients in managed care (Medicare Advantage) are excluded from 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-adjustment variable present relative to those without the risk-adjustment variable present. The model coefficient for each risk-adjustment 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 captured 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.

Predictive ability: An indicator of the model's discriminant ability or ability to distinguish high-risk subjects from low-risk subjects. A wide range between the lowest decile and highest decile suggests better discrimination.

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.

VA beneficiary: For the purposes of our measures, a "VA beneficiary" is a patient who has VA healthcare benefits (according to VA administrative data). They may or may not be dually enrolled in Medicare FFS.

6. REFERENCES

1. Bradley EH, Curry L, Horwitz LI, et al. Hospital strategies associated with 30-day readmission rates for patients with heart failure. *Circulation Cardiovascular quality and outcomes*. Jul 2013;6(4):444-50. doi:10.1161/circoutcomes.111.000101
2. Goldgrab D, Balakumaran K, Kim MJ, Tabatabai SR. Updates in heart failure 30-day readmission prevention. *Heart Fail Rev*. Mar 2019;24(2):177-187. doi:10.1007/s10741-018-9754-4
3. Horwitz LI, Grady JN, Cohen DB, et al. Development and validation of an algorithm to identify planned readmissions from claims data. *J Hosp Med*. Oct 2015;10(10):670-677. doi:10.1002/jhm.2416
4. Keenan PS, Normand S-LT, Lin Z, et al. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. *Circ Cardiovasc Qual Outcomes*. Sep 2008;1(1):29-37. doi:10.1161/CIRCOUTCOMES.108.802686
5. Krumholz HM, Lin Z, Drye EE, et al. An administrative claims measure suitable for profiling hospital performance based on 30-day all-cause readmission rates among patients with acute myocardial infarction. *Circ Cardiovasc Qual Outcomes*. Mar 2011;4(2):243-52. doi:10.1161/CIRCOUTCOMES.110.957498
6. Lindenauer PK, Strait KM, Grady JN, et al. Variation in the Diagnosis of Aspiration Pneumonia and Association with Hospital Pneumonia Outcomes. *Ann Am Thorac Soc*. May 2018;15(5):562-569. doi:10.1513/AnnalsATS.201709-728OC
7. Yazdanyar A, Lo KB, Pelayo J, et al. Association Between Cirrhosis and 30-Day Rehospitalization After Index Hospitalization for Heart Failure. *Curr Probl Cardiol*. Oct 2022;47(10):100993. doi:10.1016/j.cpcardiol.2021.100993
8. Dharmarajan K, Hsieh AF, Kulkarni VT, et al. Trajectories of risk after hospitalization for heart failure, acute myocardial infarction, or pneumonia: retrospective cohort study. *BMJ*. Feb 5 2015;350:h411. doi:10.1136/bmj.h411
9. Gil M, Mikaitis DK, Shier G, et al. Impact of a combined pharmacist and social worker program to reduce hospital readmissions. *J Manag Care Pharm*. Sep 2013;19(7):558-63. doi:10.18553/jmcp.2013.19.7.558
10. Graham J, Tomcavage J, Salek D, et al. Postdischarge monitoring using interactive voice response system reduces 30-day readmission rates in a case-managed Medicare population. *Med Care*. Jan 2012;50(1):50-7. doi:10.1097/MLR.0b013e318229433e
11. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA*. May 5 2010;303(17):1716-22. doi:10.1001/jama.2010.533
12. Lee JS, Nsa W, Hausmann LR, et al. Quality of care for elderly patients hospitalized for pneumonia in the United States, 2006 to 2010. *JAMA Intern Med*. Nov 2014;174(11):1806-14. doi:10.1001/jamainternmed.2014.4501
13. Leppin AL, Gionfriddo MR, Kessler M, et al. Preventing 30-day hospital readmissions: a systematic review and meta-analysis of randomized trials. *JAMA Intern Med*. Jul 2014;174(7):1095-107. doi:10.1001/jamainternmed.2014.1608
14. Sanchez GM, Douglass MA, Mancuso MA. Revisiting Project Re-Engineered Discharge (RED): the impact of a pharmacist telephone intervention on hospital readmission rates. *Pharmacotherapy*. Sep 2015;35(9):805-12. doi:10.1002/phar.1630
15. Normand S-LT, Shahian DM. Statistical and clinical aspects of hospital outcomes profiling. *Statist Sci*. May 2007 2007;22(2):206-226. doi:10.1214/088342307000000096
16. Centers for Medicare & Medicaid Services (CMS). CMS Announces Relief for Clinicians, Providers, Hospitals and Facilities Participating in Quality Reporting Programs in Response to COVID-19.

