2024 Condition-Specific Mortality Measures Updates and Specifications Report

Acute Myocardial Infarction — Version 18.0
Chronic Obstructive Pulmonary Disease — Version 13.0
Heart Failure — Version 18.0
Pneumonia — Version 18.0
Stroke — Version 13.0

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1. HOW TO USE THIS REPORT

This report describes the Centers for Medicare & Medicaid Services' (CMS's) condition-specific mortality measures that are publicly reported here on Medicare.gov. The measures are used to calculate hospital-level 30-day risk-standardized mortality rates (RSMRs) following acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), pneumonia, and stroke admissions. This report provides 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 and the risk-adjustment variables described in this report are detailed in the following supplemental files:

- 2024 AMI Mortality Measure Code Specifications
- 2024 COPD Mortality Measure Code Specifications
- 2024 HF Mortality Measure Code Specifications
- 2024 Pneumonia Mortality Measure Code Specifications
- 2024 Stroke Mortality Measure Code Specifications

These supplemental files are posted here on *QualityNet.*

This report includes:

- **Section 2 — An overview of the AMI, COPD, HF, pneumonia, and stroke mortality measures:**
  - Background
  - Cohort inclusions and exclusions
    - Included and excluded hospitalizations
    - How transferred patients are handled
  - Outcome
  - Risk-adjustment variables
  - Data sources
  - Mortality 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 RSMRs
- 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

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 mortality measures page here on *QualityNet.*

The mortality measure methodologies are also described in the peer-reviewed medical literature.[1-8]

For a list of the supporting resource files for the 2024 mortality 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 mortality 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 > Mortality > 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 Mortality Measures

In June 2007, CMS began publicly reporting 30-day RSMRs for AMI and HF for the nation's non-federal short-term acute care hospitals (including Indian Health Service hospitals) and critical access hospitals (CAHs), and added the pneumonia mortality measure in August 2008. In 2011, CMS and the VHA collaborated to update the mortality 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 two additional hospital 30-day mortality measures: COPD and ischemic stroke. These two measures also include admissions to non-federal 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. However, the stroke measure does not include VA hospital admissions.

Results for all five of these mortality 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, pneumonia, and stroke mortality measures for 2024 public reporting through a process of measure reevaluation.

2.2. Overview of Measure Methodology

The 2024 risk-adjusted mortality measures use specifications from the original measure methodology reports and the updated stroke mortality measure methodology report (version 1.2) posted here on *QualityNet*, with refinements to the measures as listed in Appendix C and described in the measures' prior 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 mortality outcome is attributed and includes admissions for patients:

- having a principal discharge diagnosis of AMI, COPD, HF, pneumonia, or ischemic stroke for each respective measure;

    - The COPD measure cohort also includes admissions with a principal discharge diagnosis of 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 index admission and Part A during the index admission (not applicable to VA hospitalizations in the AMI, COPD, HF, and pneumonia mortality measures);
- aged 65 or over; and
- not transferred from 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 mortality measures exclude index admissions for patients:

- with inconsistent or unknown vital status or other unreliable demographic (age and gender) data;
- enrolled in the Medicare hospice program (or used VA hospice services, in the cases of VA beneficiaries in the AMI, COPD, HF, and pneumonia mortality measures) any time in the 12 months prior to the index admission, including the first day of the index admission;
- 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.]

An additional exclusion criterion for the AMI, HF, and pneumonia cohorts is that patients discharged alive on the day of admission or the following calendar day, and not transferred to another acute care facility, are excluded as index admissions.

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 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 Mortality Measure Code Specifications supplemental file posted here on *QualityNet.*

For patients with more than one eligible admission for a given condition in a given year (July 2020 – June 2021, July 2021 – June 2022, or July 2022 – June 2023), only one index admission for that condition is randomly selected for inclusion in the cohort. Additional admissions within that year are excluded. For details on how the measures handle cases where two index admissions occur during the transition between two years within the combined three-year dataset and both are randomly selected for inclusion in that measure, please refer to Appendix D.

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, Figure 4.5.1.1, and Figure 4.6.1.1 for AMI, COPD, HF, pneumonia, and stroke, 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.

For patients transferred from one short-term acute care hospital to another, only the first admission in the series of transfers is eligible for inclusion in the cohort. The subsequent admissions are not included. The measures assign a death that occurs within 30 days to the hospital that initially admitted the patient as an inpatient. For example, if a patient is admitted to Hospital A for HF and then transferred to Hospital B, only the Hospital A admission (the index admission) would be included in the cohort, and death within 30 days of the start of the Hospital A admission would be captured in Hospital A's HF mortality outcome. In another example, if a patient is seen for HF in the ED at Hospital A (and not admitted to an inpatient acute care bed), and then transferred to Hospital B for inpatient admission, the Hospital B admission would be included in the cohort (the index admission), and a death within 30 days would be captured in Hospital B's HF mortality outcome.

2.2.2 Outcome

All-Cause Mortality

All deaths are considered an outcome, regardless of cause. There are a number of reasons for capturing deaths from any cause in the mortality measures. First, from a patient's perspective, a death from any cause is an adverse event. In addition, making inferences about quality of care based solely on the documented cause of death is difficult. For example, a patient with HF who develops a hospital-acquired infection may ultimately die of sepsis and multi-organ failure. In this context, considering the patient's death to be unrelated to the care that the patient received for HF during the index admission would be inappropriate.

30-Day Time Frame

The measures assess mortality within a 30-day period from the date of the index admission. The measures use a 30-day time frame because older adult patients are more vulnerable to adverse health outcomes occurring during this time.[9] Death within 30 days of the start of the admission 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 mortality.[10]

In determining whether a death occurred within 30 days of the index admission, the measures use the claim "FROM" date, which is the date the index admission 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 their index admission 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.

2.2.3 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 for the index admission itself. Risk-adjustment variables are also obtained from VA administrative data in the cases of VA beneficiaries in the AMI, COPD, HF, and pneumonia mortality measures. 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 'History of Coronary Artery Bypass Graft (CABG)' (used in the AMI, HF, and pneumonia mortality measures and defined, in part, by ICD-10-CM secondary diagnosis codes on the index claim), do not use the algorithm.

A different methodology is utilized for the National Institutes of Health (NIH) Stroke Scale score risk variable ('NIH Stroke Scale score') used for risk adjustment in the stroke mortality measure. In sum:

- The measure uses the NIH Stroke Scale score coded on the index admission claim for risk adjustment. This code should reflect the initial NIH Stroke Scale score documented.
- If multiple codes are reported for the NIH Stroke Scale, the NIH Stroke Scale score coded as POA is used for risk adjustment.
- If multiple codes are reported for the NIH Stroke Scale and all or none are coded as POA, one NIH Stroke Scale score is randomly selected for risk adjustment. Random selection is used in these cases instead of the highest NIH Stroke Scale score because utilization of the highest score could inadvertently adjust for increased stroke severity that is a result of care provided or complications of care.
- If no NIH Stroke Scale score ICD-10-CM code is reported on the index admission claim, a score of zero will be assigned to the admission and risk adjusted accordingly.
- The above logic incentivizes hospitals to accurately report one baseline NIH Stroke Scale score per ischemic stroke admission, and code as POA.
- In coding NIH Stroke Scale scores, all relevant official ICD-10-CM coding guidelines should be followed.

- NIH Stroke Scale score ICD-10-CM codes are outlined in the 2024 Stroke Mortality Measure Code Specifications supplemental file posted here on *QualityNet.*

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 AMI, COPD, HF, and pneumonia mortality measures were re-endorsed by the CMS consensus-based entity (CBE) without adjustment for patient-level social drivers of health in the last endorsement maintenance submission prior to 2024.

2.2.4 Data Sources

The data sources for these analyses are Medicare administrative claims for all five measures; VA administrative data for the AMI, COPD, HF, and pneumonia mortality measures; 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, in the cases of the AMI, COPD, HF, and pneumonia mortality measures) from up to 12 months prior to the index admission (as discussed in Section 2.2.3) 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.

2.2.5 Measure Calculation

The hospital-level 30-day all-cause RSMR 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.[11] At the patient level, it models the log-odds of mortality within 30 days of the start of the index admission using age, sex (in the AMI, HF, pneumonia, and stroke measures), 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 mortality 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.[11] If there were no differences among hospitals, then after adjusting for patient risk, the hospital effects should be identical across all hospitals.

The RSMR is calculated as the ratio of the number of "predicted" deaths to the number of "expected" deaths at a given hospital, multiplied by the national observed mortality rate, as illustrated in Figure 2.2.5.1.

Figure 2.2.5.1 — Equation for RSMR Calculation

$$\text{RSMR} = \frac{\text{Predicted Deaths}}{\text{Expected Deaths}} \times \text{National Observed Mortality Rate}$$

For each hospital, the numerator of the ratio is the number of deaths within 30 days predicted based on the hospital's performance with its observed case mix; the denominator is the number of deaths expected based on the nation's performance with that hospital's case mix. This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows a particular hospital's performance, given its case mix, to be compared to an average hospital's performance with the same case mix. Thus, a lower ratio indicates lower-than-expected mortality rates or better quality, while a higher ratio indicates higher-than-expected mortality rates or worse quality.

The "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors (Table 4.2.3.1, Table 4.3.3.1, Table 4.4.3.1, Table 4.5.3.1, and Table 4.6.3.1, for the AMI, COPD, HF, pneumonia, and stroke measures, respectively) and the hospital-specific effect on the risk of mortality. 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 deaths (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 mortality rate transforms the ratio into a rate that can be compared to the national observed mortality rate. The hierarchical logistic regression models are described fully in Appendix A and in the original methodology reports posted here on *QualityNet*.

2.2.6 Categorizing Hospital Performance

To categorize hospital performance, CMS estimates each hospital's RSMR and the corresponding 95% interval estimate. CMS assigns hospitals to a performance category

by comparing each hospital's RSMR interval estimate to the national observed mortality rate. Comparative performance for hospitals with 25 or more eligible cases is classified as follows:

- "Better than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is lower than the national observed mortality rate
- "No Different than the National Rate" if the 95% interval estimate surrounding the hospital's rate includes the national observed mortality rate
- "Worse than the National Rate" if the entire 95% interval estimate surrounding the hospital's rate is higher than the national observed mortality rate

If a hospital has fewer than 25 eligible cases for a measure, CMS assigns the hospital to a separate category, "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 mortality rates 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, Section 4.5.5, and Section 4.6.5, for AMI, COPD, HF, pneumonia, and stroke, respectively.

3. UPDATES TO MEASURES FOR 2024 PUBLIC REPORTING

3.1. Rationale for Measure Updates

Annual measure reevaluation ensures that the risk-standardized mortality 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 and International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-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 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 analytic packages (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.

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 mortality measure. For more details, refer to the 2024 COPD Mortality 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 2.2.3). 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.[12-15] 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 mortality 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.

A brief summary of how COVID-19 is addressed in the measures, 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 Mortality Measure Code Specifications
- 2024 COPD Mortality Measure Code Specifications
- 2024 HF Mortality Measure Code Specifications
- 2024 Pneumonia Mortality Measure Code Specifications
- 2024 Stroke Mortality 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 > Mortality > 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 RSMR 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 RSMRs 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 mortality 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, pneumonia, and stroke) are presented in Section 4.2, Section 4.3, Section 4.4, Section 4.5, and Section 4.6, respectively.

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 Mortality 2024 Model Results

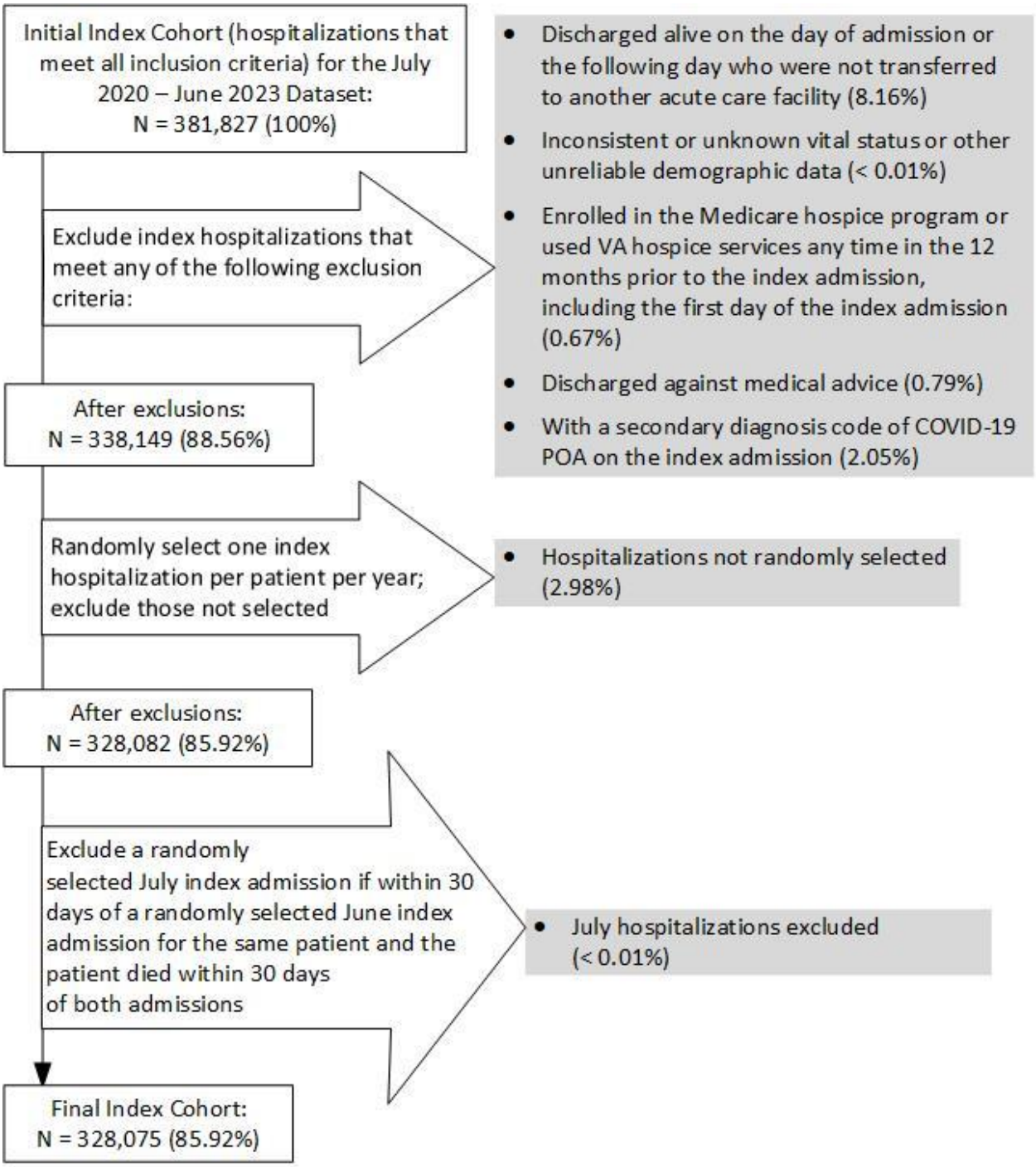
4.2.1 Index Cohort Exclusions

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;
- 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);
- with a principal discharge diagnosis of AMI; and
- who were not transferred from another acute care facility.

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	115,920	108,477	103,678	328,075
Mean age (SD)	77.6 (8.0)	77.7 (7.9)	77.8 (7.9)	77.7 (8.0)
Male	57.0	57.1	56.8	57.0
History of COVID-19	4.0	9.9	17.1	10.1
Anterior myocardial infarction	8.5	8.5	8.2	8.4
Non-anterior location of myocardial infarction	15.4	15.4	15.0	15.3
History of coronary artery bypass graft (CABG) surgery	14.9	14.9	14.3	14.7
History of percutaneous transluminal coronary angioplasty (PTCA)	23.6	25.1	25.0	24.5
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	4.5	5.0	5.0	4.8
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	46.7	47.8	47.4	47.3
Protein-calorie malnutrition (CC 21)	5.6	6.3	6.7	6.2
Chronic liver disease (CC 27 – 29)	2.1	2.4	2.5	2.3
Dementia or other specified brain disorders (CC 51 – 53)	14.4	15.8	15.8	15.3
Major psychiatric disorders (CC 57 – 59)	6.7	8.2	8.6	7.8
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	5.4	6.2	6.1	5.9
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	24.3	27.1	27.4	26.2
Congestive heart failure (CC 85)	49.6	51.3	51.8	50.8
Acute myocardial infarction (CC 86)	12.6	15.7	16.0	14.7
Unstable angina and other acute ischemic heart disease (CC 87)	19.1	19.9	19.5	19.5
Coronary atherosclerosis or angina (CC 88 – 89)	82.0	82.5	82.9	82.4
Valvular and rheumatic heart disease (CC 91)	27.8	31.9	33.3	30.9
Hypertension (CC 95)	73.1	79.4	79.6	77.2
Stroke (CC 99 – 100)	5.1	6.4	6.5	6.0
Cerebrovascular disease (CC 101 – 102, 105)	15.8	19.6	19.8	18.3
Vascular disease and complications (CC 106 – 108)	27.1	31.6	31.7	30.1
Chronic obstructive pulmonary disease (COPD) (CC 111)	22.8	23.3	22.8	23.0
Pneumonia (CC 114 – 116)	14.0	16.3	16.8	15.7
Renal failure (CC 135 – 140)	45.9	47.1	47.2	46.7
Trauma; other injuries (CC 166 – 168, 170 – 174)	19.4	26.6	27.1	24.2

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	-3.547	-3.595	-3.637	-3.573
Years over 65 (continuous)	0.053	0.053	0.053	0.053
Male	0.084	0.110	0.085	0.095
History of COVID-19	-0.350	-0.377	-0.286	-0.354
Anterior myocardial infarction	0.941	0.942	1.040	0.974
Non-anterior location of myocardial infarction	0.836	0.857	0.878	0.857
History of coronary artery bypass graft (CABG) surgery	0.096	0.115	0.041	0.089
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.204	-0.150	-0.182	-0.180
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	0.658	0.590	0.533	0.600
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	0.063	0.079	0.069	0.070
Protein-calorie malnutrition (CC 21)	0.482	0.446	0.464	0.469
Chronic liver disease (CC 27 – 29)	0.385	0.377	0.375	0.382
Dementia or other specified brain disorders (CC 51 – 53)	0.436	0.411	0.295	0.384
Major psychiatric disorders (CC 57 – 59)	-0.037	-0.135	-0.053	-0.078
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.275	0.225	0.266	0.257
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	1.137	1.119	1.059	1.105
Congestive heart failure (CC 85)	0.337	0.341	0.311	0.331
Acute myocardial infarction (CC 86)	0.067	-0.004	-0.028	0.008
Unstable angina and other acute ischemic heart disease (CC 87)	-0.243	-0.290	-0.239	-0.255
Coronary atherosclerosis or angina (CC 88 – 89)	-0.429	-0.460	-0.466	-0.448
Valvular and rheumatic heart disease (CC 91)	0.043	0.024	0.125	0.060
Hypertension (CC 95)	-0.266	-0.255	-0.246	-0.268
Stroke (CC 99 – 100)	0.207	0.160	0.137	0.166
Cerebrovascular disease (CC 101 – 102, 105)	-0.046	-0.022	-0.035	-0.039
Vascular disease and complications (CC 106 – 108)	0.139	0.145	0.110	0.132
Chronic obstructive pulmonary disease (COPD) (CC 111)	-0.029	-0.053	-0.035	-0.041
Pneumonia (CC 114 – 116)	0.227	0.250	0.233	0.230
Renal failure (CC 135 – 140)	0.590	0.563	0.648	0.603

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Trauma; other injuries (CC 166 – 168, 170 – 174)	-0.013	0.036	0.023	0.010

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

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)	1.05 (1.05 – 1.06)	1.05 (1.05 – 1.06)	1.05 (1.05 – 1.06)	1.05 (1.05 – 1.06)
Male	1.09 (1.05 – 1.13)	1.12 (1.07 – 1.16)	1.09 (1.04 – 1.14)	1.10 (1.07 – 1.13)
History of COVID-19	0.70 (0.64 – 0.77)	0.69 (0.64 – 0.73)	0.75 (0.71 – 0.79)	0.70 (0.68 – 0.73)
Anterior myocardial infarction	2.56 (2.41 – 2.72)	2.57 (2.41 – 2.73)	2.83 (2.65 – 3.02)	2.65 (2.55 – 2.75)
Non-anterior location of myocardial infarction	2.31 (2.19 – 2.43)	2.36 (2.24 – 2.48)	2.41 (2.28 – 2.54)	2.36 (2.29 – 2.43)
History of coronary artery bypass graft (CABG) surgery	1.10 (1.04 – 1.16)	1.12 (1.06 – 1.19)	1.04 (0.98 – 1.11)	1.09 (1.06 – 1.13)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.82 (0.78 – 0.86)	0.86 (0.82 – 0.91)	0.83 (0.79 – 0.88)	0.84 (0.81 – 0.86)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	1.93 (1.79 – 2.08)	1.80 (1.67 – 1.94)	1.70 (1.58 – 1.84)	1.82 (1.74 – 1.90)
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	1.06 (1.02 – 1.11)	1.08 (1.04 – 1.13)	1.07 (1.03 – 1.12)	1.07 (1.05 – 1.10)
Protein-calorie malnutrition (CC 21)	1.62 (1.52 – 1.73)	1.56 (1.46 – 1.67)	1.59 (1.49 – 1.70)	1.60 (1.54 – 1.66)
Chronic liver disease (CC 27 – 29)	1.47 (1.31 – 1.65)	1.46 (1.30 – 1.63)	1.46 (1.30 – 1.63)	1.47 (1.37 – 1.56)
Dementia or other specified brain disorders (CC 51 – 53)	1.55 (1.47 – 1.62)	1.51 (1.44 – 1.58)	1.34 (1.28 – 1.41)	1.47 (1.43 – 1.51)
Major psychiatric disorders (CC 57 – 59)	0.96 (0.89 – 1.04)	0.87 (0.81 – 0.94)	0.95 (0.88 – 1.02)	0.92 (0.89 – 0.96)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.32 (1.22 – 1.42)	1.25 (1.16 – 1.35)	1.30 (1.21 – 1.41)	1.29 (1.24 – 1.35)
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	3.12 (2.99 – 3.25)	3.06 (2.93 – 3.20)	2.88 (2.76 – 3.01)	3.02 (2.95 – 3.10)
Congestive heart failure (CC 85)	1.40 (1.34 – 1.46)	1.41 (1.34 – 1.47)	1.36 (1.30 – 1.43)	1.39 (1.36 – 1.43)

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)
Acute myocardial infarction (CC 86)	1.07 (1.01 – 1.13)	1.00 (0.94 – 1.05)	0.97 (0.92 – 1.03)	1.01 (0.98 – 1.04)
Unstable angina and other acute ischemic heart disease (CC 87)	0.78 (0.74 – 0.83)	0.75 (0.71 – 0.79)	0.79 (0.74 – 0.83)	0.78 (0.75 – 0.80)
Coronary atherosclerosis or angina (CC 88 – 89)	0.65 (0.62 – 0.68)	0.63 (0.60 – 0.67)	0.63 (0.59 – 0.66)	0.64 (0.62 – 0.66)
Valvular and rheumatic heart disease (CC 91)	1.04 (1.00 – 1.09)	1.02 (0.98 – 1.07)	1.13 (1.08 – 1.18)	1.06 (1.04 – 1.09)
Hypertension (CC 95)	0.77 (0.74 – 0.80)	0.78 (0.74 – 0.81)	0.78 (0.74 – 0.82)	0.77 (0.75 – 0.79)
Stroke (CC 99 – 100)	1.23 (1.14 – 1.33)	1.17 (1.09 – 1.27)	1.15 (1.06 – 1.24)	1.18 (1.13 – 1.23)
Cerebrovascular disease (CC 101 – 102, 105)	0.96 (0.91 – 1.01)	0.98 (0.93 – 1.03)	0.97 (0.92 – 1.02)	0.96 (0.93 – 0.99)
Vascular disease and complications (CC 106 – 108)	1.15 (1.10 – 1.20)	1.16 (1.11 – 1.21)	1.12 (1.07 – 1.17)	1.14 (1.11 – 1.17)
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.97 (0.93 – 1.02)	0.95 (0.91 – 0.99)	0.97 (0.92 – 1.01)	0.96 (0.93 – 0.99)
Pneumonia (CC 114 – 116)	1.25 (1.19 – 1.32)	1.28 (1.22 – 1.35)	1.26 (1.20 – 1.33)	1.26 (1.22 – 1.30)
Renal failure (CC 135 – 140)	1.80 (1.73 – 1.88)	1.76 (1.68 – 1.83)	1.91 (1.83 – 2.00)	1.83 (1.78 – 1.87)
Trauma; other injuries (CC 166 – 168, 170 – 174)	0.99 (0.94 – 1.03)	1.04 (0.99 – 1.08)	1.02 (0.98 – 1.07)	1.01 (0.98 – 1.04)

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)	1.4 – 41.1	1.5 – 40.9	1.3 – 39.1	1.4 – 40.4
c-statistics	0.78	0.78	0.78	0.78

4.2.4 Distribution of Hospital Volumes and Mortality Rates for AMI

The national *observed* mortality rate in the combined three-year dataset was 12.6%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 12.9%
- July 1, 2021 – June 30, 2022: 12.7%
- July 1, 2022 – June 30, 2023: 12.2%

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	3,410	3,469	3,336	3,953
Mean number of admissions (SD)	34.0 (43.2)	31.3 (39.9)	31.1 (38.4)	83.0 (116.3)
Range (min. – max.)	1 – 326	1 – 338	1 – 336	1 – 931
25th percentile	3	3	3	4
50th percentile	16	15	16	27
75th percentile	51	46	46	127

Table 4.2.4.2 shows the distribution of hospital RSMRs.

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

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	3,410	3,469	3,336	3,953
Mean (SD)	13.0 (0.8)	12.7 (0.7)	12.2 (0.6)	12.7 (1.0)
Range (min. – max.)	9.3 – 17.3	9.0 – 17.2	8.4 – 15.7	7.7 – 17.6
25th percentile	12.6	12.4	12.0	12.3
50th percentile	12.9	12.6	12.2	12.6
75th percentile	13.4	13.1	12.5	13.1

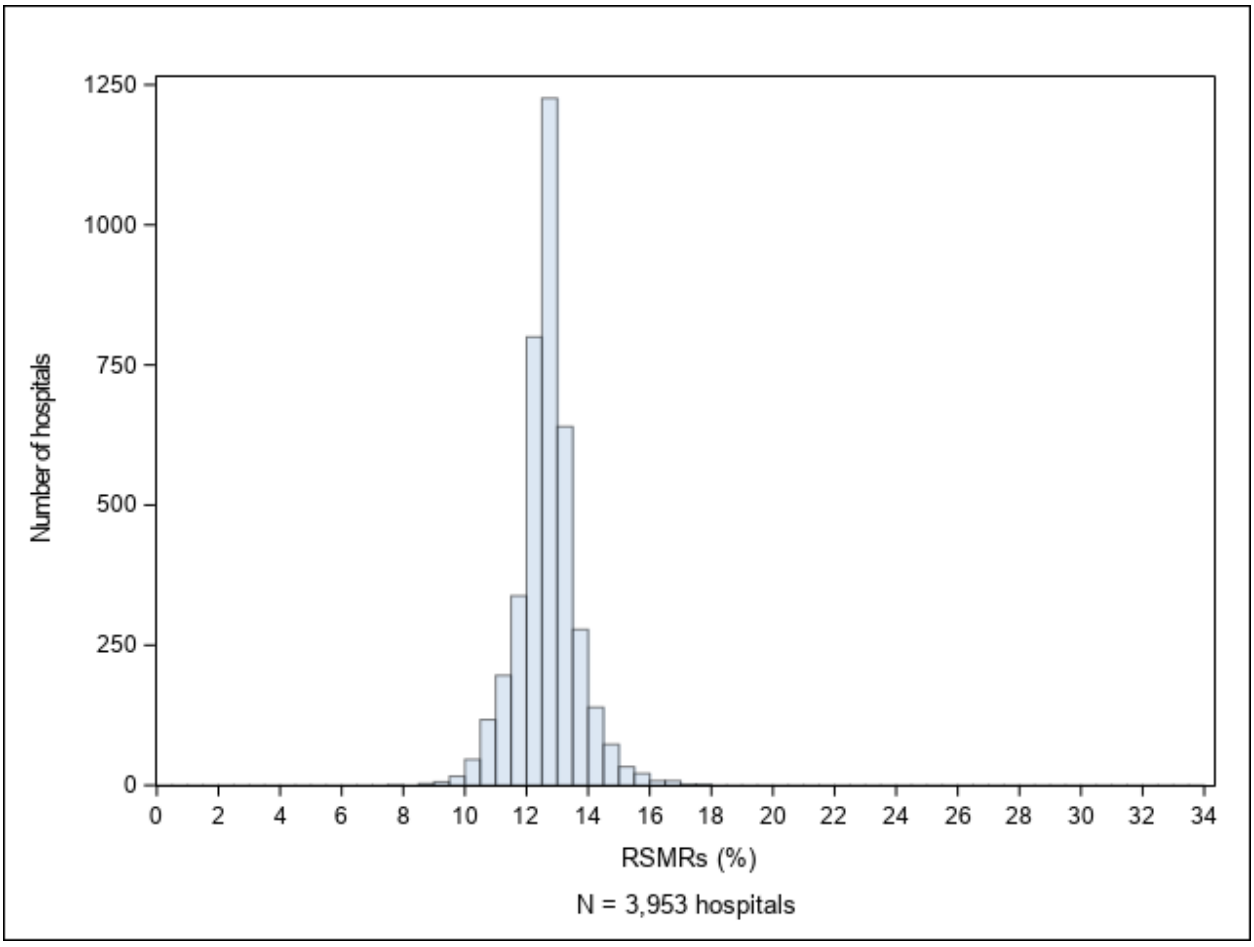
Table 4.2.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

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)	0.053 (0.007)	0.052 (0.008)	0.043 (0.008)	0.050 (0.004)

Figure 4.2.4.1 shows the overall distribution of the hospital RSMRs for the combined three-year dataset, which indicates that the hospital RSMRs are normally distributed. The odds of all-cause mortality if a patient is treated at a hospital one standard deviation (SD) above the national rate were 1.56 times higher than the odds of all-cause mortality 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.[11]

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



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

Of 3,953 hospitals in the study cohort, 29 performed “Better than the National Rate,” 1,966 performed “No Different than the National Rate,” and 28 performed “Worse than the National Rate.” 1,930 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.3. COPD Mortality 2024 Model Results

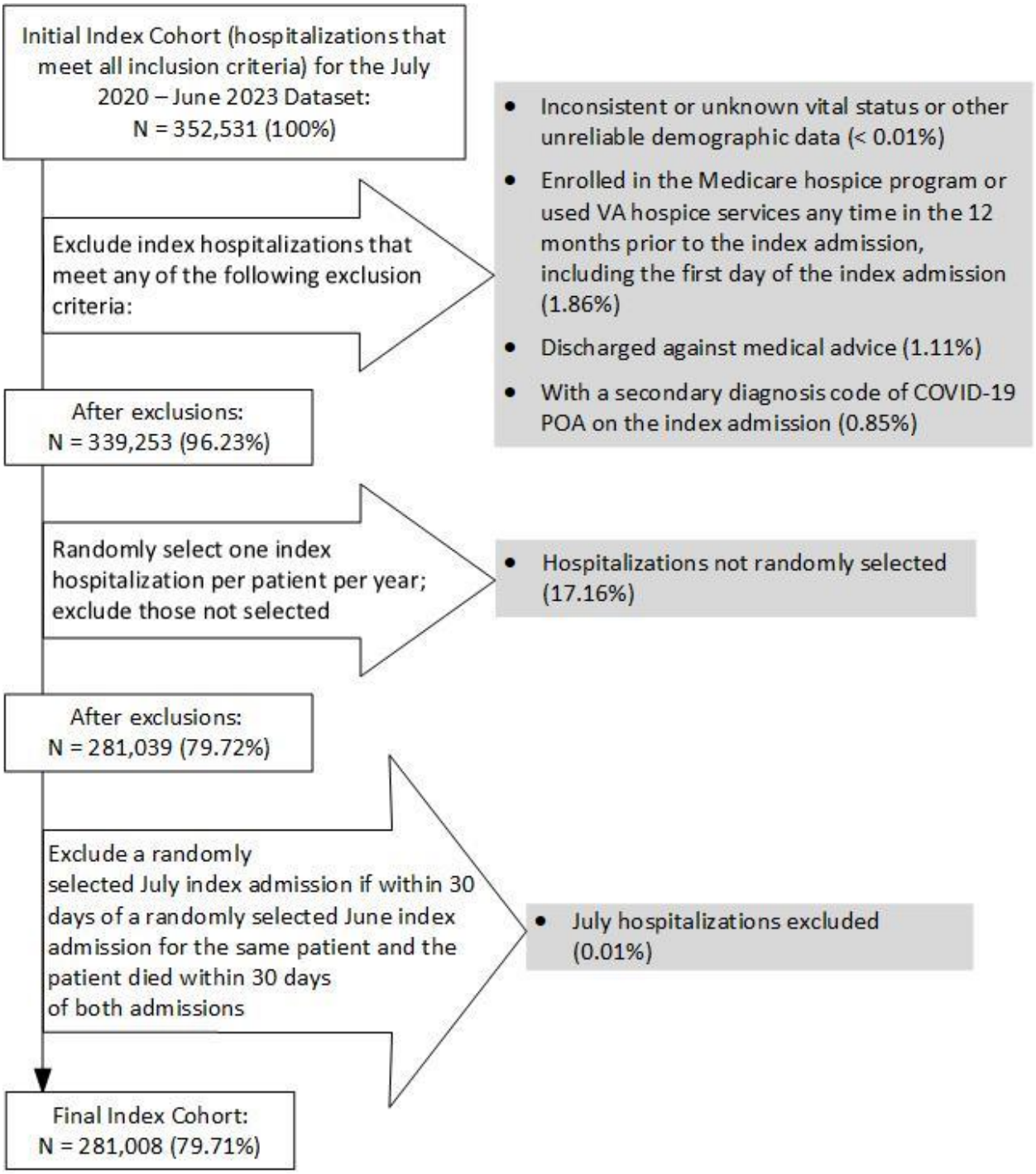
4.3.1 Index Cohort Exclusions

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;
- 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);
- with a principal discharge diagnosis of COPD or principal discharge diagnosis of acute respiratory failure with a secondary diagnosis of COPD with exacerbation; and
- who were not transferred from another acute care facility.