Accessed March 4, 2024. <https://www.cms.gov/Newsroom/Press-Releases/Cms-Announces-Relief-Clinicians-Providers-Hospitals-And-Facilities-Participating-Quality-Reporting>

17. Centers for Medicare & Medicaid Services (CMS). COVID-19 Quality Reporting Programs Guidance Memo. Accessed March 4, 2024. <https://www.cms.gov/files/document/guidance-memo-exceptions-and-extensions-quality-reporting-and-value-based-purchasing-programs.pdf>
18. Hospital Inpatient Value, Incentives, and Quality Reporting Outreach and Education Support Contractor (Health Services Advisory Group, Inc.). CMS Announces Updates on Hospital Quality Reporting and Value-based Payment Programs due to the COVID-19 Public Health Emergency. Accessed March 4, 2024. <https://qualitynet.cms.gov/files/5f0707a3b8112700239dca19?filename=2020-62-IP.pdf>
19. Centers for Medicare & Medicaid Services (CMS). Frequently Asked Questions: COVID-19 Extraordinary Circumstances Exception for Inpatient Acute Care Hospitals. Accessed March 4, 2024. https://qualitynet.cms.gov/files/5f6d198d4ac8370021c54179?filename=HQR_FAQs_092420.pdf
20. Pope GC, Ellis RP, Ash AS, et al. Diagnostic cost group hierarchical condition category models for Medicare risk adjustment. *Final Report to the Health Care Financing Administration under Contract Number 500-95-048*. Health Economics Research, Inc. Accessed March 4, 2024. http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf
21. Pope GC, Kautter J, Ingber MJ, et al. Evaluation of the CMS-HCC Risk Adjustment Model: Final Report. RTI International. Updated March 2011. Accessed March 4, 2024. https://www.cms.gov/Medicare/Health-Plans/MedicareAdvtgSpecRateStats/downloads/evaluation_risk_adj_model_2011.pdf
22. Daniels MJ, Gatsonis C. Hierarchical generalized linear models in the analysis of variations in health care utilization. *J Am Stat Assoc*. 1999;94(445):29-42. doi:10.1080/01621459.1999.10473816
23. Normand S-LT, Wang Y, Krumholz HM. Assessing surrogacy of data sources for institutional comparisons. *Health Serv Outcomes Res Meth*. 2007/06/01 2007;7(1-2):79-96. doi:10.1007/s10742-006-0018-8
24. Triche EW, Xin X, Stackland S, et al. Incorporating Present-on-Admission Indicators in Medicare Claims to Inform Hospital Quality Measure Risk Adjustment Models. *JAMA Netw Open*. May 3 2021;4(5):e218512. doi:10.1001/jamanetworkopen.2021.8512
25. Lampropulos JF, Kim N, Wang Y, et al. Trends in left ventricular assist device use and outcomes among Medicare beneficiaries, 2004-2011. *Open Heart*. 2014;1(1):e000109. doi:10.1136/openhrt-2014-000109
26. Goldstein LB. Accuracy of ICD-9-CM coding for the identification of patients with acute ischemic stroke: effect of modifier codes. *Stroke*. Aug 1998;29(8):1602-1604.

7. APPENDICES

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

The condition-specific measures use hierarchical generalized linear models (HGLMs) to estimate risk-standardized readmission rates for hospitals. This modeling approach accounts for the within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes.

In each measure, an HGLM model is estimated. Then for each hospital, a standardized readmission ratio (SRR) is calculated. The RSRR is calculated by multiplying the SRR for each hospital by the national observed readmission rate.

Hierarchical Generalized Linear Model

For each measure, we fit an HGLM, which accounts for clustering of observations within hospitals. We assume the outcome has a known exponential family distribution and relates linearly to the covariates via a known link function, h . Specifically, we assume a binomial distribution and a logit link function. Further, we account for the clustering within hospitals by estimating a hospital-specific effect, α_i , which we assume follows a normal distribution with a mean μ and variance τ^2 , the between-hospital variance component. The following equation defines the HGLM:

$$h(\Pr(Y_{ij} = 1|Z_{ij}, \omega_i)) = \log\left(\frac{\Pr(Y_{ij}=1|Z_{ij}, \omega_i)}{1-\Pr(Y_{ij}=1|Z_{ij}, \omega_i)}\right) = \alpha_i + \beta Z_{ij} \quad (1)$$

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

$$i=1, \dots, l; j=1, \dots, n_i$$

where Y_{ij} denotes the outcome (equal to 1 if the patient is readmitted within 30 days of discharge, 0 otherwise) for the j -th patient at the i -th hospital; $Z_{ij} = (Z_{ij1}, Z_{ij2}, \dots, Z_{ijp})^T$ is a set of p patient-specific covariates derived from the data; l denotes the total number of hospitals; and n_i denotes the number of index admissions at hospital i . The hospital-specific intercept of the i -th hospital, α_i , defined above, comprises μ , the adjusted average intercept over all hospitals in the sample, and ω_i , the hospital-specific intercept deviation from μ .²²

We estimate the HGLMs using the SAS software system (GLIMMIX procedure).