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	88,341	95,233	97,434	281,008
Mean age (SD)	76.1 (7.3)	76.4 (7.3)	76.7 (7.4)	76.4 (7.3)
History of COVID-19	6.7	15.4	25.0	16.0
History of mechanical ventilation	9.2	11.7	12.4	11.2
Metastatic cancer and acute leukemia (CC 8)	4.1	4.1	4.1	4.1
Lung and other severe cancers (CC 9)	9.1	9.6	9.7	9.5
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	12.2	14.2	14.6	13.7
Other digestive and urinary neoplasms (CC 14)	4.7	7.0	7.1	6.3
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	38.7	39.6	39.6	39.3
Protein-calorie malnutrition (CC 21)	13.2	14.7	15.5	14.5
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	81.7	85.7	86.8	84.8
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	51.8	55.9	56.5	54.8
Other gastrointestinal disorders (CC 38)	59.4	64.5	65.0	63.1
Osteoarthritis of hip or knee (CC 42)	9.2	12.8	13.1	11.8
Other musculoskeletal and connective tissue disorders (CC 45)	59.8	66.8	66.9	64.6
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	46.8	50.8	51.9	49.9
Dementia or other specified brain disorders (CC 51 – 53)	16.0	18.1	19.0	17.7
Substance use disorder, mild, except alcohol and cannabis (CC 56, 202 – 203)	36.3	38.1	38.4	37.6
Other psychiatric disorders (CC 63)	32.8	35.5	35.6	34.7
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	5.5	6.3	6.4	6.1
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	20.2	23.9	24.4	22.9
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	70.7	74.7	75.5	73.7
Congestive heart failure (CC 85)	54.6	55.0	54.1	54.6
Coronary atherosclerosis or angina (CC 88 – 89)	46.5	48.5	48.0	47.7

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Hypertension and hypertensive disease (CC 94 – 95)	74.2	80.0	80.2	78.3
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	45.2	48.2	48.7	47.4
Stroke (CC 99 – 100)	4.5	5.7	6.0	5.4
Vascular or circulatory disease (CC 106 – 109)	41.4	48.0	48.5	46.1
Fibrosis of lung or other chronic lung disorders (CC 112)	11.4	13.1	13.5	12.7
Asthma (CC 113)	12.3	15.0	15.8	14.4
Pneumonia (CC 114 – 116)	41.4	45.6	47.4	44.9
Pleural effusion/pneumothorax (CC 117)	14.4	16.7	17.0	16.1
Other respiratory disorders (CC 118)	48.9	55.0	58.4	54.2
Other retinal disorders (CC 125)	7.6	10.9	11.8	10.2
Other eye disorders (CC 128)	14.7	21.7	22.8	19.9
Other ear, nose, throat, and mouth disorders (CC 131)	25.2	33.5	36.7	32.0
Renal failure (CC 135 – 140)	39.5	41.1	41.2	40.6
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	8.3	9.6	9.8	9.2
Other dermatological disorders (CC 165)	23.8	31.9	34.0	30.1
Trauma (CC 166 – 168, 170 – 173)	8.3	11.2	12.0	10.6
Vertebral fractures without spinal cord injury (CC 169)	4.1	5.2	5.2	4.9
Major complications of medical care and trauma (CC 176 – 177)	8.0	10.2	10.4	9.6

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	-3.213	-3.281	-3.404	-3.265
Years over 65 (continuous)	0.030	0.031	0.036	0.032
History of COVID-19	-0.229	-0.378	-0.261	-0.332
History of mechanical ventilation	0.031	0.109	0.096	0.081
Metastatic cancer and acute leukemia (CC 8)	0.871	0.827	0.877	0.862
Lung and other severe cancers (CC 9)	0.422	0.323	0.351	0.370
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	0.024	-0.012	-0.027	-0.002

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Other digestive and urinary neoplasms (CC 14)	-0.157	-0.240	-0.191	-0.202
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	-0.015	-0.047	-0.017	-0.023
Protein-calorie malnutrition (CC 21)	0.620	0.581	0.689	0.636
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	-0.150	-0.235	-0.257	-0.211
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	0.446	0.387	0.382	0.407
Other gastrointestinal disorders (CC 38)	-0.213	-0.156	-0.162	-0.179
Osteoarthritis of hip or knee (CC 42)	-0.136	-0.146	-0.175	-0.154
Other musculoskeletal and connective tissue disorders (CC 45)	-0.169	-0.165	-0.201	-0.179
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.120	0.124	0.114	0.122
Dementia or other specified brain disorders (CC 51 – 53)	0.229	0.231	0.156	0.208
Substance use disorder, mild, except alcohol and cannabis (CC 56, 202 – 203)	-0.215	-0.154	-0.169	-0.188
Other psychiatric disorders (CC 63)	0.008	0.032	0.055	0.031
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.052	0.103	0.032	0.068
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	-0.166	-0.154	-0.084	-0.137
Respirator dependence/respiratory failure (CC 82 – 83)	0.318	0.179	0.224	0.248
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	0.282	0.371	0.355	0.327
Congestive heart failure (CC 85)	0.275	0.276	0.317	0.292
Coronary atherosclerosis or angina (CC 88 – 89)	-0.070	-0.034	-0.022	-0.042
Hypertension and hypertensive disease (CC 94 – 95)	-0.168	-0.124	-0.153	-0.158
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	0.141	0.248	0.131	0.175
Stroke (CC 99 – 100)	-0.063	0.038	0.063	0.016
Vascular or circulatory disease (CC 106 – 109)	0.118	0.088	0.048	0.087
Fibrosis of lung or other chronic lung disorders (CC 112)	0.185	0.121	0.091	0.131
Asthma (CC 113)	-0.299	-0.245	-0.339	-0.292
Pneumonia (CC 114 – 116)	0.407	0.348	0.325	0.356
Pleural effusion/pneumothorax (CC 117)	0.341	0.392	0.357	0.361
Other respiratory disorders (CC 118)	-0.233	-0.220	-0.263	-0.241
Other retinal disorders (CC 125)	-0.076	-0.130	-0.170	-0.138
Other eye disorders (CC 128)	-0.148	-0.137	-0.089	-0.120

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Other ear, nose, throat, and mouth disorders (CC 131)	-0.176	-0.175	-0.182	-0.186
Renal failure (CC 135 – 140)	0.297	0.207	0.272	0.262
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	0.402	0.400	0.381	0.396
Other dermatological disorders (CC 165)	-0.113	-0.106	-0.071	-0.099
Trauma (CC 166 – 168, 170 – 173)	0.054	0.003	0.061	0.029
Vertebral fractures without spinal cord injury (CC 169)	0.118	0.085	0.171	0.119
Major complications of medical care and trauma (CC 176 – 177)	-0.082	-0.084	-0.040	-0.068

Table 4.3.3.2 shows the risk-adjusted ORs and 95% CIs for the COPD mortality 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)	1.03 (1.03 – 1.03)	1.03 (1.03 – 1.03)	1.04 (1.03 – 1.04)	1.03 (1.03 – 1.03)
History of COVID-19	0.80 (0.73 – 0.87)	0.69 (0.64 – 0.73)	0.77 (0.73 – 0.82)	0.72 (0.69 – 0.75)
History of mechanical ventilation	1.03 (0.96 – 1.11)	1.12 (1.04 – 1.19)	1.10 (1.03 – 1.18)	1.08 (1.04 – 1.13)
Metastatic cancer and acute leukemia (CC 8)	2.39 (2.16 – 2.64)	2.29 (2.07 – 2.52)	2.40 (2.17 – 2.66)	2.37 (2.24 – 2.51)
Lung and other severe cancers (CC 9)	1.53 (1.42 – 1.64)	1.38 (1.28 – 1.49)	1.42 (1.32 – 1.53)	1.45 (1.39 – 1.51)
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	1.02 (0.96 – 1.10)	0.99 (0.93 – 1.06)	0.97 (0.91 – 1.04)	1.00 (0.96 – 1.04)
Other digestive and urinary neoplasms (CC 14)	0.85 (0.76 – 0.96)	0.79 (0.71 – 0.87)	0.83 (0.75 – 0.92)	0.82 (0.77 – 0.87)
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	0.98 (0.94 – 1.04)	0.95 (0.91 – 1.00)	0.98 (0.93 – 1.03)	0.98 (0.95 – 1.01)
Protein-calorie malnutrition (CC 21)	1.86 (1.75 – 1.97)	1.79 (1.69 – 1.89)	1.99 (1.88 – 2.11)	1.89 (1.83 – 1.95)
Morbid obesity; other endocrine/metabolic/nutritional disorders (CC 22, 25 – 26)	0.86 (0.81 – 0.92)	0.79 (0.74 – 0.85)	0.77 (0.72 – 0.83)	0.81 (0.78 – 0.84)

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 significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	1.56 (1.48 – 1.64)	1.47 (1.40 – 1.55)	1.46 (1.39 – 1.55)	1.50 (1.46 – 1.55)
Other gastrointestinal disorders (CC 38)	0.81 (0.77 – 0.85)	0.86 (0.81 – 0.90)	0.85 (0.81 – 0.90)	0.84 (0.81 – 0.86)
Osteoarthritis of hip or knee (CC 42)	0.87 (0.80 – 0.95)	0.86 (0.80 – 0.93)	0.84 (0.78 – 0.91)	0.86 (0.82 – 0.90)
Other musculoskeletal and connective tissue disorders (CC 45)	0.84 (0.80 – 0.89)	0.85 (0.80 – 0.89)	0.82 (0.77 – 0.86)	0.84 (0.81 – 0.86)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.13 (1.07 – 1.19)	1.13 (1.08 – 1.19)	1.12 (1.06 – 1.18)	1.13 (1.10 – 1.16)
Dementia or other specified brain disorders (CC 51 – 53)	1.26 (1.19 – 1.33)	1.26 (1.19 – 1.33)	1.17 (1.10 – 1.24)	1.23 (1.19 – 1.27)
Substance use disorder, mild, except alcohol and cannabis (CC 56, 202 – 203)	0.81 (0.76 – 0.85)	0.86 (0.81 – 0.90)	0.84 (0.80 – 0.89)	0.83 (0.80 – 0.85)
Other psychiatric disorders (CC 63)	1.01 (0.96 – 1.06)	1.03 (0.98 – 1.08)	1.06 (1.00 – 1.11)	1.03 (1.00 – 1.06)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.05 (0.96 – 1.16)	1.11 (1.01 – 1.21)	1.03 (0.94 – 1.13)	1.07 (1.01 – 1.13)
Polyneuropathy, mononeuropathy, and other neurological conditions/injuries (CC 81)	0.85 (0.80 – 0.90)	0.86 (0.81 – 0.91)	0.92 (0.87 – 0.97)	0.87 (0.84 – 0.90)
Respirator dependence/respiratory failure (CC 82 – 83)	1.37 (1.19 – 1.59)	1.20 (1.03 – 1.39)	1.25 (1.07 – 1.47)	1.28 (1.17 – 1.40)
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	1.33 (1.25 – 1.40)	1.45 (1.36 – 1.54)	1.43 (1.33 – 1.53)	1.39 (1.34 – 1.44)
Congestive heart failure (CC 85)	1.32 (1.25 – 1.39)	1.32 (1.25 – 1.39)	1.37 (1.30 – 1.45)	1.34 (1.30 – 1.38)
Coronary atherosclerosis or angina (CC 88 – 89)	0.93 (0.89 – 0.98)	0.97 (0.92 – 1.02)	0.98 (0.93 – 1.03)	0.96 (0.93 – 0.99)
Hypertension and hypertensive disease (CC 94 – 95)	0.85 (0.80 – 0.89)	0.88 (0.84 – 0.94)	0.86 (0.81 – 0.91)	0.85 (0.83 – 0.88)
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	1.15 (1.10 – 1.21)	1.28 (1.22 – 1.35)	1.14 (1.08 – 1.20)	1.19 (1.16 – 1.23)
Stroke (CC 99 – 100)	0.94 (0.84 – 1.05)	1.04 (0.95 – 1.14)	1.07 (0.97 – 1.17)	1.02 (0.96 – 1.07)
Vascular or circulatory disease (CC 106 – 109)	1.13 (1.07 – 1.18)	1.09 (1.04 – 1.15)	1.05 (1.00 – 1.10)	1.09 (1.06 – 1.12)
Fibrosis of lung or other chronic lung disorders (CC 112)	1.20 (1.13 – 1.29)	1.13 (1.06 – 1.20)	1.10 (1.03 – 1.17)	1.14 (1.10 – 1.18)
Asthma (CC 113)	0.74 (0.69 – 0.80)	0.78 (0.73 – 0.84)	0.71 (0.66 – 0.77)	0.75 (0.72 – 0.78)
Pneumonia (CC 114 – 116)	1.50 (1.43 – 1.58)	1.42 (1.35 – 1.49)	1.38 (1.31 – 1.46)	1.43 (1.39 – 1.47)

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)
Pleural effusion/pneumothorax (CC 117)	1.41 (1.33 – 1.49)	1.48 (1.40 – 1.56)	1.43 (1.35 – 1.51)	1.43 (1.39 – 1.48)
Other respiratory disorders (CC 118)	0.79 (0.75 – 0.83)	0.80 (0.76 – 0.84)	0.77 (0.73 – 0.81)	0.79 (0.76 – 0.81)
Other retinal disorders (CC 125)	0.93 (0.85 – 1.01)	0.88 (0.81 – 0.95)	0.84 (0.78 – 0.91)	0.87 (0.83 – 0.91)
Other eye disorders (CC 128)	0.86 (0.80 – 0.92)	0.87 (0.82 – 0.92)	0.91 (0.86 – 0.97)	0.89 (0.86 – 0.92)
Other ear, nose, throat, and mouth disorders (CC 131)	0.84 (0.79 – 0.89)	0.84 (0.80 – 0.88)	0.83 (0.79 – 0.88)	0.83 (0.81 – 0.86)
Renal failure (CC 135 – 140)	1.35 (1.28 – 1.41)	1.23 (1.17 – 1.29)	1.31 (1.25 – 1.38)	1.30 (1.26 – 1.34)
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	1.50 (1.39 – 1.61)	1.49 (1.40 – 1.59)	1.46 (1.37 – 1.57)	1.49 (1.43 – 1.55)
Other dermatological disorders (CC 165)	0.89 (0.85 – 0.94)	0.90 (0.86 – 0.95)	0.93 (0.88 – 0.98)	0.91 (0.88 – 0.93)
Trauma (CC 166 – 168, 170 – 173)	1.06 (0.98 – 1.14)	1.00 (0.94 – 1.07)	1.06 (0.99 – 1.14)	1.03 (0.99 – 1.07)
Vertebral fractures without spinal cord injury (CC 169)	1.13 (1.01 – 1.25)	1.09 (0.99 – 1.19)	1.19 (1.08 – 1.30)	1.13 (1.06 – 1.19)
Major complications of medical care and trauma (CC 176 – 177)	0.92 (0.85 – 1.00)	0.92 (0.86 – 0.99)	0.96 (0.89 – 1.04)	0.93 (0.89 – 0.98)

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)	1.6 – 28.4	1.4 – 26.7	1.0 – 24.2	1.3 – 26.2
c-statistic	0.73	0.73	0.74	0.73

4.3.4 Distribution of Hospital Volumes and Mortality Rates for COPD

The national *observed* mortality rate in the combined three-year dataset was 9.4%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 10.2%
- July 1, 2021 – June 30, 2022: 9.6%
- July 1, 2022 – June 30, 2023: 8.5%

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	4,214	4,257	4,236	4,470
Mean number of admissions (SD)	21.0 (23.2)	22.4 (25.3)	23.0 (26.4)	62.9 (73.0)
Range (min. – max.)	1 – 194	1 – 213	1 – 235	1 – 635
25th percentile	5	5	5	13
50th percentile	13	13	13	35
75th percentile	30	31	31	89

Table 4.3.4.2 shows the distribution of hospital RSMRs.