Risk-Standardized Measure Score Calculation

Using the HGLM defined by Equation (1), to obtain the parameter estimates $\hat{\mu}$, $\{\hat{\alpha}_1, \hat{\alpha}_2, \dots, \hat{\alpha}_l\}$, $\hat{\beta}$, and $\hat{\tau}^2$, we calculate an SRR, \hat{s}_i , for each hospital by computing the ratio of the number of predicted readmissions to the number of expected readmissions. Specifically, we calculate:

$$\text{Predicted Value: } \hat{p}_{ij} = h^{-1}(\hat{\alpha}_i + \hat{\beta} Z_{ij}) = \frac{\exp(\hat{\alpha}_i + \hat{\beta} Z_{ij})}{\exp(\hat{\alpha}_i + \hat{\beta} Z_{ij}) + 1} \quad (2)$$

$$\text{Expected Value: } \hat{e}_{ij} = h^{-1}(\hat{\mu} + \hat{\beta}Z_{ij}) = \frac{\exp(\hat{\mu} + \hat{\beta}Z_{ij})}{\exp(\hat{\mu} + \hat{\beta}Z_{ij}) + 1} \quad (3)$$

$$\text{Standardized Readmission Ratio: } \hat{s}_i = \frac{\sum_{j=1}^{n_i} \hat{p}_{ij}}{\sum_{j=1}^{n_i} \hat{e}_{ij}} \quad (4)$$

We calculate an RSRR, \widehat{RSRR}_i , for each hospital by using the estimate from Equation (4) and multiplying by the national observed readmission rate, denoted by \bar{y} . Specifically, we calculate:

$$\text{Risk-Standardized Readmission Rate: } \widehat{RSRR}_i = \hat{s}_i \times \bar{y} \quad (5)$$

Creating Interval Estimates

The measure score is a complex function of parameter estimates; therefore, we use re-sampling and simulation techniques to derive an interval estimate to determine if a hospital is performing better than, worse than, or no different than expected. A hospital is considered better than expected if the upper bound of their CI falls below the national observed readmission rate, \bar{y} , and considered worse if the lower bound of their entire CI falls above \bar{y} . A hospital is considered no different than expected if the CI overlaps \bar{y} .

More specifically, we use bootstrapping procedures to compute the CIs. Because the theoretical-based standard errors are not easily derived, and to avoid making unnecessary assumptions, we use the bootstrap to empirically construct the sampling distribution for each hospital risk-standardized ratio. The bootstrapping algorithm is described below.

Bootstrapping Algorithm

Let I denote the total number of hospitals in the sample. We repeat steps 1 – 4 below for $b = 1, 2, \dots, B$ times:

1. Sample I hospitals with replacement.
2. Fit the HGLM defined by Equation (1) using all patients within each sampled hospital. The starting values are the parameter estimates obtained by fitting the model to all hospitals. If some hospitals are selected more than once in a bootstrapped sample, we treat them as distinct so that we have I random effects to estimate the variance components. After Step 2, we have:
 - a. The estimated regression coefficients of the risk factors, $\hat{\beta}^{(b)}$.
 - b. The parameters governing the random effects, hospital adjusted outcomes, distribution $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$.
 - c. The set of hospital-specific intercepts and corresponding variances, $\{\hat{\alpha}_i^{(b)}, \text{var}(\hat{\alpha}_i^{(b)})\}; i = 1, 2, \dots, I\}$.

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 $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \text{var}(\alpha_i^{(b)}))$ 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 $\hat{p}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\hat{s}_i^{(b)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\alpha_i^{(b*)}$ is obtained from Step 3.

Ninety-five percent interval estimates (or alternative interval estimates) for the hospital-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of a large selected number of estimates for all hospitals (or the percentiles corresponding to the alternative desired intervals).²³

Appendix B. Data QA

This production year required updates to all SAS packs to account for updates in ICD-10 codes and associated mappings of clinical groupers.

This section represents QA for the subset of the work YNHSC/CORE conducted to maintain and report these readmission measures. It does not describe the QA for processing data and creating the input files, nor does it include the QA for the final processing of production data for public reporting, because another contractor conducts that work.

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

Phase I

As the first step in the QA process, we review changes in the cohort and outcome definitions as determined by the measure-specific code set files that were updated to account for changes in ICD-10 coding. This includes updates to the AHRQ HCUP CCS and the HCC clinical category maps.

In general, we use both manual scan and descriptive analyses to conduct data validity checks, including cross-checking readmission information, distributions of ICD-10 codes, and frequencies of key variables.

Phase II

We update the existing SAS packs to accommodate the new codes and updates to the measures. To ensure accuracy in SAS pack coding, two analysts independently write SAS code for any major 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 III

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

During this phase, we also compare prior years' risk-adjustment coefficients and variable frequencies to enable us to check for potential inconsistencies in the data and the impact of any changes to the SAS packs. Anything that seems outside of normal coding fluctuation is reviewed in more detail.

Appendix C. Annual Updates

Prior annual updates for the measures can be found in the annual updates and specifications reports available [here](#) on *QualityNet*. For convenience, we have listed all prior updates 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.

2024

2024 Measures Updates and Specifications Report (Version 17.0 — AMI, HF, and Pneumonia) (Version 13.0 — COPD)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2023 public reporting (namely, October 1, 2022 [FY 2023] and April 1, 2023) into the cohort definitions and risk models;
 - applied a YNNHSC/CORE-modified v4.0 of the AHRQ HCUP’s beta version 2019.1 CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2023 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by the activities described in [Section 3.1](#).
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Expanded the measurement period for 2024 public reporting to three years (the typical measurement period prior to the COVID-19 PHE)
 - Rationale: The rates for the measures are calculated using rolling data. Each year, the rates are updated by dropping the data representing the oldest year and adding data for the newest available year. As a result, the 2024 measurement period begins with July 2020 discharges (incremented one year from the start of the 2023 public reporting period of July 2019).

2023

2023 Measures Updates and Specifications Report (Version 16.0 — AMI, HF, and Pneumonia) (Version 12.0 — COPD)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2022 public reporting (namely, October 1, 2021 [FY 2022] and April 1, 2022) into the cohort definitions and risk models;
 - applied a YNNHSC/CORE-modified v3.0 of the AHRQ HCUP’s beta version 2019.1 CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2022 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.

2022 Measures Updates and Specifications Report (Version 15.0 — AMI, HF, and Pneumonia) (Version 11.0 — COPD)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the ICD-10-CM/PCS code set releases since 2021 public reporting (namely, April 1, 2020; August 1, 2020; October 1, 2020 [FY 2021]; and January 1, 2021) into the cohort definitions and risk models;
 - applied a YNNHSC/CORE-modified v2.0 of the AHRQ HCUP’s beta version 2019.1 CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2021 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Adjusted the specifications and methodologies for all four measures as publicly reported on Medicare.gov in response to the COVID-19 PHE — Specifically, we:
 - removed COVID-19 index admissions from the cohorts;
 - rendered COVID-19 readmissions ineligible for the readmission outcome and excluded them;
 - added a new ‘History of COVID-19’ risk variable to the risk-adjustment models;
 - shortened the measurement period for 2022 public reporting to approximately 29 months (from the typical three-year measurement period), similar to 2021 public reporting; and
 - reduced the look-back period for use of claims/VA data in risk adjustment to less than 12 months (from the typical 12 months) for those patients whose 12-month period included any portion of the January 1, 2020 through June 30, 2020 claims exclusion time frame. This reduced look-back period also applies to the identification of patients with a procedure code for LVAD implantation or heart transplantation prior to the index admission (an exclusion for the HF readmission measure cohort).
 - Rationale: The COVID-19 PHE continues to have significant and enduring effects on the provision of medical care in the country and around the world. Adjustments to measure specifications and methodologies for 2022 help to ensure the intent of the measures is maintained. The measurement period and look-back period reductions (in certain cases) are in response to CMS’s decision to exclude claims data for January 1, 2020 through June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Added a POA algorithm to the risk-adjustment methodology used to pull CC-defined risk-adjustment variables from the index admission claim/VA data
 - Rationale: POA coding is a logical reflection of comorbidities. POA indicators more accurately distinguish complications of care from conditions already present at admission, in comparison to the previous methodology that utilized only the potential complications list.²⁴ Additionally, use of POA indicators helps particularly in cases where a patient has not been hospitalized or had provider visits in the last year or where a comorbid condition present at the time of admission is relatively new.

2021

2021 Measures Updates and Specifications Report (Version 14.0 — AMI, HF, and Pneumonia) (Version 10.0 — COPD)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the FY 2020 version of the ICD-10-CM/PCS (effective with October 1, 2019+ discharges) into the cohort definitions and risk models;
 - applied a YNNHSC/CORE-modified version of the AHRQ HCUP's beta version 2019.1 CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2020 V24 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS and CMS-HCC crosswalk as well as the workgroup review activities.
- Shortened the measurement period for 2021 public reporting to approximately 29 months (from the typical three-year measurement period)
 - Rationale: The measurement period reduction is in response to the COVID-19 PHE and CMS's decision to exclude claims data for January 1, 2020 through June 30, 2020 (Q1 and Q2 of 2020) under its ECE policy.
- Removed the International Classification of Diseases, Ninth Revision (ICD-9) code-based specifications from the measures and SAS packs
 - Rationale: The Medicare claims and VA administrative data for the measurement period of July 1, 2017 through December 1, 2019 are completely ICD-10 code-based. 2020 public reporting was the last year that warranted any ICD-9 code specifications.