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

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,214	4,257	4,236	4,470
Mean (SD)	10.2 (0.8)	9.7 (1.0)	8.5 (0.7)	9.5 (1.3)
Range (min. – max.)	6.8 – 14.2	6.5 – 16.5	5.5 – 12.8	5.4 – 18.2
25th percentile	9.8	9.1	8.1	8.8
50th percentile	10.1	9.5	8.4	9.3
75th percentile	10.6	10.2	8.9	10.1

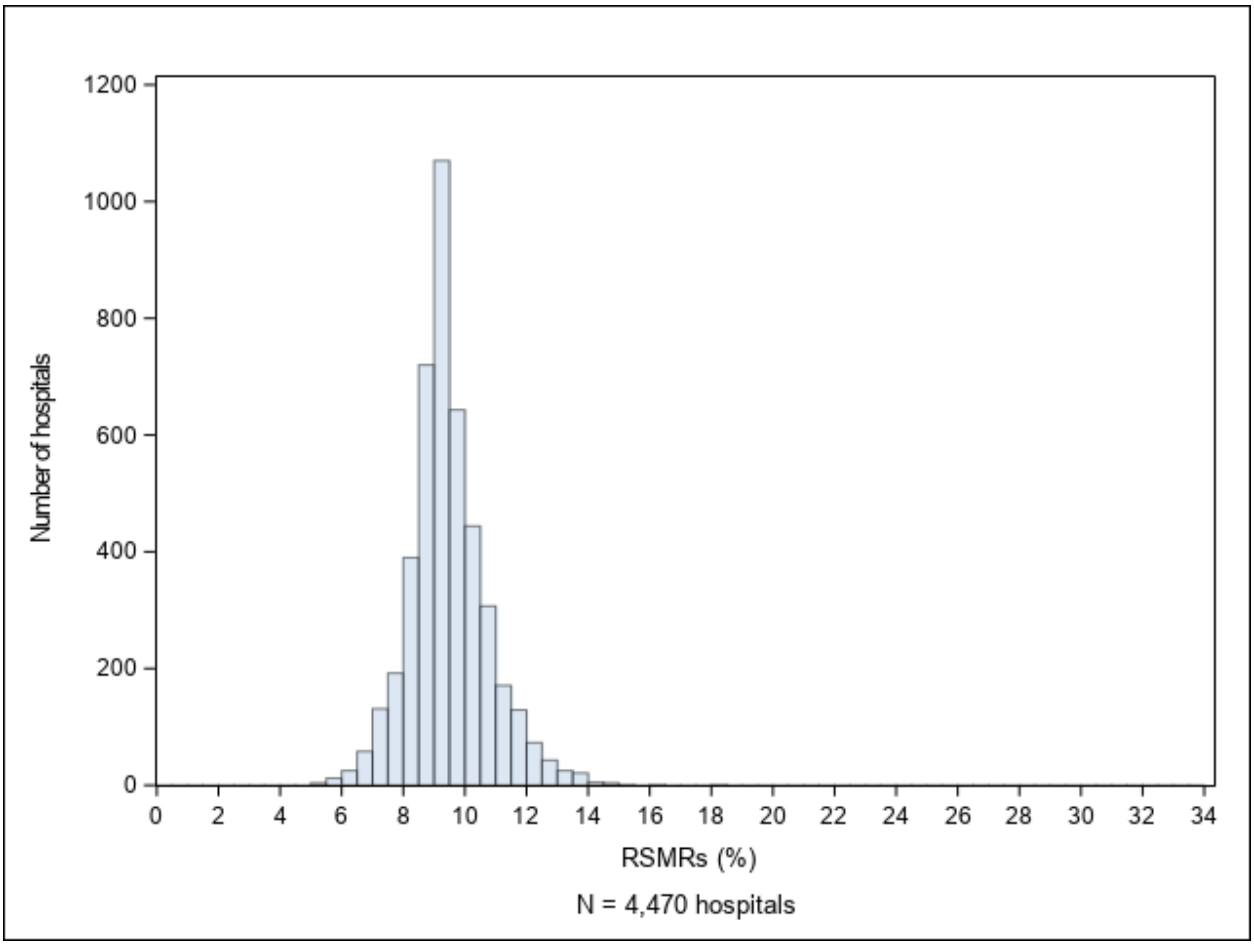
Table 4.3.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

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)	0.082 (0.012)	0.109 (0.013)	0.089 (0.013)	0.098 (0.007)

Figure 4.3.4.1 shows the overall distribution of the hospital RSMRs for the combined three-year dataset, which indicates that the hospital RSMRs are normally distributed. The odds of all-cause mortality if a patient is treated at a hospital one SD above the national rate were 1.87 times higher than the odds of all-cause mortality 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.[11]

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



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

Of 4,470 hospitals in the study cohort, 46 performed “Better than the National Rate,” 2,620 performed “No Different than the National Rate,” and 32 performed “Worse than the National Rate.” 1,772 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.4. HF Mortality 2024 Model Results

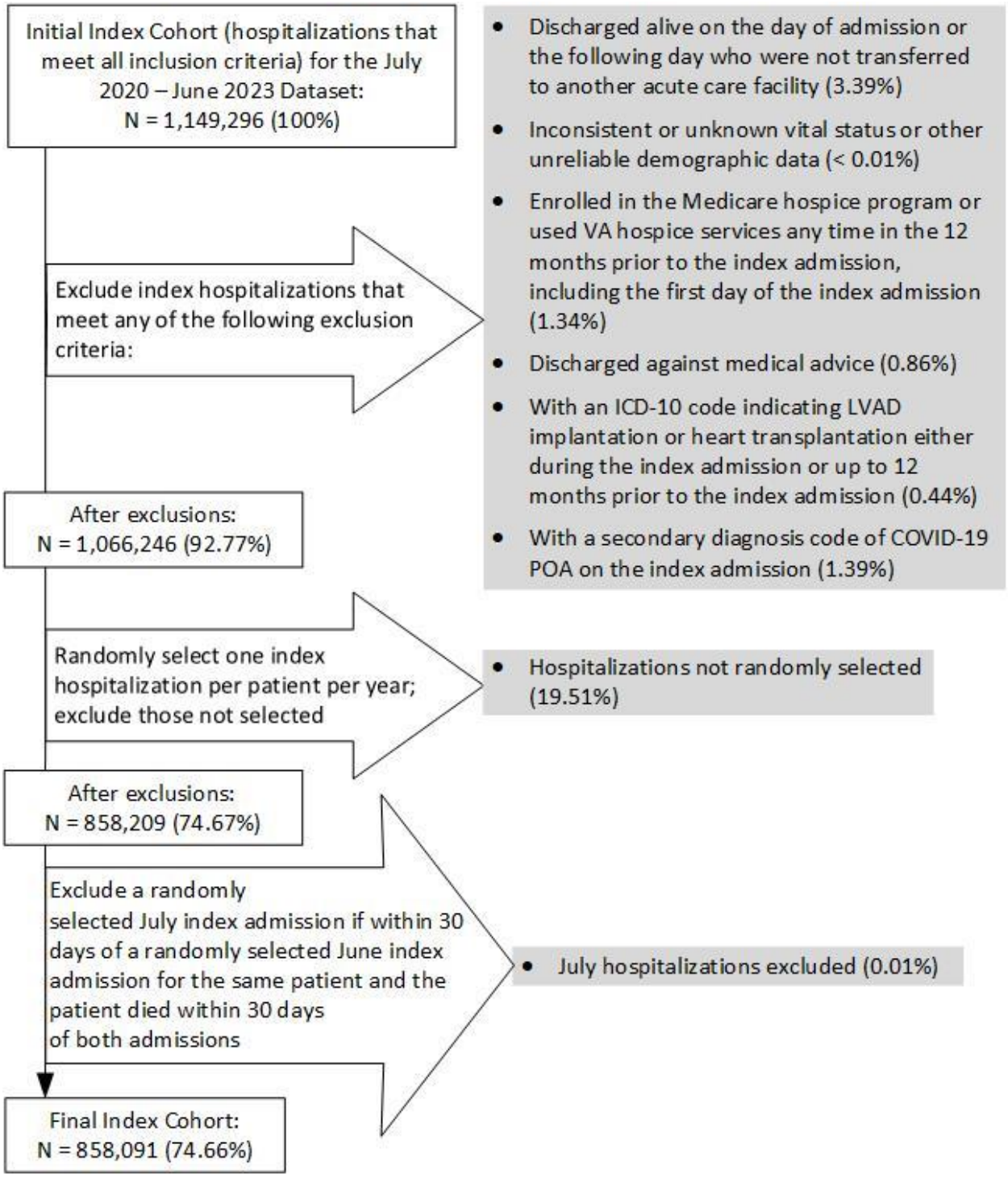
4.4.1 Index Cohort Exclusions

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;
- 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);
- with a principal discharge diagnosis of HF; and
- who were not transferred from another acute care facility.

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	289,863	284,962	283,266	858,091
Mean age (SD)	80.3 (8.5)	80.7 (8.4)	81.0 (8.4)	80.7 (8.4)
Male	49.2	48.4	48.3	48.6
History of COVID-19	6.7	14.3	23.1	14.7
History of coronary artery bypass graft (CABG) surgery	18.6	18.2	17.4	18.1
History of percutaneous transluminal coronary angioplasty (PTCA)	21.0	22.2	22.2	21.8
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	5.9	6.3	6.6	6.3
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	53.5	54.1	53.7	53.8
Protein-calorie malnutrition (CC 21)	10.5	12.1	12.9	11.8
Chronic liver disease (CC 27 – 29)	5.0	5.7	5.8	5.5
Dementia or other specified brain disorders (CC 51 – 53)	19.9	22.7	23.2	21.9
Major psychiatric disorders (CC 57 – 59)	9.3	11.7	12.3	11.1
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	7.0	8.2	8.2	7.8
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	55.9	60.7	61.8	59.4
Congestive heart failure (CC 85)	76.1	79.8	80.2	78.6
Acute myocardial infarction (CC 86)	16.3	19.9	21.1	19.1
Unstable angina and other acute ischemic heart disease (CC 87)	13.0	15.3	15.6	14.6
Coronary atherosclerosis or angina (CC 88 – 89)	64.6	66.0	65.9	65.5
Valvular and rheumatic heart disease (CC 91)	48.6	55.2	57.0	53.6
Hypertension (CC 95)	68.4	78.2	78.5	75.0
Stroke (CC 99 – 100)	6.2	8.2	8.4	7.6
Vascular disease and complications (CC 106 – 108)	35.9	42.2	42.8	40.3
Chronic obstructive pulmonary disease (COPD) (CC 111)	40.8	41.6	40.7	41.0
Pneumonia (CC 114 – 116)	31.8	35.4	36.3	34.5
Renal failure (CC 135 – 140)	69.6	70.3	70.0	69.9
Trauma; other injuries (CC 166 – 168, 170 – 174)	28.6	37.7	39.2	35.1

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	-3.866	-3.849	-3.988	-3.858
Years over 65 (continuous)	0.048	0.047	0.048	0.048
Male	0.247	0.253	0.230	0.254
History of COVID-19	-0.299	-0.235	-0.184	-0.253
History of coronary artery bypass graft (CABG) surgery	0.061	0.076	0.093	0.074
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.165	-0.150	-0.117	-0.148
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	0.536	0.448	0.520	0.508
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	-0.022	-0.032	0.002	-0.016
Protein-calorie malnutrition (CC 21)	0.740	0.652	0.668	0.700
Chronic liver disease (CC 27 – 29)	0.392	0.361	0.380	0.384
Dementia or other specified brain disorders (CC 51 – 53)	0.347	0.274	0.327	0.320
Major psychiatric disorders (CC 57 – 59)	-0.028	-0.055	-0.051	-0.040
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.108	0.078	0.113	0.103
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	0.403	0.445	0.434	0.419
Congestive heart failure (CC 85)	0.174	0.170	0.129	0.160
Acute myocardial infarction (CC 86)	0.345	0.294	0.323	0.318
Unstable angina and other acute ischemic heart disease (CC 87)	0.024	0.023	0.029	0.033
Coronary atherosclerosis or angina (CC 88 – 89)	-0.015	-0.030	-0.056	-0.029
Valvular and rheumatic heart disease (CC 91)	0.062	0.105	0.126	0.092
Hypertension (CC 95)	-0.270	-0.293	-0.297	-0.295
Stroke (CC 99 – 100)	-0.037	-0.035	-0.026	-0.032
Vascular disease and complications (CC 106 – 108)	0.039	0.068	0.048	0.053
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.054	0.050	0.062	0.054
Pneumonia (CC 114 – 116)	0.202	0.212	0.172	0.191
Renal failure (CC 135 – 140)	0.496	0.492	0.496	0.503
Trauma; other injuries (CC 166 – 168, 170 – 174)	0.076	0.057	0.063	0.057

Table 4.4.3.2 shows the risk-adjusted ORs and 95% CIs for the HF mortality 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)	7/2021 – 6/2022 OR (95% CI)	7/2022 – 6/2023 OR (95% CI)	7/2020 – 6/2023 OR (95% CI)
Years over 65 (continuous)	1.05 (1.05 – 1.05)	1.05 (1.05 – 1.05)	1.05 (1.05 – 1.05)	1.05 (1.05 – 1.05)
Male	1.28 (1.25 – 1.31)	1.29 (1.26 – 1.32)	1.26 (1.23 – 1.29)	1.29 (1.27 – 1.31)
History of COVID-19	0.74 (0.71 – 0.78)	0.79 (0.76 – 0.82)	0.83 (0.81 – 0.86)	0.78 (0.76 – 0.79)
History of coronary artery bypass graft (CABG) surgery	1.06 (1.03 – 1.10)	1.08 (1.05 – 1.11)	1.10 (1.06 – 1.13)	1.08 (1.06 – 1.10)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.85 (0.82 – 0.88)	0.86 (0.83 – 0.89)	0.89 (0.86 – 0.92)	0.86 (0.85 – 0.88)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	1.71 (1.64 – 1.78)	1.56 (1.50 – 1.63)	1.68 (1.61 – 1.75)	1.66 (1.62 – 1.70)
Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 17 – 19, 123)	0.98 (0.95 – 1.00)	0.97 (0.94 – 0.99)	1.00 (0.98 – 1.03)	0.98 (0.97 – 1.00)
Protein-calorie malnutrition (CC 21)	2.10 (2.03 – 2.16)	1.92 (1.86 – 1.98)	1.95 (1.89 – 2.01)	2.01 (1.98 – 2.05)
Chronic liver disease (CC 27 – 29)	1.48 (1.41 – 1.55)	1.43 (1.37 – 1.50)	1.46 (1.40 – 1.53)	1.47 (1.43 – 1.51)
Dementia or other specified brain disorders (CC 51 – 53)	1.41 (1.38 – 1.45)	1.32 (1.28 – 1.35)	1.39 (1.35 – 1.43)	1.38 (1.36 – 1.40)
Major psychiatric disorders (CC 57 – 59)	0.97 (0.93 – 1.01)	0.95 (0.91 – 0.98)	0.95 (0.91 – 0.99)	0.96 (0.94 – 0.98)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.11 (1.06 – 1.17)	1.08 (1.04 – 1.13)	1.12 (1.07 – 1.17)	1.11 (1.08 – 1.14)
Cardio-respiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02	1.50 (1.46 – 1.54)	1.56 (1.52 – 1.60)	1.54 (1.50 – 1.59)	1.52 (1.50 – 1.54)
Congestive heart failure (CC 85)	1.19 (1.15 – 1.23)	1.19 (1.15 – 1.23)	1.14 (1.10 – 1.18)	1.17 (1.15 – 1.20)
Acute myocardial infarction (CC 86)	1.41 (1.37 – 1.45)	1.34 (1.30 – 1.38)	1.38 (1.34 – 1.42)	1.37 (1.35 – 1.40)
Unstable angina and other acute ischemic heart disease (CC 87)	1.02 (0.99 – 1.06)	1.02 (0.99 – 1.06)	1.03 (1.00 – 1.06)	1.03 (1.01 – 1.05)
Coronary atherosclerosis or angina (CC 88 – 89)	0.98 (0.96 – 1.01)	0.97 (0.94 – 1.00)	0.95 (0.92 – 0.97)	0.97 (0.96 – 0.99)
Valvular and rheumatic heart disease (CC 91)	1.06 (1.04 – 1.09)	1.11 (1.08 – 1.14)	1.13 (1.10 – 1.16)	1.10 (1.08 – 1.11)
Hypertension (CC 95)	0.76 (0.74 – 0.78)	0.75 (0.73 – 0.77)	0.74 (0.72 – 0.76)	0.74 (0.73 – 0.76)

Variable	07/2020 – 06/2021 OR (95% CI)	7/2021 – 6/2022 OR (95% CI)	7/2022 – 6/2023 OR (95% CI)	7/2020 – 6/2023 OR (95% CI)
Stroke (CC 99 – 100)	0.96 (0.92 – 1.01)	0.97 (0.93 – 1.01)	0.97 (0.93 – 1.02)	0.97 (0.94 – 0.99)
Vascular disease and complications (CC 106 – 108)	1.04 (1.01 – 1.07)	1.07 (1.04 – 1.10)	1.05 (1.02 – 1.08)	1.05 (1.04 – 1.07)
Chronic obstructive pulmonary disease (COPD) (CC 111)	1.06 (1.03 – 1.08)	1.05 (1.03 – 1.08)	1.06 (1.04 – 1.09)	1.06 (1.04 – 1.07)
Pneumonia (CC 114 – 116)	1.22 (1.19 – 1.25)	1.24 (1.21 – 1.27)	1.19 (1.16 – 1.22)	1.21 (1.19 – 1.23)
Renal failure (CC 135 – 140)	1.64 (1.60 – 1.69)	1.64 (1.59 – 1.68)	1.64 (1.59 – 1.69)	1.65 (1.63 – 1.68)
Trauma; other injuries (CC 166 – 168, 170 – 174)	1.08 (1.05 – 1.11)	1.06 (1.03 – 1.09)	1.07 (1.04 – 1.09)	1.06 (1.04 – 1.07)

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)	3.0 – 28.4	2.7 – 27.6	2.4 – 26.3	2.7 – 27.4
c-statistic	0.69	0.69	0.70	0.69

4.4.4 Distribution of Hospital Volumes and Mortality Rates for HF

The national *observed* mortality rate in the combined three-year dataset was 11.9%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 12.1%
- July 1, 2021 – June 30, 2022: 12.3%
- July 1, 2022 – June 30, 2023: 11.4%

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	4,351	4,335	4,316	4,500
Mean number of admissions (SD)	66.6 (86.8)	65.7 (86.6)	65.6 (87.3)	190.7 (257.0)
Range (min. – max.)	1 – 950	1 – 935	1 – 990	1 – 2,875
25th percentile	8	8	7	21
50th percentile	30	30	29	79
75th percentile	96	94	95	274

Table 4.4.4.2 shows the distribution of hospital RSMRs.