2020

2020 Measures Updates and Specifications Report (Version 13.0 — AMI, HF, and Pneumonia) (Version 9.0 — COPD)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the FY 2019 version of the ICD-10-CM/PCS (effective with October 1, 2018+ discharges) into the cohort definitions and risk models;
 - applied version 2019.1 (beta version) of the AHRQ HCUP CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2019 V22 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches.
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS, AHRQ HCUP CCS, and CMS-HCC crosswalk as well as the workgroup review activities.
- Added admission data from VA hospitals to the COPD readmission measure
 - Rationale: Creates a more inclusive perspective of the relative quality of U.S. hospitals
- Added the revenue center codes 0138 (Semi_private 3 and 4 beds-rehabilitation) and 0158 (Room&Board ward (medical or general)-rehabilitation) to the revenue center code list used to

identify transfers to rehabilitation units, to ensure these transfers are not captured as readmissions for any hospital (Refer to the [2018 updates](#) below)

- Rationale: Revenue center codes 0138 and 0158 are appropriate codes for identifying rehabilitation stays in non-VA hospital claims.

2019

2019 Measures Updates and Specifications Report (Version 12.0 — AMI, HF, and Pneumonia) (Version 8.0 — COPD)

- Removed the stroke readmission measure
 - Rationale: Removal of the stroke readmission measure from the Hospital Inpatient Quality Reporting Program measure set was finalized in the FY 2019 IPPS Final Rule.
- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the FY 2018 version of the ICD-10-CM/PCS (effective with October 1, 2017+ discharges) into the cohort definitions, planned readmission algorithm, and risk models;
 - applied version 2018.1 of the AHRQ HCUP CCS for ICD-10-CM/PCS to the planned readmission algorithm;
 - applied a modified version of the FY 2018 V22 CMS-HCC crosswalk that is maintained by RTI International to the risk models; and
 - made additional code specification changes prompted by other workgroup activities, including code frequency monitoring, review of select pre-existing ICD-10 code specifications, and neighboring code searches. For example, ICD-10-CM code I21.9, Acute myocardial infarction, unspecified, was identified through a “neighboring code search” (found near existing code I21.4, Non-ST elevation (N-STEMI) myocardial infarction) and determined through clinical review to be a code which meets measure intent. As a result, it was added to the AMI cohort inclusion list.
 - Rationale: Revisions to the measure specifications were warranted to accommodate updated versions of the ICD-10-CM/PCS, AHRQ HCUP CCS, and CMS-HCC crosswalk as well as the workgroup review activities.

2018

2018 Measures Updates and Specifications Report (Version 11.0 — AMI, HF, and Pneumonia) (Version 7.0 — COPD and Stroke)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
 - incorporated the code changes that occurred in the FY 2017 version of the ICD-10-CM/PCS into the cohort definitions, planned readmission algorithm, and risk models;
 - applied the 2017.1 and 2017.2 versions of the AHRQ HCUP CCS to the planned readmission algorithm for diagnoses and procedures, respectively;
 - applied the FY 2017 version of the V22 CMS-HCC crosswalk maintained by RTI International to the risk models; and
 - monitored code frequencies to identify any code specification changes warranted due to possible changes in coding practices and patterns. Additionally, our clinical and measure experts reviewed the pre-existing ICD-10 code-based specifications to confirm the appropriateness of the specifications unaffected by the updates.
 - Rationale: Updated versions of the ICD-10-CM/PCS, AHRQ HCUP CCS, and CMS-HCC crosswalk were released. Revisions to the measure specifications were warranted to accommodate these updates.
- Updated the methodology used in analytic input file production to identify transfers to rehabilitation units, to further ensure these transfers are not captured as readmissions for any

hospital. In addition to the previous methods described in the [2010](#) and [2017 updates](#) below and the 2010 Measures Maintenance Report posted [here](#) on *QualityNet*, use of revenue center codes has been implemented to help identify these cases in both ICD-9 and ICD-10 code-based non-VA hospital claims. Specifically:

- 0024: Inpatient Rehabilitation Facility services paid under PPS submitted as TOB 11X
- 0118: Private medical or general-rehabilitation
- 0128: Semi-private 2 bed (medical or general)-rehabilitation
- 0148: Private (deluxe)-rehabilitation
 - Rationale: The inability to use principal discharge diagnosis codes to identify rehabilitation stays (due to ICD-10 coding guidance) has led to an under-counting of these transfers primarily for Maryland hospitals and CAHs, hospitals that are not part of the IPPS. Utilization of revenue center codes augments our ability to identify and exclude admissions to rehabilitation beds in these hospitals that are not identified through discharge disposition codes alone. Of note, rehabilitation units are most often identified by CMS certification number (CCN).
- Removed the obstetric AHRQ CCS procedure and diagnosis categories from the planned readmission algorithm. Specifically, AHRQ CCS procedure categories 134 and 135 and AHRQ CCS diagnosis categories 194 and 196 were deleted from the always planned procedure and diagnosis lists, respectively. They remain in the SAS packs but are commented out.
 - Rationale: The obstetric codes were incorporated into the initial planned readmission algorithm specifications during development. They were provided for all-payer settings but are not applicable to the CMS readmission measures that include only those patients aged 65 or over.

2017

2017 Measures Updates and Specifications Report (Version 10.0 — AMI, HF, and Pneumonia) (Version 6.0 — COPD and Stroke)

- Revised the measure specifications to accommodate the implementation of ICD-10 coding — Specifically, we:
 - identified the ICD-10 codes used to define each of the measure cohorts for discharges on or after October 1, 2015;
 - updated the planned readmission algorithm by applying the most recent (2016) version of the ICD-10-based AHRQ HCUP CCS and ICD-10 codes for certain “potentially planned procedures” and “acute diagnoses” to the algorithm specifications, for discharges on or after October 1, 2015; and
 - re-specified the risk models, updating the CC-based risk variables to the ICD-10-compatible HCC system version 22 and applying ICD-10 codes for certain risk variables (for example, ‘History of percutaneous transluminal coronary angioplasty (PTCA)’ to the models.
 - Rationale: The ICD-9 code sets used to report medical diagnoses and inpatient procedures were replaced by ICD-10 code sets on October 1, 2015. The U.S. Department of Health and Human Services mandated that ICD-10 codes be used for medical coding, effective with October 1, 2015 discharges. The measurement period for 2017 public reporting required data from claims that include ICD-10 codes in addition to data from claims that include ICD-9 codes. Thus, re-specification was warranted to accommodate ICD-10 coding.
- Updated the methodologies used to identify transfers to psychiatric and rehabilitation units, to ensure these transfers are not captured as readmissions for any hospital (as described in the [2010 update](#) below and the 2010 Measures Maintenance Report posted [here](#) on *QualityNet*) — Specifically:

- Psychiatric admissions — Criteria (2) and (3) from the 2010 update apply. However, criterion (1) was modified slightly to: the admission being evaluated as a potential readmission has a psychiatric principal discharge diagnosis code (ICD-9-CM codes beginning with “29,” “30,” or “31,” for discharges prior to October 1, 2015, or ICD-10-CM codes beginning with “F,” for discharges on or after October 1, 2015).
- Rehabilitation admissions — For discharges on or after October 1, 2015, the previous approach is replaced with:
 - (1) the index admission has a discharge disposition code to a rehabilitation hospital or rehabilitation unit from the index admission; and
 - (2) the admission being evaluated as a potential readmission occurred on the same day as or the day following the index discharge.
 - Rationale: With the implementation of ICD-10 coding effective with discharges on or after October 1, 2015, the ICD-9-code-based criterion developed in 2010 needed to be re-specified. For psychiatric admissions, defining “psychiatric diagnosis” with ICD-10-CM codes for discharges on or after October 1, 2015 was a simple solution, as mental health diagnosis codes all reside under the Category “F” (Mental, Behavioral and Neurodevelopmental disorders). However, for rehabilitation admissions, rehabilitation diagnosis codes are not coded consistently. Thus, re-defining the V57.0 ICD-9-CM code criterion with ICD-10-CM codes was not a viable option, and a different strategy was warranted.

2016

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

- Updated the pneumonia measure specifications as described in the Reevaluation and Re-Specification Report of the Hospital-Level 30-Day Risk-Standardized Measures Following Hospitalization for Pneumonia posted [here](#) on *QualityNet* — Specifically, we:
 - Updated the pneumonia cohort to 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 or aspiration pneumonia. The need to make these changes was further underscored by wide variation across hospitals in the use of sepsis codes and, to a lesser extent, aspiration pneumonia codes. Systematic changes and differences in hospital coding practices potentially bias efforts to compare hospital performance.
 - Updated the risk variable list in concordance with the expanded cohort (CC 77 and CC 78 added)
 - Rationale: Presence of ‘Respirator 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 time frame.
- Re-specified 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.

- Updated the 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.²⁵ These patients represent a clinically distinct group.
- Added one ischemic stroke code (ICD-9 code 436 Acute, but ill-defined, cerebrovascular disease) to the stroke measure cohort
 - 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 ICD-9 code 436.²⁶ 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.
- Applied the 2015 version of the AHRQ HCUP CCS to the planned readmission algorithm
 - Rationale: A 2015 version of the AHRQ HCUP CCS was released.

2015

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

- Applied the updated AHRQ HCUP CCS version to the planned readmission algorithm
 - Rationale: An updated version of the AHRQ HCUP 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)

- Re-specified 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.
- Applied the updated AHRQ HCUP CCS version to the planned readmission algorithm
 - Rationale: An updated version of the AHRQ HCUP CCS was released in 2013.

2013

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

- Re-specified 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.
- Updated the 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)

- Re-specified the measure 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.
- Updated the 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)

- Re-specified the measure 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.
- Updated the 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.
- Removed ICD-9 code 436 from the measure cohort
 - Rationale: ICD-9-CM code 436 is not commonly used to define acute ischemic stroke.