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

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,351	4,335	4,316	4,500
Mean (SD)	12.1 (1.3)	12.4 (1.6)	11.4 (1.3)	12.1 (2.0)
Range (min. – max.)	6.5 – 19.4	6.2 – 20.3	6.5 – 20.7	5.0 – 23.2
25th percentile	11.5	11.6	10.8	11.0
50th percentile	12.0	12.3	11.3	12.0
75th percentile	12.8	13.2	12.1	13.2

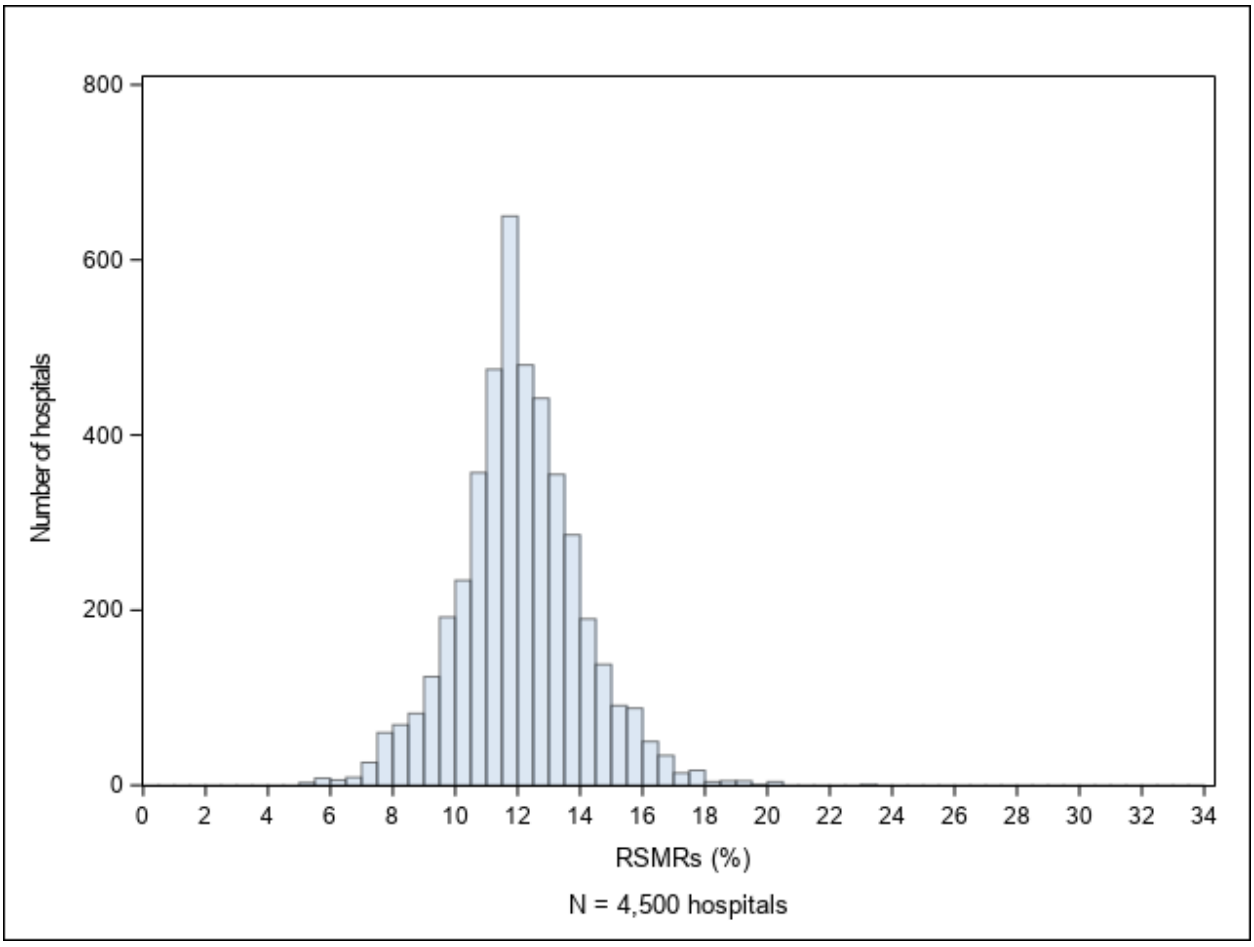
Table 4.4.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

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)	0.072 (0.005)	0.088 (0.006)	0.079 (0.006)	0.092 (0.004)

Figure 4.4.4.1 shows the overall distribution of the hospital RSMRs for the combined three-year dataset, which indicates that the hospital RSMRs are normally distributed. The odds of all-cause mortality if a patient is treated at a hospital one SD above the national rate were 1.83 times higher than the odds of all-cause mortality 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.[11]

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



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

Of 4,500 hospitals in the study cohort, 288 performed “Better than the National Rate,” 2,810 performed “No Different than the National Rate,” and 126 performed “Worse than the National Rate.” 1,276 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.5. Pneumonia Mortality 2024 Model Results

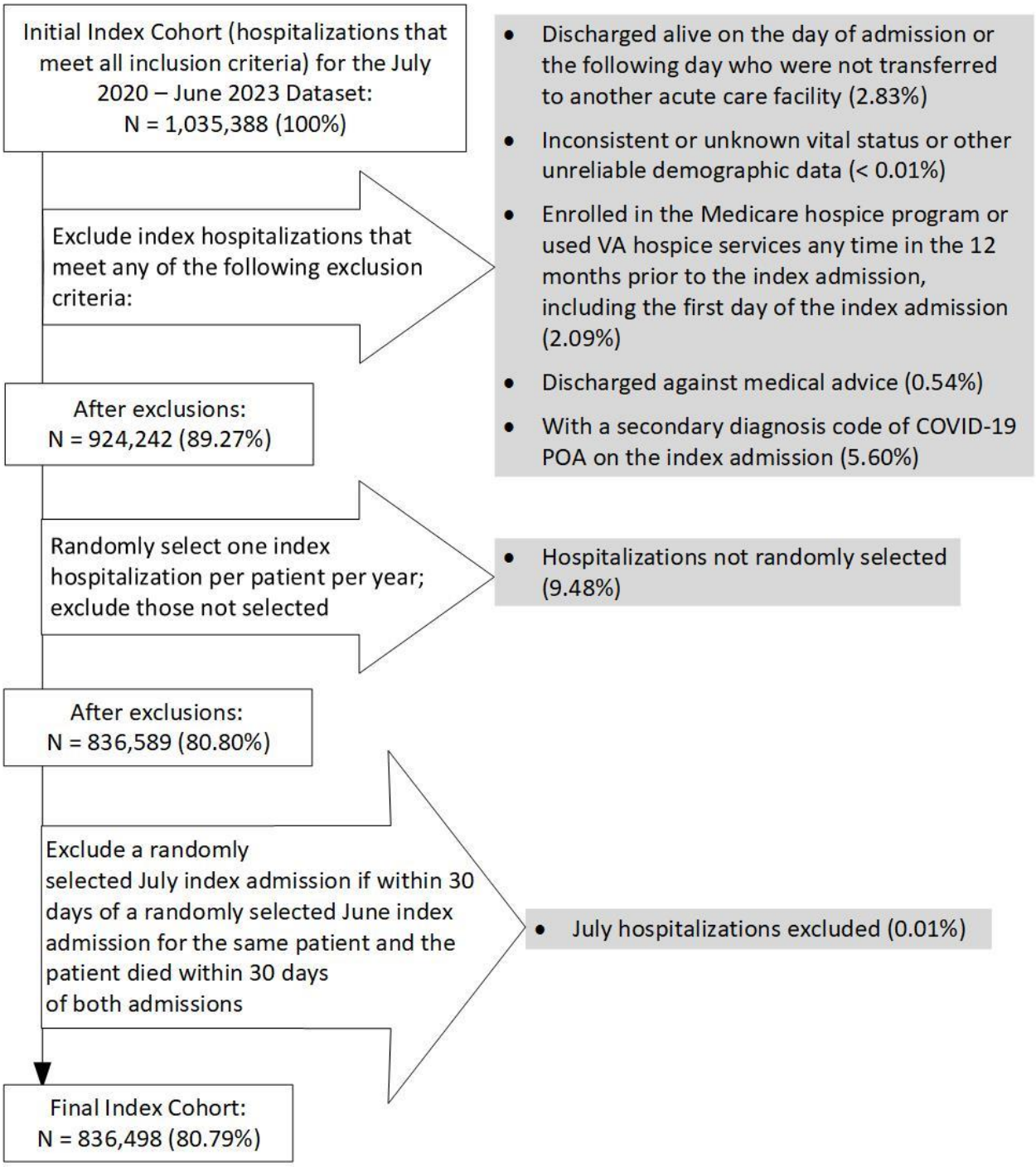
4.5.1 Index Cohort Exclusions

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:

- 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);
- aged 65 or over; and
- who were not transferred from another acute care facility.

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	247,086	276,307	313,105	836,498
Mean age (SD)	79.6 (8.5)	79.9 (8.5)	80.0 (8.5)	79.9 (8.5)
Male	52.1	50.1	48.4	50.1
History of COVID-19	9.4	17.5	26.0	18.3
History of coronary artery bypass graft (CABG) surgery	9.3	9.2	8.6	9.0
History of percutaneous transluminal coronary angioplasty (PTCA)	12.3	13.3	13.0	12.9
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	14.9	17.8	17.9	17.0
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	13.4	13.2	13.0	13.2
Protein-calorie malnutrition (CC 21)	20.4	21.1	21.1	20.9
Disorders of fluid/electrolyte/acid-base balance (CC 24)	60.0	62.9	63.2	62.2
Chronic liver disease (CC 27 – 29)	3.8	4.0	4.1	4.0
Severe hematological disorders (CC 46)	2.0	2.1	2.0	2.0
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	55.0	58.7	59.0	57.7
Delirium and encephalopathy (CC 50)	27.7	29.2	28.3	28.4
Dementia or other specified brain disorders (CC 51 – 53)	32.6	33.4	32.4	32.8
Major psychiatric disorders (CC 57 – 59)	14.5	16.4	17.0	16.1
Depression (CC 61)	22.9	24.8	24.3	24.1
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	11.5	11.8	11.2	11.5
Parkinson's and Huntington's diseases (CC 78)	5.1	5.1	4.9	5.0
Seizure disorders and convulsions (CC 79)	7.3	7.5	7.0	7.3
Respirator dependence/tracheostomy status (CC 82)	2.0	1.9	1.7	1.8
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	61.3	67.3	69.8	66.5
Congestive heart failure (CC 85)	48.2	51.3	51.9	50.6
Acute myocardial infarction (CC 86)	10.0	11.4	11.8	11.1
Unstable angina and other acute ischemic heart disease (CC 87)	7.3	8.9	9.2	8.6
Coronary atherosclerosis or angina (CC 88 – 89)	43.5	45.8	45.6	45.0
Hypertension (CC 95)	73.4	79.6	79.5	77.8
Stroke (CC 99 – 100)	8.6	10.2	9.8	9.6
Cerebrovascular disease (CC 101 – 102, 105)	18.4	22.5	22.2	21.2
Vascular disease and complications (CC 106 – 108)	32.2	37.8	37.9	36.2
Chronic obstructive pulmonary disease (COPD) (CC 111)	44.6	46.6	47.0	46.2
Fibrosis of lung or other chronic lung disorders (CC 112)	10.4	12.7	13.3	12.3
Asthma (CC 113)	9.1	11.5	12.7	11.3
Pneumonia; pleural effusion/pneumothorax (CC 114 – 117)	41.3	45.5	45.4	44.2
Renal failure (CC 135 – 140)	52.5	53.6	52.7	53.0

Variable (% unless otherwise indicated)	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Decubitus ulcer of skin (CC 157 – 160)	11.0	11.8	11.3	11.4
Trauma; other injuries (CC 166 – 168, 170 – 174)	31.5	39.9	40.2	37.5
Vertebral fractures without spinal cord injury (CC 169)	4.6	6.0	6.0	5.6

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	-3.276	-3.394	-3.684	-3.409
Years over 65 (continuous)	0.043	0.041	0.043	0.042
Male	0.190	0.213	0.206	0.218
History of COVID-19	-0.182	-0.190	-0.214	-0.261
History of coronary artery bypass graft (CABG) surgery	-0.011	0.023	0.018	0.013
History of percutaneous transluminal coronary angioplasty (PTCA)	-0.124	-0.122	-0.123	-0.126
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	-0.220	-0.242	-0.195	-0.219
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	0.941	0.853	0.881	0.897
Protein-calorie malnutrition (CC 21)	0.681	0.709	0.747	0.728
Disorders of fluid/electrolyte/acid-base balance (CC 24)	0.296	0.285	0.260	0.280
Chronic liver disease (CC 27 – 29)	0.353	0.345	0.359	0.354
Severe hematological disorders (CC 46)	0.275	0.173	0.158	0.210
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.012	0.038	0.073	0.042
Delirium and encephalopathy (CC 50)	0.385	0.431	0.484	0.443
Dementia or other specified brain disorders (CC 51 – 53)	0.357	0.325	0.318	0.339
Major psychiatric disorders (CC 57 – 59)	-0.050	-0.044	-0.016	-0.037
Depression (CC 61)	-0.131	-0.111	-0.111	-0.112
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	0.126	0.101	0.115	0.122
Parkinson's and Huntington's diseases (CC 78)	0.177	0.136	0.142	0.156
Seizure disorders and convulsions (CC 79)	-0.068	-0.078	-0.065	-0.067
Respirator dependence/tracheostomy status (CC 82)	-0.160	-0.187	-0.138	-0.144
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	0.505	0.450	0.409	0.444
Congestive heart failure (CC 85)	0.149	0.161	0.172	0.159
Acute myocardial infarction (CC 86)	0.343	0.292	0.302	0.308

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Unstable angina and other acute ischemic heart disease (CC 87)	0.046	0.059	0.051	0.052
Coronary atherosclerosis or angina (CC 88 – 89)	-0.112	-0.088	-0.095	-0.098
Hypertension (CC 95)	-0.165	-0.184	-0.168	-0.193
Stroke (CC 99 – 100)	0.137	0.049	0.062	0.080
Cerebrovascular disease (CC 101 – 102, 105)	-0.034	-0.069	-0.067	-0.070
Vascular disease and complications (CC 106 – 108)	0.045	0.029	0.044	0.035
Chronic obstructive pulmonary disease (COPD) (CC 111)	-0.144	-0.128	-0.119	-0.134
Fibrosis of lung or other chronic lung disorders (CC 112)	0.097	0.111	0.117	0.107
Asthma (CC 113)	-0.267	-0.269	-0.311	-0.291
Pneumonia; pleural effusion/pneumothorax (CC 114 – 117)	0.102	0.128	0.182	0.136
Renal failure (CC 135 – 140)	0.215	0.202	0.197	0.212
Decubitus ulcer of skin (CC 157 – 160)	0.396	0.383	0.390	0.396
Trauma; other injuries (CC 166 – 168, 170 – 174)	0.007	0.015	0.026	-0.002
Vertebral fractures without spinal cord injury (CC 169)	0.112	0.071	0.074	0.078

Table 4.5.3.2 shows the risk-adjusted ORs and 95% CIs for the pneumonia mortality 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)	1.04 (1.04 – 1.04)	1.04 (1.04 – 1.04)	1.04 (1.04 – 1.05)	1.04 (1.04 – 1.04)
Male	1.21 (1.18 – 1.24)	1.24 (1.21 – 1.27)	1.23 (1.20 – 1.26)	1.24 (1.23 – 1.26)
History of COVID-19	0.83 (0.80 – 0.86)	0.83 (0.80 – 0.85)	0.81 (0.79 – 0.83)	0.77 (0.76 – 0.78)
History of coronary artery bypass graft (CABG) surgery	0.99 (0.95 – 1.03)	1.02 (0.99 – 1.06)	1.02 (0.98 – 1.06)	1.01 (0.99 – 1.04)
History of percutaneous transluminal coronary angioplasty (PTCA)	0.88 (0.85 – 0.92)	0.88 (0.86 – 0.92)	0.88 (0.86 – 0.91)	0.88 (0.86 – 0.90)
Septicemia, sepsis, systemic inflammatory response syndrome/shock (CC 2)	0.80 (0.78 – 0.83)	0.79 (0.76 – 0.81)	0.82 (0.80 – 0.85)	0.80 (0.79 – 0.82)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	2.56 (2.49 – 2.64)	2.35 (2.28 – 2.41)	2.41 (2.35 – 2.48)	2.45 (2.41 – 2.49)
Protein-calorie malnutrition (CC 21)	1.98 (1.93 – 2.03)	2.03 (1.98 – 2.08)	2.11 (2.06 – 2.16)	2.07 (2.04 – 2.10)
Disorders of fluid/electrolyte/acid-base balance (CC 24)	1.34 (1.31 – 1.38)	1.33 (1.30 – 1.36)	1.30 (1.27 – 1.33)	1.32 (1.31 – 1.34)
Chronic liver disease (CC 27 – 29)	1.42 (1.35 – 1.50)	1.41 (1.35 – 1.48)	1.43 (1.37 – 1.50)	1.42 (1.38 – 1.47)

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)
Severe hematological disorders (CC 46)	1.32 (1.23 – 1.41)	1.19 (1.11 – 1.27)	1.17 (1.10 – 1.25)	1.23 (1.19 – 1.28)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.01 (0.99 – 1.04)	1.04 (1.01 – 1.06)	1.08 (1.05 – 1.10)	1.04 (1.03 – 1.06)
Delirium and encephalopathy (CC 50)	1.47 (1.43 – 1.51)	1.54 (1.50 – 1.58)	1.62 (1.58 – 1.66)	1.56 (1.54 – 1.58)
Dementia or other specified brain disorders (CC 51 – 53)	1.43 (1.40 – 1.46)	1.38 (1.35 – 1.42)	1.37 (1.34 – 1.41)	1.40 (1.38 – 1.42)
Major psychiatric disorders (CC 57 – 59)	0.95 (0.92 – 0.98)	0.96 (0.93 – 0.99)	0.98 (0.96 – 1.01)	0.96 (0.95 – 0.98)
Depression (CC 61)	0.88 (0.85 – 0.90)	0.89 (0.87 – 0.92)	0.89 (0.87 – 0.92)	0.89 (0.88 – 0.91)
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	1.13 (1.10 – 1.17)	1.11 (1.07 – 1.14)	1.12 (1.09 – 1.16)	1.13 (1.11 – 1.15)
Parkinson's and Huntington's diseases (CC 78)	1.19 (1.14 – 1.25)	1.15 (1.10 – 1.20)	1.15 (1.10 – 1.21)	1.17 (1.14 – 1.20)
Seizure disorders and convulsions (CC 79)	0.93 (0.90 – 0.97)	0.93 (0.89 – 0.96)	0.94 (0.90 – 0.98)	0.94 (0.91 – 0.96)
Respirator dependence/tracheostomy status (CC 82)	0.85 (0.79 – 0.92)	0.83 (0.77 – 0.89)	0.87 (0.81 – 0.94)	0.87 (0.83 – 0.90)
Respiratory arrest; cardio-respiratory failure and shock (CC 83 – 84), plus ICD-10-CM codes R09.01 and R09.02	1.66 (1.62 – 1.70)	1.57 (1.53 – 1.61)	1.50 (1.47 – 1.54)	1.56 (1.54 – 1.58)
Congestive heart failure (CC 85)	1.16 (1.13 – 1.19)	1.18 (1.15 – 1.20)	1.19 (1.16 – 1.22)	1.17 (1.16 – 1.19)
Acute myocardial infarction (CC 86)	1.41 (1.36 – 1.46)	1.34 (1.30 – 1.38)	1.35 (1.31 – 1.39)	1.36 (1.34 – 1.38)
Unstable angina and other acute ischemic heart disease (CC 87)	1.05 (1.01 – 1.09)	1.06 (1.02 – 1.10)	1.05 (1.02 – 1.09)	1.05 (1.03 – 1.08)
Coronary atherosclerosis or angina (CC 88 – 89)	0.89 (0.87 – 0.92)	0.92 (0.89 – 0.94)	0.91 (0.89 – 0.93)	0.91 (0.89 – 0.92)
Hypertension (CC 95)	0.85 (0.83 – 0.87)	0.83 (0.81 – 0.85)	0.85 (0.82 – 0.87)	0.82 (0.81 – 0.84)
Stroke (CC 99 – 100)	1.15 (1.10 – 1.19)	1.05 (1.01 – 1.09)	1.06 (1.03 – 1.10)	1.08 (1.06 – 1.11)
Cerebrovascular disease (CC 101 – 102, 105)	0.97 (0.94 – 0.99)	0.93 (0.91 – 0.96)	0.94 (0.91 – 0.96)	0.93 (0.92 – 0.95)
Vascular disease and complications (CC 106 – 108)	1.05 (1.02 – 1.07)	1.03 (1.01 – 1.05)	1.04 (1.02 – 1.07)	1.04 (1.02 – 1.05)
Chronic obstructive pulmonary disease (COPD) (CC 111)	0.87 (0.85 – 0.89)	0.88 (0.86 – 0.90)	0.89 (0.87 – 0.91)	0.87 (0.86 – 0.89)
Fibrosis of lung or other chronic lung disorders (CC 112)	1.10 (1.06 – 1.14)	1.12 (1.08 – 1.15)	1.12 (1.09 – 1.16)	1.11 (1.09 – 1.13)

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)
Asthma (CC 113)	0.77 (0.74 – 0.80)	0.76 (0.74 – 0.79)	0.73 (0.71 – 0.76)	0.75 (0.73 – 0.76)
Pneumonia; pleural effusion/pneumothorax (CC 114 – 117)	1.11 (1.08 – 1.13)	1.14 (1.11 – 1.16)	1.20 (1.17 – 1.23)	1.15 (1.13 – 1.16)
Renal failure (CC 135 – 140)	1.24 (1.21 – 1.27)	1.22 (1.20 – 1.25)	1.22 (1.19 – 1.25)	1.24 (1.22 – 1.25)
Decubitus ulcer of skin (CC 157 – 160)	1.49 (1.44 – 1.53)	1.47 (1.42 – 1.51)	1.48 (1.43 – 1.52)	1.49 (1.46 – 1.51)
Trauma; other injuries (CC 166 – 168, 170 – 174)	1.01 (0.98 – 1.03)	1.01 (0.99 – 1.04)	1.03 (1.00 – 1.05)	1.00 (0.99 – 1.01)
Vertebral fractures without spinal cord injury (CC 169)	1.12 (1.07 – 1.17)	1.07 (1.03 – 1.12)	1.08 (1.03 – 1.12)	1.08 (1.06 – 1.11)

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)	3.8 – 45.9	3.4 – 42.7	2.3 – 39.4	3.1 – 42.4
c-statistics	0.73	0.72	0.74	0.73

4.5.4 Distribution of Hospital Volumes and Mortality Rates for Pneumonia

The national *observed* mortality rate in the combined three-year dataset was 17.9%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 20.1%
- July 1, 2021 – June 30, 2022: 18.2%
- 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	4,450	4,449	4,450	4,566
Mean number of admissions (SD)	55.5 (65.7)	62.1 (73.8)	70.4 (86.6)	183.2 (223.0)
Range (min. – max.)	1 – 854	1 – 1,000	1 – 1,196	1 – 3,044
25th percentile	11	13	13	35
50th percentile	31	35	39	98
75th percentile	79	87	99	259

Table 4.5.4.2 shows the distribution of hospital RSMRs.

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

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	4,450	4,449	4,450	4,566
Mean (SD)	20.2 (2.0)	18.3 (1.9)	15.8 (1.8)	18.1 (2.7)
Range (min. – max.)	11.8 – 30.4	9.5 – 28.5	9.0 – 28.1	8.6 – 34.6
25th percentile	19.2	17.2	14.8	16.4
50th percentile	20.1	18.2	15.7	17.9
75th percentile	21.3	19.3	16.8	19.6

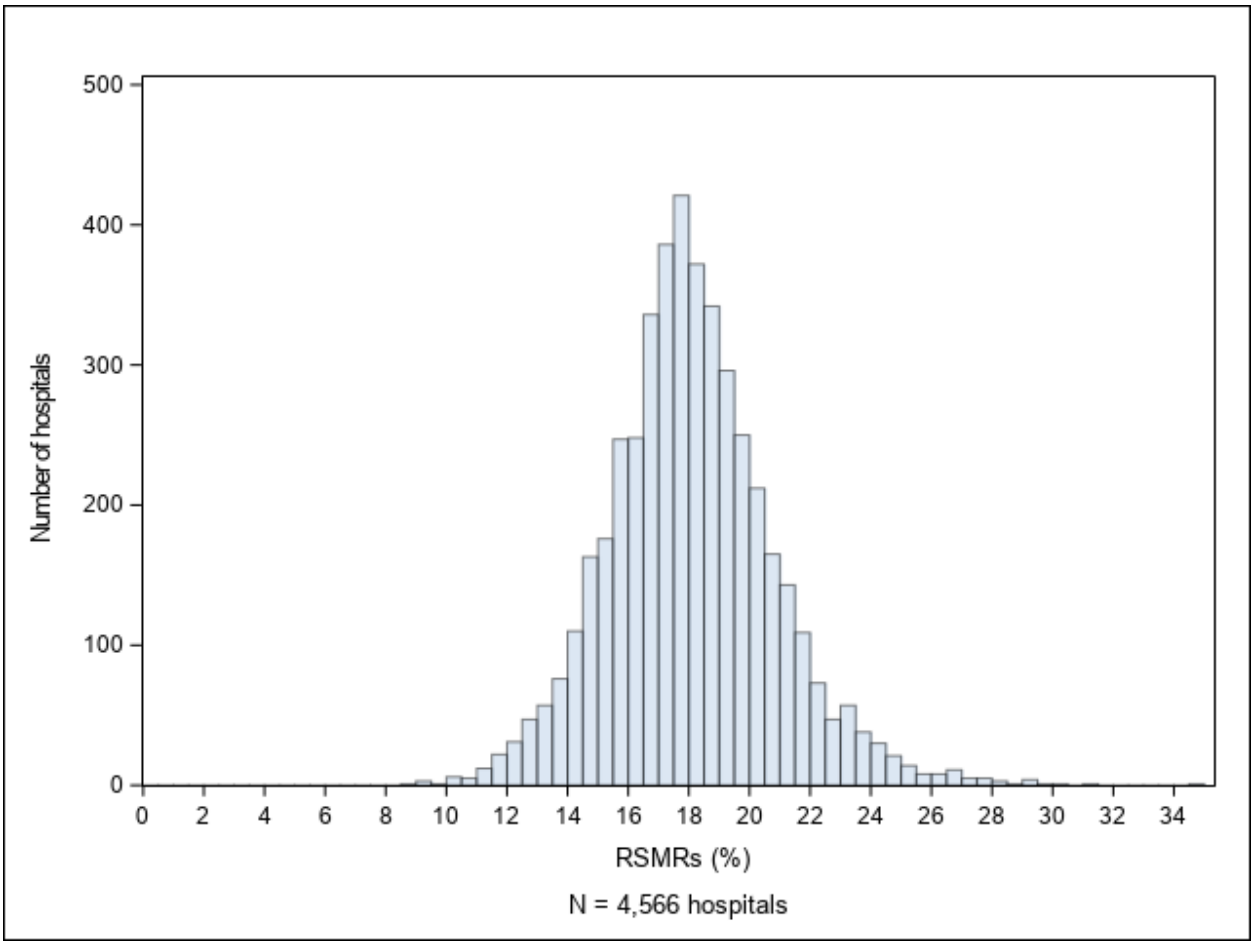
Table 4.5.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

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)	0.067 (0.005)	0.070 (0.005)	0.077 (0.005)	0.084 (0.003)

Figure 4.5.4.1 shows the overall distribution of the hospital RSMRs for the combined three-year dataset, which indicates that the hospital RSMRs are normally distributed. The odds of all-cause mortality if a patient is treated at a hospital one SD above the national rate were 1.78 times higher than the odds of all-cause mortality 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.[11]

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



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

Of 4,566 hospitals in the study cohort, 326 performed “Better than the National Rate,” 3,236 performed “No Different than the National Rate,” and 185 performed “Worse than the National Rate.” 819 were classified as “Number of Cases Too Small” (fewer than 25) to reliably conclude how the hospital is performing.

4.6. Stroke Mortality 2024 Model Results

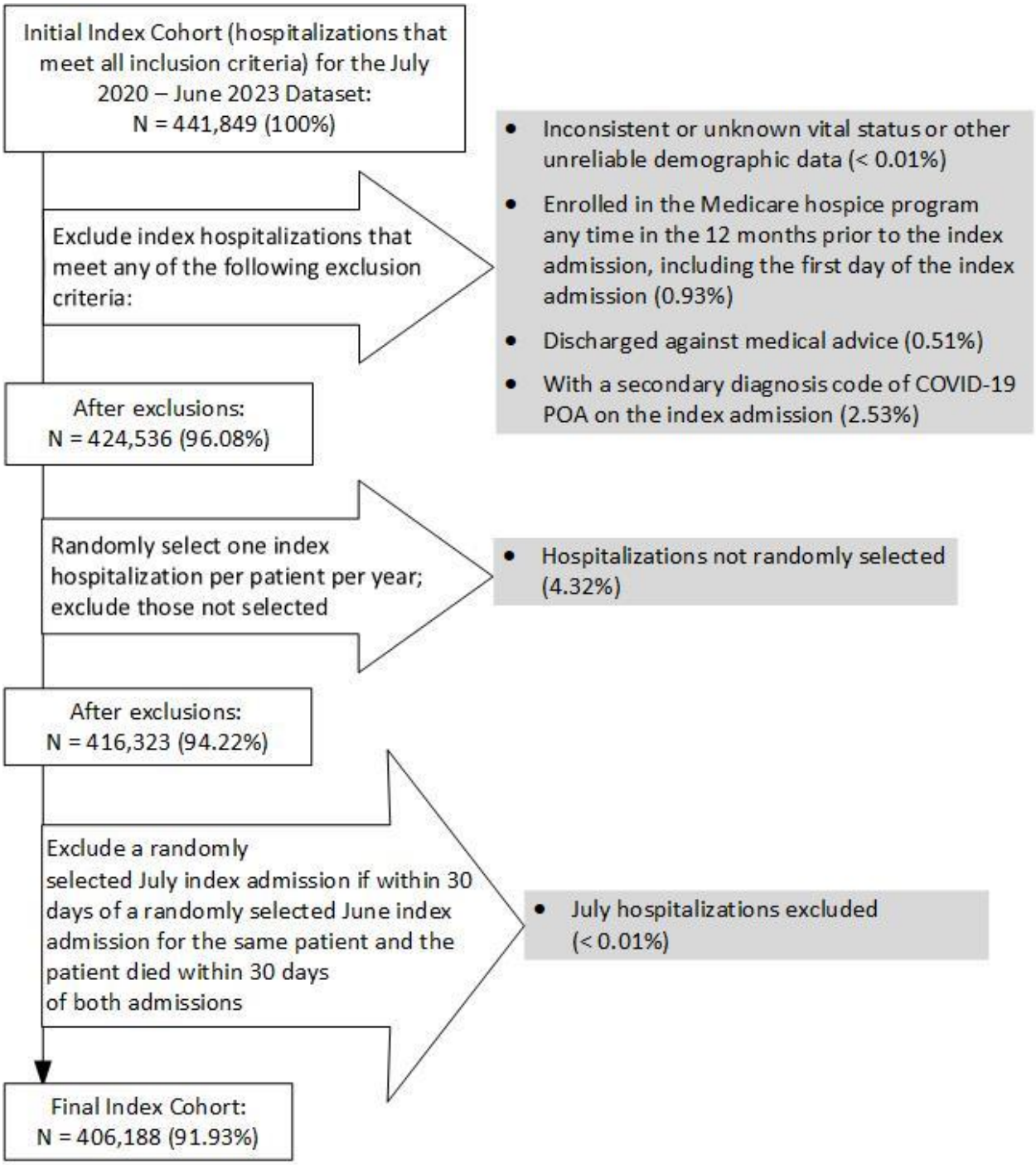
4.6.1 Index Cohort Exclusions

The exclusion criteria for this measure are presented in Section 2.2.1. The percentage of stroke admissions that met each exclusion criterion in the July 2020 – June 2023 dataset is presented in Figure 4.6.1.1.