2012

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

- Added VA one-day stays
 - Rationale: Stays of fewer 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 measures.
- 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.
- Updated the 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 (Version 4.0 — AMI, HF, and Pneumonia)

- Added two pneumonia codes (482.42 and 488.11) to the pneumonia measure cohort
 - 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.
- Added VA hospitals

- Rationale: Creates a more inclusive perspective of the relative quality of U.S. hospitals
- Updated the 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 (Version 3.0 — AMI, HF, and Pneumonia)

- Revised the period for collecting comorbidities from claims
 - 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.
- Updated the methodology used to determine readmission outcome in cases of admission to psychiatric and rehabilitation hospital units — Specifically:
 - Rehabilitation admissions are identified by the ICD-9-CM principal discharge diagnosis code; codes beginning with “V57” indicate admission to a rehabilitation unit.
 - A psychiatric admission is identified 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-CM codes beginning with “29,” “30,” or “31”).
 - (2) The index admission has a discharge disposition code to a psychiatric hospital or psychiatric unit from the index admission.
 - (3) The admission being evaluated as a potential readmission occurred during the same day as or the day following the index discharge.
 - Psychiatric/rehabilitation admissions identified as described above are not captured as readmissions. Note that we do not expect to see rehabilitation claims in hospital data from states other than Maryland.
 - The criteria for identifying such admissions are available in the 2010 Measures Maintenance Report posted [here](#) on *QualityNet*.
 - Rationale: Psychiatric and rehabilitation units within short-term acute care hospitals in Maryland have the same type of provider ID number (or CCN) as the acute care hospital in which they are housed. Transfers to these units can therefore look like readmissions. To accurately assess readmissions in Maryland and allow for public reporting of Maryland readmission rates, methodologies to identify these cases were needed, to ensure these transfers are not counted as readmissions for any hospital.
- Updated the 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 (Version 2.0 — AMI, HF, and Pneumonia)

- Increased the period of claims and enrollment data for public reporting to three years
 - 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.
- Added the exclusion of patients discharged against medical advice
 - Rationale: Providers are unable to deliver full care and prepare the patient for discharge when patients leave against medical advice.
- Updated the 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 (CBE #0505)

Cohort

Inclusion Criteria for AMI Measure

- **Principal discharge diagnosis of AMI**
 - Rationale: AMI is the condition targeted for measurement.
- **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations)**
 - Rationale: For patients who are not VA beneficiaries, the 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission.
- **Aged 65 or over**
 - Rationale: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or over.
- **Discharged alive from a non-federal short-term acute care hospital or VA hospital**
 - Rationale: It is only possible for patients to be readmitted if they are discharged alive.
- **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

- **Without at least 30 days of post-discharge enrollment in Medicare FFS (not applicable to VA hospitalizations)**
 - Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- **Discharged against medical advice**
 - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **Same-day discharges**
 - Rationale: Patients admitted and then discharged on the same day are not included as an index admission because it is unlikely that these admissions are for clinically significant AMIs.
- **AMI admissions within 30 days of discharge from a prior AMI index admission**
 - Rationale: Additional AMI admissions within 30 days are excluded as index admissions because they are part of determination of the outcome. CMS does not want to potentially count the additional admission as both an index admission and an unplanned readmission outcome for the first admission.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**

- Rationale: COVID-19 patients are removed from the AMI cohort in response to the COVID-19 PHE, and to maintain alignment with the AMI readmission measure included in the FY 2025 Hospital Readmission Reduction Program (HRRP).

The ICD-10-CM codes used to define the AMI cohort are outlined in the 2024 AMI Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.

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's 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.
- **Readmissions with a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the readmission claim are not eligible and are excluded**
 - Rationale: COVID-19 readmissions are not eligible for the readmission outcome in response to the COVID-19 PHE, and to maintain alignment with the AMI readmission measure included in the FY 2025 HRRP.

Appendix D.2 Hospital-Level 30-Day RSRR following COPD (CBE #1891)

Cohort

Inclusion Criteria for COPD Measure

- **Principal discharge diagnosis of COPD or principal discharge diagnosis of acute respiratory failure with a secondary diagnosis of COPD with exacerbation**
 - Rationale: COPD is the condition targeted for measurement. Acute 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.
- **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations)**
 - Rationale: For patients who are not VA beneficiaries, the 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission.
- **Aged 65 or over**
 - Rationale: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or over.
- **Discharged alive from a non-federal short-term acute care hospital or VA hospital**
 - Rationale: It is only possible for patients to be readmitted if they are discharged alive.
- **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

- **Without at least 30 days of post-discharge enrollment in Medicare FFS (not applicable to VA hospitalizations)**
 - Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- **Discharged against medical advice**
 - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **COPD admissions within 30 days of discharge from a prior COPD index admission**
 - Rationale: Additional COPD admissions within 30 days are excluded as index admissions because they are part of determination of the outcome. CMS does not want to potentially count the additional admission as both an index admission and an unplanned readmission outcome for the first admission.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
 - Rationale: COVID-19 patients are removed from the COPD cohort in response to the COVID-19 PHE, and to maintain alignment with the COPD readmission measure included in the FY 2025 HRRP.