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 ischemic stroke;
- 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; and
- who were not transferred from another acute care facility.

Figure 4.6.1.1 — Stroke Cohort Exclusions in the July 2020 – June 2023 Dataset



4.6.2 Frequency of Stroke 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 4.6.2.1 for more detail.

Of note, the percent of index admissions reporting the NIH Stroke Scale score on the administrative claim increased from 61.7% in 2023 public reporting to 64.6% in 2024 public reporting.

Table 4.6.2.1 — Frequency of Stroke 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	143,262	133,746	129,180	406,188
Mean age (SD)	79.5 (8.4)	79.7 (8.3)	79.6 (8.2)	79.6 (8.3)
History of COVID-19	3.9	9.2	15.8	9.5
Transfer from another ED	13.6	12.0	12.1	12.6
Mean NIH Stroke Scale score (SD)	4.1 (6.7)	4.3 (6.7)	4.3 (6.7)	4.2 (6.7)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	5.2	5.6	5.8	5.5
Protein-calorie malnutrition (CC 21)	7.2	8.3	8.9	8.1
Disorders of fluid/electrolyte/acid-base; other endocrine/metabolic/nutritional disorders (CC 22 – 26)	89.2	91.5	92.1	90.9
Other gastrointestinal disorders (CC 38)	44.8	51.1	51.8	49.1
Disorders of the vertebrae and spinal discs (CC 41)	17.0	21.9	22.9	20.5
Osteoarthritis of hip or knee (CC 42)	10.4	14.2	14.8	13.0
Other musculoskeletal and connective tissue disorders (CC 45)	54.1	62.4	63.1	59.7
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	31.9	36.6	37.9	35.4
Dementia or other specified brain disorders (CC 51 – 53)	27.0	29.1	28.8	28.3
Multiple sclerosis; mononeuropathy, other neurological conditions/injuries (CC 77, 81)	17.0	20.3	20.9	19.3
Seizure disorders and convulsions (CC 79)	6.6	7.0	7.0	6.9
Congestive heart failure (CC 85)	28.7	30.9	31.5	30.3
Congenital cardiac/circulatory defects (CC 92 – 93)	0.7	1.1	3.1	1.6
Specified heart arrhythmias (CC 96)	39.2	40.4	40.8	40.1
Cerebrovascular atherosclerosis, aneurysm, and other disease (CC 102)	13.1	15.9	16.3	15.1
Pneumonia (CC 114 – 116)	11.2	13.2	13.7	12.6
Renal failure (CC 135 – 140)	36.7	39.1	39.4	38.3

4.6.3 Stroke Model Parameters and Performance

Table 4.6.3.1 shows hierarchical logistic regression model parameter coefficients by individual year and for the combined three-year dataset.

Table 4.6.3.1 — Hierarchical Logistic Regression Model Parameter Coefficients for Stroke over Different Time Periods

Variable	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Intercept	-3.676	-3.693	-3.758	-3.684
Years over 65 (continuous)	0.061	0.058	0.057	0.059
History of COVID-19	-0.115	-0.125	-0.164	-0.176
Transfer from another ED	0.239	0.206	0.223	0.224
NIH Stroke Scale score (continuous)	0.087	0.087	0.090	0.089
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	1.164	1.004	1.101	1.095
Protein-calorie malnutrition (CC 21)	0.710	0.678	0.712	0.714
Disorders of fluid/electrolyte/acid-base; other endocrine/metabolic/nutritional disorders (CC 22 – 26)	-0.267	-0.232	-0.216	-0.242
Other gastrointestinal disorders (CC 38)	-0.109	-0.110	-0.134	-0.122
Disorders of the vertebrae and spinal discs (CC 41)	-0.159	-0.111	-0.137	-0.137
Osteoarthritis of hip or knee (CC 42)	-0.191	-0.150	-0.142	-0.162
Other musculoskeletal and connective tissue disorders (CC 45)	-0.052	-0.036	-0.038	-0.047
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	0.175	0.202	0.192	0.188
Dementia or other specified brain disorders (CC 51 – 53)	0.380	0.369	0.384	0.379
Multiple sclerosis; mononeuropathy, other neurological conditions/injuries (CC 77, 81)	-0.154	-0.168	-0.148	-0.160
Seizure disorders and convulsions (CC 79)	0.325	0.198	0.230	0.255
Congestive heart failure (CC 85)	0.218	0.221	0.174	0.206
Congenital cardiac/circulatory defects (CC 92 – 93)	0.003	-0.161	-0.370	-0.260
Specified heart arrhythmias (CC 96)	0.282	0.294	0.254	0.278
Cerebrovascular atherosclerosis, aneurysm, and other disease (CC 102)	-0.227	-0.139	-0.198	-0.187
Pneumonia (CC 114 – 116)	0.764	0.691	0.685	0.712
Renal failure (CC 135 – 140)	0.280	0.249	0.242	0.260

Table 4.6.3.2 shows the risk-adjusted ORs and 95% CIs for the stroke mortality model by individual year and for the combined three-year dataset.

Table 4.6.3.2 — Adjusted OR and 95% CIs for the Stroke 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)	1.06 (1.06 – 1.06)	1.06 (1.06 – 1.06)	1.06 (1.06 – 1.06)	1.06 (1.06 – 1.06)

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)
History of COVID-19	0.89 (0.82 – 0.96)	0.88 (0.83 – 0.94)	0.85 (0.81 – 0.89)	0.84 (0.81 – 0.87)
Transfer from another ED	1.27 (1.21 – 1.33)	1.23 (1.17 – 1.29)	1.25 (1.18 – 1.32)	1.25 (1.21 – 1.29)
NIH Stroke Scale score (continuous)	1.09 (1.09 – 1.09)	1.09 (1.09 – 1.09)	1.09 (1.09 – 1.10)	1.09 (1.09 – 1.09)
Metastatic cancer, acute leukemia and other severe cancers (CC 8 – 9)	3.20 (3.02 – 3.40)	2.73 (2.57 – 2.90)	3.01 (2.83 – 3.20)	2.99 (2.89 – 3.10)
Protein-calorie malnutrition (CC 21)	2.03 (1.93 – 2.14)	1.97 (1.87 – 2.07)	2.04 (1.94 – 2.15)	2.04 (1.98 – 2.10)
Disorders of fluid/electrolyte/acid-base; other endocrine/metabolic/nutritional disorders (CC 22 – 26)	0.77 (0.73 – 0.81)	0.79 (0.75 – 0.84)	0.81 (0.75 – 0.86)	0.79 (0.76 – 0.81)
Other gastrointestinal disorders (CC 38)	0.90 (0.87 – 0.93)	0.90 (0.86 – 0.93)	0.87 (0.84 – 0.91)	0.89 (0.87 – 0.90)
Disorders of the vertebrae and spinal discs (CC 41)	0.85 (0.81 – 0.90)	0.90 (0.86 – 0.94)	0.87 (0.83 – 0.91)	0.87 (0.85 – 0.90)
Osteoarthritis of hip or knee (CC 42)	0.83 (0.78 – 0.87)	0.86 (0.82 – 0.91)	0.87 (0.82 – 0.91)	0.85 (0.82 – 0.88)
Other musculoskeletal and connective tissue disorders (CC 45)	0.95 (0.92 – 0.98)	0.96 (0.93 – 1.00)	0.96 (0.92 – 1.00)	0.95 (0.93 – 0.98)
Iron deficiency or other/unspecified anemias and blood disease (CC 49)	1.19 (1.15 – 1.24)	1.22 (1.18 – 1.27)	1.21 (1.17 – 1.26)	1.21 (1.18 – 1.23)
Dementia or other specified brain disorders (CC 51 – 53)	1.46 (1.41 – 1.52)	1.45 (1.39 – 1.50)	1.47 (1.41 – 1.53)	1.46 (1.43 – 1.49)
Multiple sclerosis; mononeuropathy, other neurological conditions/injuries (CC 77, 81)	0.86 (0.82 – 0.90)	0.85 (0.81 – 0.88)	0.86 (0.82 – 0.90)	0.85 (0.83 – 0.87)
Seizure disorders and convulsions (CC 79)	1.38 (1.30 – 1.47)	1.22 (1.15 – 1.30)	1.26 (1.18 – 1.34)	1.29 (1.24 – 1.34)
Congestive heart failure (CC 85)	1.24 (1.20 – 1.29)	1.25 (1.20 – 1.30)	1.19 (1.14 – 1.24)	1.23 (1.20 – 1.26)
Congenital cardiac/circulatory defects (CC 92 – 93)	1.00 (0.83 – 1.21)	0.85 (0.72 – 1.01)	0.69 (0.61 – 0.78)	0.77 (0.71 – 0.84)
Specified heart arrhythmias (CC 96)	1.33 (1.28 – 1.37)	1.34 (1.29 – 1.39)	1.29 (1.24 – 1.34)	1.32 (1.29 – 1.35)
Cerebrovascular atherosclerosis, aneurysm, and other disease (CC 102)	0.80 (0.76 – 0.84)	0.87 (0.83 – 0.91)	0.82 (0.78 – 0.86)	0.83 (0.81 – 0.85)
Pneumonia (CC 114 – 116)	2.15 (2.05 – 2.24)	2.00 (1.91 – 2.09)	1.98 (1.90 – 2.08)	2.04 (1.99 – 2.09)
Renal failure (CC 135 – 140)	1.32 (1.28 – 1.37)	1.28 (1.24 – 1.33)	1.27 (1.23 – 1.32)	1.30 (1.27 – 1.32)

Overall, model performance was stable over the three-year time period (Table 4.6.3.3).

Table 4.6.3.3 — Stroke 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)	1.9 – 50.0	1.9 – 48.5	1.7 – 47.5	1.9 – 48.7
c-statistic	0.79	0.79	0.79	0.79

4.6.4 Distribution of Hospital Volumes and Mortality Rates for Stroke

The national *observed* mortality rate in the combined three-year dataset was 13.9%. For the individual years, the *observed* rates were as follows:

- July 1, 2020 – June 30, 2021: 14.3%
- July 1, 2021 – June 30, 2022: 14.1%
- July 1, 2022 – June 30, 2023: 13.2%

Table 4.6.4.1 shows the distribution of hospital admission volumes.

Table 4.6.4.1 — Distribution of Hospital Stroke 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	3,689	3,697	3,596	4,068
Mean number of admissions (SD)	38.8 (54.1)	36.2 (50.1)	35.9 (49.3)	99.8 (148.2)
Range (min. – max.)	1 – 500	1 – 461	1 – 467	1 – 1,428
25th percentile	4	4	4	7
50th percentile	16	15	15	34
75th percentile	53	49	48	135

Table 4.6.4.2 shows the distribution of hospital RSMRs.

Table 4.6.4.2 — Distribution of Hospital Stroke RSMRs over Different Time Periods

Characteristic	07/2020 – 06/2021	07/2021 – 06/2022	07/2022 – 06/2023	07/2020 – 06/2023
Number of hospitals	3,689	3,697	3,596	4,068
Mean (SD)	14.4 (1.2)	14.1 (1.1)	13.2 (0.9)	14.0 (1.6)
Range (min. – max.)	8.8 – 22.2	9.8 – 20.3	9.0 – 19.4	8.0 – 21.5
25th percentile	13.8	13.6	12.8	13.2
50th percentile	14.2	14.0	13.1	13.8
75th percentile	14.9	14.7	13.7	14.7

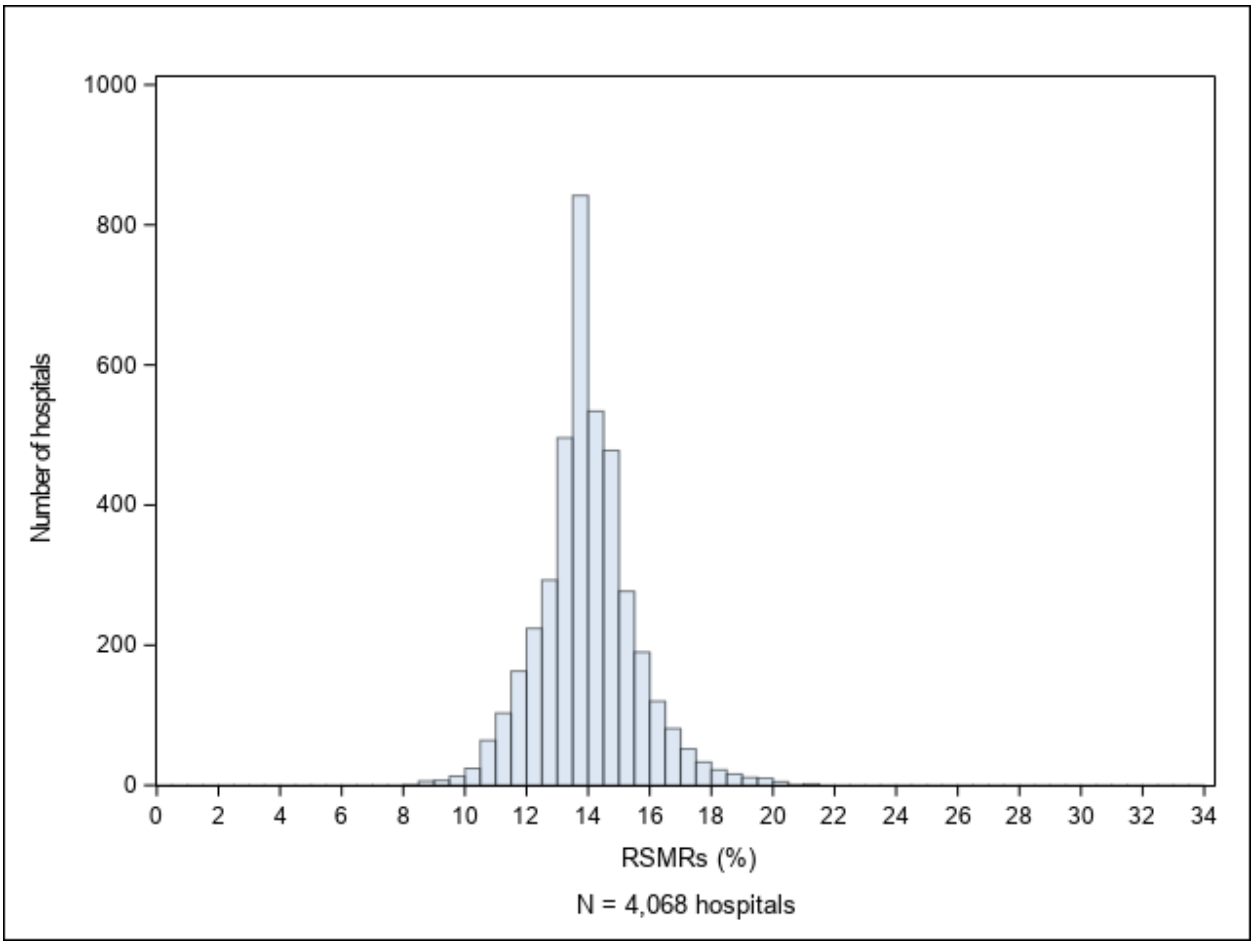
Table 4.6.4.3 shows the between-hospital variance by individual year as well as for the combined three-year dataset.

Table 4.6.4.3 — Between-Hospital Variance for Stroke 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)	0.075 (0.007)	0.070 (0.008)	0.064 (0.008)	0.080 (0.005)

Figure 4.6.4.1 shows the overall distribution of the hospital RSMRs for the combined three-year dataset, which indicates that the hospital RSMRs are normally distributed. The odds of all-cause mortality if a patient is treated at a hospital one SD above the national rate were 1.76 times higher than the odds of all-cause mortality 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.[11]

Figure 4.6.4.1 — Distribution of Hospital 30-Day Stroke RSMRs between July 2020 and June 2023



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

Of 4,068 hospitals in the study cohort, 99 performed "Better than the National Rate," 2,105 performed "No Different than the National Rate," and 47 performed "Worse than the National Rate." 1,817 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 died within 30 days of the start of the admission. 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.

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.[16, 17] 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 mortality (or Expected deaths): The number of deaths 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 mortality 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 mortality 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 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 die. 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" mortality.

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

Interval estimate: Similar to a CI, the interval estimate is a range of probable values for the estimate that characterizes the amount of associated uncertainty. For example, a 95% interval estimate for a mortality 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 Institutes of Health Stroke Severity Scale (NIH Stroke Scale): The NIH Stroke Scale evaluates the effects of acute ischemic stroke on a patient's level of consciousness, language, neglect, visual-field loss, extraocular movement, motor strength, ataxia, dysarthria, and sensory loss. It is an 11-item neurologic examination stroke scale used to provide a quantitative measure of stroke-related neurologic deficit ranging from 0 to 42, with higher values indicating more severe strokes (0 indicating no stroke symptoms, 1–4 minor stroke, 5–15 moderate stroke, 16–20 moderate to severe stroke, and 21–42 severe stroke).