The ICD-10-CM codes used to define the COPD cohort are outlined in the 2024 COPD Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.

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’s 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.
- **Readmissions with a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the readmission claim are not eligible and are excluded**
 - Rationale: COVID-19 readmissions are not eligible for the readmission outcome in response to the COVID-19 PHE, and to maintain alignment with the COPD readmission measure included in the FY 2025 HRRP.

Appendix D.3 Hospital-Level 30-Day RSRR following HF (CBE #0330)

Cohort

Inclusion Criteria for HF Measure

- **Principal discharge diagnosis of HF**
 - Rationale: HF is the condition targeted for measurement.
- **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations)**
 - Rationale: For patients who are not VA beneficiaries, the 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission.
- **Aged 65 or over**
 - Rationale: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or over.
- **Discharged alive from a non-federal short-term acute care hospital or VA hospital**
 - Rationale: It is only possible for patients to be readmitted if they are discharged alive.
- **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

- **Without at least 30 days of post-discharge enrollment in Medicare FFS (not applicable to VA hospitalizations)**
 - Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- **Discharged against medical advice**
 - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **HF admissions within 30 days of discharge from a prior HF index admission**
 - Rationale: Additional HF admissions within 30 days are excluded as index admissions because they are part of determination of the outcome. CMS does not want to potentially count the additional admission as both an index admission and an unplanned readmission outcome for the first admission.
- **With an ICD-10 code indicating LVAD implantation or heart transplantation either during the index admission or up to 12 months prior to the index admission**
 - Rationale: These patients represent a clinically distinct group.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**
 - Rationale: COVID-19 patients are removed from the HF cohort in response to the COVID-19 PHE, and to maintain alignment with the HF readmission measure included in the FY 2025 HRRP.

The ICD-10 codes used to define HF cohort inclusions and exclusions are outlined in the 2024 HF Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.

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’s 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.
- **Readmissions with a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the readmission claim are not eligible and are excluded**
 - Rationale: COVID-19 readmissions are not eligible for the readmission outcome in response to the COVID-19 PHE, and to maintain alignment with the HF readmission measure included in the FY 2025 HRRP.

Cohort

Inclusion Criteria for Pneumonia Measure

- **Diagnosis coding that met one of the two following requirements:**
 1. **Principal discharge diagnosis of pneumonia**
 2. **a. Principal discharge diagnosis of sepsis (that is not severe); and
b. A secondary diagnosis of pneumonia coded as POA; and
c. No secondary diagnosis of sepsis that is both severe and coded as POA.**
 - Rationale: Pneumonia is the condition targeted for measurement. Sepsis admissions with a secondary diagnosis of pneumonia, as described above, are also included in order for the measure to more fully reflect the population of patients being treated for pneumonia.
- **Enrolled in Medicare FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission (not applicable to VA hospitalizations)**
 - Rationale: For patients who are not VA beneficiaries, the 12-month Part A and Part B prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself. Medicare Part A during the index admission is required to ensure Medicare FFS enrollment at the time of admission.
- **Aged 65 or over**
 - Rationale: Patients younger than 65 are not included in the measure because they are considered to be too clinically distinct from patients 65 or over.
- **Discharged alive from a non-federal short-term acute care hospital or VA hospital**
 - Rationale: It is only possible for patients to be readmitted if they are discharged alive.
- **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

- **Without at least 30 days of post-discharge enrollment in Medicare FFS (not applicable to VA hospitalizations)**
 - Rationale: The 30-day readmission outcome cannot be assessed in this group since claims data are used to determine whether a patient was readmitted.
- **Discharged against medical advice**
 - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **Pneumonia admissions within 30 days of discharge from a prior pneumonia index admission**
 - Rationale: Additional pneumonia admissions within 30 days are excluded as index admissions because they are part of determination of the outcome. CMS does not want to potentially count the additional admission as both an index admission and an unplanned readmission outcome for the first admission.
- **With a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the index admission claim**

- Rationale: COVID-19 patients are removed from the pneumonia cohort in response to the COVID-19 PHE, and to maintain alignment with the pneumonia readmission measure included in the FY 2025 HRRP.

The ICD-10-CM codes used to define the pneumonia cohort are outlined in the 2024 Pneumonia Readmission Measure Code Specifications supplemental file posted [here](#) on *QualityNet*.

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's 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.
- **Readmissions with a principal diagnosis code of COVID-19 or with a secondary diagnosis code of COVID-19 coded as POA on the readmission claim are not eligible and are excluded**
 - Rationale: COVID-19 readmissions are not eligible for the readmission outcome in response to the COVID-19 PHE, and to maintain alignment with the pneumonia readmission measure included in the FY 2025 HRRP.

Appendix E. Planned Readmission Algorithm

Figure E.1 — Planned Readmission Algorithm Version 4.0 2024 Flowchart