National observed mortality 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 mortality measures, the outcome is mortality within 30 days of the start of the admission.

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

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.

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.

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7. APPENDICES

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

The condition-specific measures use hierarchical generalized linear models (HGLMs) to estimate RSMRs 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 mortality ratio (SMR) is calculated. The RSMR is calculated by multiplying the SMR for each hospital by the national observed mortality 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:

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

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

$$i=1,\ldots,I;\ j=1,\ldots,n_i$$

where Y_{ij} denotes the outcome (equal to 1 if the patient dies within 30 days, 0 otherwise) for the *j-th* patient at the *i-th* hospital; $Z_{ij}=\left(Z_{ij1},Z_{ij2},\ldots,Z_{ijp}\right)^T$ is a set of *p* patient-specific covariates derived from the data; *I* 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.[18]

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 $\hat{\mu}$, $\{\hat{\alpha}_1,\hat{\alpha}_2,\ldots,\hat{\alpha}_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$, we calculate an SMR, $\hat{s}_i$, for each hospital by computing the ratio of the number of predicted deaths to the number of expected deaths. Specifically, we calculate:

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

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

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

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

Risk-Standardized Mortality Rate: $\widehat{RSMR}_i = \hat{s}_i \times \bar{y}$ (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 mortality rate, $\bar{y}$, and considered worse if the lower bound of their 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,…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, $\left\{\hat{\alpha}_i^{(b)}, \hat{var}\left(\alpha_i^{(b)}\right); i = 1,2,\ldots,I\right\}$.
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 $\alpha_i^{(b*)} \sim N(\hat{\alpha}_i^{(b)}, \hat{var}\left(\alpha_i^{(b)}\right))$ 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 randomly half of the B estimates (or the percentiles corresponding to the alternative desired intervals).[19]

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 YNHHSC/CORE conducted to maintain and report these mortality 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 mortality measures.

Phase I

As the first step in the QA process, we review changes in the cohort 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 HCC clinical category maps.

In general, we use both manual scan and descriptive analyses to conduct data validity checks, including cross-checking mortality 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 mortality measures: data preparation, sample selection, hierarchical modeling, and calculation of RSMRs. This process highlights any programming errors in syntax or logic. Once the parallel programming process is complete, the analysts cross-check their codes by analyzing datasets in parallel, checking for consistency of output, and reconciling any discrepancies.

Phase 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 here under the reporting year and corresponding report. In 2013, CMS began assigning version numbers to its measures. The measure specifications in the original methodology reports are considered Version 1.0 for each measure. The measure specifications in the updated stroke mortality methodology report are considered Version 1.2. The measures receive a new version number for each subsequent year of public reporting.

2024

2024 Measures Updates and Specifications Report (Version 18.0 — AMI, HF, and Pneumonia) (Version 13.0 — COPD and Stroke)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - incorporated the code changes that occurred in the 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 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 17.0 — AMI, HF, and Pneumonia) (Version 12.0 — COPD and Stroke)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - incorporated the code changes that occurred in the 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 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 16.0 — AMI, HF, and Pneumonia) (Version 11.0 — COPD and Stroke)

- Updated the ICD-10 code-based specifications used in the measures — Specifically, we:
  - incorporated the code changes that occurred in the 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 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 five measures as publicly reported on Medicare.gov in response to the COVID-19 PHE — Specifically, we:
  - removed COVID-19 index admissions from the cohorts;
  - 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 mortality 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.[20] 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.
- Updated the stroke mortality measure specifications as described in the Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Ischemic Stroke Hospitalization with Claims-Based Risk Adjustment for Stroke Severity Measure Methodology Report posted here on *QualityNet*:
  - added an 'NIH Stroke Scale score' risk variable to risk adjustment; and

- reselected the risk variables in response to the addition of the 'NIH Stroke Scale score' risk variable (23 risk variables were removed from the model).
  - Rationale: The addition of an 'NIH Stroke Scale score' risk variable to the stroke mortality measure was done in response to stakeholder feedback and an effort to continually improve on existing quality measures. Clinicians, stakeholders, and professional organizations highlight the importance of including an assessment of stroke severity in risk-adjustment models of stroke mortality. Several studies have demonstrated that initial stroke severity is the strongest predictor of mortality in ischemic stroke patients.[7, 21-23] The incorporation of the NIH Stroke Scale warranted model respecification to identify risk variables significantly associated with mortality.

2021

2021 Measures Updates and Specifications Report (Version 15.0 — AMI, HF, and Pneumonia) (Version 10.0 — 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 2020 version of the ICD-10-CM/PCS (effective with October 1, 2019+ discharges) into the cohort definitions and risk models;
  - 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 all measures except the stroke mortality measure) for the measurement period of July 1, 2017 – 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 14.0 — AMI, HF, and Pneumonia) (Version 9.0 — 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 2019 version of the ICD-10-CM/PCS (effective with October 1, 2018+ discharges) into the cohort definitions and risk models;
  - 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 and CMS-HCC crosswalk as well as the workgroup review activities.
- Added admission data from VA hospitals to the COPD mortality measure
    - Rationale: Creates a more inclusive perspective of the relative quality of U.S. hospitals

2019

2019 Measures Updates and Specifications Report (Version 13.0 — AMI, HF, and Pneumonia) (Version 8.0 — 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 2018 version of the ICD-10-CM/PCS (effective with October 1, 2017+ discharges) into the cohort definitions and risk models;
    - 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 and CMS-HCC crosswalk as well as the workgroup review activities.

2018

2018 Measures Updates and Specifications Report (Version 12.0 — 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 and risk models;
    - 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 and CMS-HCC crosswalk were released. Revisions to the measure specifications were warranted to accommodate these updates.

2017

2017 Measures Updates and Specifications Report (Version 11.0 — 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; 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.

2016

2016 Measures Updates and Specifications Report (Version 10.0 — 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 (CCs 2, 23, 48, 77, 78, 114, and 148 added)
    - Rationale: 'Presence of Septicemia/shock' (CC 2), 'Disorders of fluid/electrolyte/acid-base balance' (CC 23), 'Delirium and encephalopathy' (CC 48), 'Respirator dependence/tracheostomy status' (CC 77), 'Respiratory arrest' (CC 78), 'Pleural effusion/pneumothorax' (CC 114), and 'Decubitus ulcer of skin' (CC 148) in the 12 months prior to the index admission all had strong associations with mortality 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.
- 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.[24] 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.[25] 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.

2015

2015 Measures Updates and Specifications Report (Version 9.0 — AMI, HF, and Pneumonia) (Version 4.0 — COPD and Stroke)

No updates were made to the specifications of the AMI, HF, pneumonia, COPD, and stroke mortality measures for 2015 public reporting.

2014

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

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

2013

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

- 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)

- 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)

- 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.
- Incorporated risk adjustment for ED transfer patients
  - Rationale: ED transfer patients may be at higher risk of mortality.
- Removed ICD-9-CM 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 6.0 — 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 measure.
- Added the exclusion of patients based on enrollment in VA hospice
  - Rationale: VA patients who have a history of VA hospice care in the 12 months prior to the index admission are now excluded.
- 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 5.0 — 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 4.0 — 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 revision includes more clinical covariates for 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.

2009

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

- Revised the methodology to randomly select one AMI admission per patient per year for inclusion in the cohort
  - Rationale: Three-year data increased the number of multiple AMI admissions, which would be statistically correlated. Randomly selecting one AMI admission per year aligned the measure with HF and 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 RSMR 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.

2008 Measures Maintenance Report (Version 2.0 — AMI, HF, and Pneumonia)

- Added three viral pneumonia codes (480.0, 480.1, and 480.2) to the pneumonia measure cohort
  - Rationale: Viral pneumonias are common causes of pneumonia in the elderly.
- Added the exclusion of patients with a history of Medicare hospice enrollment in the 12 months prior to or on the index admission date
  - Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care.
- Incorporated additional checks for cases with unreliable data. Patients for whom ANY of the following were true were excluded from the cohorts:
  - Age is greater than 115 years old
  - The date of discharge is before the date of admission
  - Gender is unknown
  - Two hospitals have conflicting death information for the same patient.
    - Rationale: The measures cannot be accurately calculated for patients with unreliable data.
- Modified the list of conditions that are considered to be potential complications in the index admission
  - Rationale: The models do not adjust for risk factors present on an index admission if the conditions may represent complications of care.
- Removed the hierarchical component of the HCC system from the risk-adjustment methodology
  - Rationale: The hierarchical logic is meant to predict expenditures, not to estimate prevalence of comorbidities. Dropping the hierarchy allowed the risk factor coefficients to better reflect the true disease burden.
- 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 RSMR following AMI (CBE #0230)

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.
- **Not transferred from another acute care facility**
  - Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for AMI Measure

- **Discharged alive on the day of admission or the following day and not transferred to another acute care facility**
  - Rationale: It is unlikely that these patients had clinically significant AMI.
- **Inconsistent or unknown vital status or other unreliable demographic data**
  - Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
- **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
  - Rationale: These patients are likely continuing to seek comfort measures only, so mortality is not necessarily an adverse outcome or signal of poor quality care. Patients who transition to hospice during their hospital stay (after the first day of the index admission) are not excluded. Such transitions may be the result of quality failures that have led to poor clinical outcomes. Thus, excluding these patients could mask quality problems.
- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

- **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 mortality measure included in the FY 2025 Hospital Value-Based Purchasing (VBP) Program.

After the above exclusions are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Additional admissions within that year are excluded.

For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year dataset, if a randomly selected July index admission falls within 30 days of a randomly selected June index admission (the transition period between two years) and the patient died within 30 days of both admissions, the measure includes only the June admission. The July admission is excluded to avoid assigning a single death to two admissions. For example, if a patient has a randomly selected admission on June 18, 2021 and then again on July 2, 2021, and then subsequently dies on July 15, 2021, the measure will exclude the July 2, 2021 admission, and the death that occurred will be attributed to the June 18, 2021 admission.

The ICD-10-CM codes used to define the AMI cohort are outlined in the 2024 AMI Mortality Measure Code Specifications supplemental file posted here on *QualityNet*.

Outcome

Outcome Criteria for AMI Measure

Death, from any cause, within 30 days of the start of the index admission
Rationale: From a patient's perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and 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 mortality.

Appendix D.2 Hospital-Level 30-Day RSMR following COPD (CBE #1893)

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 in order 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.
- **Not transferred from another acute care facility**
  - Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for COPD Measure

- **Inconsistent or unknown vital status or other unreliable demographic data**
  - Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
- **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
  - Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care. Patients who transition to hospice during their hospital stay (after the first day of the index admission) are not excluded. Such transitions may be the result of quality failures that have led to poor clinical outcomes. Thus, excluding these patients could mask quality problems.
- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **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 mortality measure included in the FY 2025 Hospital VBP Program.

After the above exclusions are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Additional admissions within that year are excluded.

For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year dataset, if a randomly selected July index admission falls within 30 days of a randomly selected June index admission (the transition period between two years) and the patient died within 30 days of both admissions, the measure includes only the June admission. The July admission is excluded to avoid assigning a single death to two admissions. For example, if a patient has a randomly selected admission on June 18, 2021 and then again on July 2, 2021, and then subsequently dies on July 15, 2021, the measure will exclude the July 2, 2021 admission, and the death that occurred will be attributed to the June 18, 2021 admission.

The ICD-10-CM codes used to define the COPD cohort are outlined in the 2024 COPD Mortality Measure Code Specifications supplemental file posted here on *QualityNet*.

Outcome

Outcome Criteria for COPD Measure

Death, from any cause, within 30 days of the start of the index admission
Rationale: From a patient's perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and 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 mortality.

Appendix D.3 Hospital-Level 30-Day RSMR following HF (CBE #0229)

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.
- **Not transferred from another acute care facility**
  - Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for HF Measure

- **Discharged alive on the day of admission or the following day and not transferred to another acute care facility**
  - Rationale: It is unlikely that these patients had clinically significant HF.
- **Inconsistent or unknown vital status or other unreliable demographic data**
  - Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
- **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
  - Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care. Patients who transition to hospice during their hospital stay (after the first day of the index admission) are not excluded. Such transitions may be the result of quality failures that have led to poor clinical outcomes. Thus, excluding these patients could mask quality problems.
- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **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 mortality measure included in the FY 2025 Hospital VBP Program.

  After the above exclusions are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Additional admissions within that year are excluded.

  For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year dataset, if a randomly selected July index admission falls within 30 days of a randomly selected June index admission (the transition period between two years) and the patient died within 30 days of both admissions, the measure includes only the June admission. The July admission is excluded to avoid assigning a single death to two admissions. For example, if a patient has a randomly selected admission on June 18, 2021 and then again on July 2, 2021, and then subsequently dies on July 15, 2021, the measure will exclude the July 2, 2021 admission, and the death that occurred will be attributed to the June 18, 2021 admission.

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

Outcome

Outcome Criteria for HF Measure

Death, from any cause, within 30 days of the start of the index admission
Rationale: From a patient's perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and 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 mortality.

Appendix D.4 Hospital-Level 30-Day RSMR following Pneumonia (CBE #0468)

Cohort

Inclusion Criteria for Pneumonia Measure

- **Diagnosis coding that met one of the two following requirements:**
  1. **Principal discharge diagnosis of pneumonia; or**
  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.
- **Not transferred from another acute care facility**
  - Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for Pneumonia Measure

- **Discharged alive on the day of admission or the following day and not transferred to another acute care facility**
  - Rationale: It is unlikely that these patients had clinically significant pneumonia.
- **Inconsistent or unknown vital status or other unreliable demographic data**
  - Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database or where the date of death occurs before the date of discharge but the patient was discharged alive.
- **Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission**
  - Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care for these patients. Patients who transition to hospice during their hospital stay (after the first day of the index admission) are not excluded. Such transitions may be the result of quality failures

that have led to poor clinical outcomes. Thus, excluding these patients could mask quality problems.

- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **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 mortality measure included in the FY 2025 Hospital VBP Program.

After the above exclusions are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Additional admissions within that year are excluded.

For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year dataset, if a randomly selected July index admission falls within 30 days of a randomly selected June index admission (the transition period between two years) and the patient died within 30 days of both admissions, the measure includes only the June admission. The July admission is excluded to avoid assigning a single death to two admissions. For example, if a patient has a randomly selected admission on June 18, 2021 and then again on July 2, 2021, and then subsequently dies on July 15, 2021, the measure will exclude the July 2, 2021 admission, and the death that occurred will be attributed to the June 18, 2021 admission.

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

Outcome

Outcome Criteria for Pneumonia Measure

Death, from any cause, within 30 days of the start of the index admission
Rationale: From a patient's perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and 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 mortality.

Appendix D.5 Hospital-Level 30-Day RSMR following Ischemic Stroke

Cohort

Inclusion Criteria for Stroke Measure

- **Principal discharge diagnosis of ischemic stroke**
  - Rationale: Ischemic stroke is the condition targeted for measurement. Hemorrhagic strokes are not included in the cohort. Ischemic strokes are the most common type of stroke, accounting for the vast majority of stroke hospitalizations. Additionally, the causes, prognosis, and treatment of ischemic stroke are quite different than those of hemorrhagic stroke. Combining ischemic and hemorrhagic stroke patients could make it more difficult to account for a hospital's patient case mix.
- **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**
  - Rationale: 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.
- **Not transferred from another acute care facility**
  - Rationale: Hospitalizations in which a patient was transferred in from another acute care facility are not included because it is the hospital where the patient was initially admitted that initiates patient management and is responsible for making critical acute care decisions (including the decision to transfer and where to transfer).

Exclusion Criteria for Stroke Measure

- **Inconsistent or unknown vital status or other unreliable demographic data**
  - Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
- **Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission**
  - Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care for these patients. Patients who transition to hospice during their hospital stay (after the first day of the index admission) are not excluded. Such transitions may be the result of quality failures that have led to poor clinical outcomes. Thus, excluding these patients could mask quality problems.
- **Discharged against medical advice**
  - Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

- **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 stroke cohort in response to the COVID-19 PHE.

    After the above exclusions are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Additional admissions within that year are excluded.

    For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year dataset, if a randomly selected July index admission falls within 30 days of a randomly selected June index admission (the transition period between two years) and the patient died within 30 days of both admissions, the measure includes only the June admission. The July admission is excluded to avoid assigning a single death to two admissions. For example, if a patient has a randomly selected admission on June 18, 2021 and then again on July 2, 2021, and then subsequently dies on July 15, 2021, the measure will exclude the July 2, 2021 admission, and the death that occurred will be attributed to the June 18, 2021 admission.

The ICD-10-CM codes used to define the ischemic stroke cohort are outlined in the 2024 Stroke Mortality Measure Code Specifications supplemental file posted here on *QualityNet*.

Outcome

Outcome Criteria for Stroke Measure

Death, from any cause, within 30 days of the start of the index admission
Rationale: From a patient's perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and 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 mortality.