

**2024 Condition- and Procedure-Specific Readmission Measures
Supplemental Methodology Report**

**Acute Myocardial Infarction
Chronic Obstructive Pulmonary Disease
Heart Failure
Pneumonia
Isolated Coronary Artery Bypass Graft (CABG) Surgery
Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee
Arthroplasty (TKA)**

Submitted By:

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

Prepared For:

Centers for Medicare & Medicaid Services (CMS)

March 2024

Table of Contents

LIST OF TABLES	4
1. EXECUTIVE SUMMARY.....	9
2. BACKGROUND AND OBJECTIVES	10
2.1. Importance of Including MA Beneficiaries in Hospital Outcome Measures.....	10
2.2. Importance of Risk Adjustment Model Changes	10
2.3. Objectives	10
3. METHODS	11
3.1. Data Sources	11
3.2. Cohort and Outcomes.....	12
3.3. Risk Model Reselection	12
3.4. Statistical Analyses.....	13
4. RESULTS.....	14
4.1. Acute Myocardial Infarction (AMI) Readmission Results	14
AMI Admission Volume and Observed Readmission Rate	14
Frequency of AMI Risk Variables	15
AMI Model Performance	20
Risk-Standardized Readmission Rates for AMI	20
Measure Reliability for AMI	21
Change in Hospital Performance for AMI	22
4.2. Chronic Obstructive Pulmonary Disease (COPD) Readmission Results	24
COPD Admission Volume and Observed Readmission Rate	24
Frequency of COPD Risk Variables	24
COPD Model Performance.....	29
Risk-Standardized Readmission Rates for COPD	29
Measure Reliability for COPD.....	30
Change in Hospital Performance for COPD	31
4.3. Heart Failure Readmission Results	33
Heart Failure Admission Volume and Observed Readmission Rate	33
Frequency of Heart Failure Risk Variables	33
Heart Failure Model Performance	40
Risk-Standardized Readmission Rates for Heart Failure.....	40
Measure Reliability for Heart Failure.....	41
Change in Hospital Performance for Heart Failure.....	42
4.4. Pneumonia Readmission Results	44
Pneumonia Admission Volume and Observed Readmission Rate.....	44
Frequency of Pneumonia Risk Variables.....	44
Pneumonia Model Performance.....	51
Risk-Standardized Readmission Rates for Pneumonia	51

Measure Reliability for Pneumonia	52
Change in Hospital Performance for Pneumonia	52
4.5. Isolated Coronary Artery Bypass Graft (CABG) Surgery Readmission Results.....	55
CABG Admission Volume and Observed Readmission Rate	55
Frequency of CABG Risk Variables	55
CABG Model Performance	60
Risk-Standardized Readmission Rates for CABG.....	60
Measure Reliability for CABG.....	61
Change in Hospital Performance for CABG.....	61
4.6. Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) Readmission Results	64
THA/TKA Admission Volume and Observed Readmission Rate.....	64
Frequency of THA/TKA Risk Variables.....	64
THA/TKA Model Performance.....	69
Risk-Standardized Readmission Rates for THA/TKA	69
Measure Reliability for THA/TKA	70
Change in Hospital Performance for THA/TKA	70
5. REFERENCES.....	73

LIST OF TABLES

Table 1: Claim Type Codes	12
Table 4.1.1: Number of Admissions and Observed 30-Day Readmission Rate for AMI, FFS versus MA Admissions, CY 2022.....	14
Table 4.1.2: Frequency of CC-Based Risk Variables in the AMI Cohort, FFS versus MA Admissions, CY 2022	15
Table 4.1.3: Frequency of ICD-10-Based Risk Variables in the AMI Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the AMI Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022.....	17
Table 4.1.4: AMI Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	20
Table 4.1.5: AMI Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals	21
Table 4.1.6: AMI Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	21
Table 4.1.7: AMI Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	22
Table 4.1.8: Shifts in RSRR Hospital Performance Quintile Rankings for AMI, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	23
Table 4.1.9: Shifts in RSRR Hospital Performance Quintile Rankings for AMI, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022.....	23
Table 4.2.1: Number of Admissions and Observed 30-Day Readmission Rate for COPD, FFS versus MA Admissions, CY 2022.....	24
Table 4.2.2: Frequency of CC-Based Risk Variables in the COPD Cohort, FFS versus MA Admissions, CY 2022.....	24
Table 4.2.3: Frequency of ICD-10-Based Risk Variables in the COPD Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the COPD Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022	26
Table 4.2.4: COPD Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	29
Table 4.2.5: COPD Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals	30
Table 4.2.6: COPD Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	30

Table 4.2.7: COPD Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	31
Table 4.2.8: Shifts in RSRR Hospital Performance Quintile Rankings for COPD, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	32
Table 4.2.9: Shifts in RSRR Hospital Performance Quintile Rankings for COPD, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022.....	32
Table 4.3.1: Number of Admissions and Observed 30-Day Readmission Rate for Heart Failure, FFS versus MA Admissions, CY 2022	33
Table 4.3.2: Frequency of CC-Based Risk Variables in the Heart Failure Cohort, FFS versus MA Admissions, CY 2022.....	33
Table 4.3.3: Frequency of ICD-10-Based Risk Variables in the Heart Failure Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the Heart Failure Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022.....	35
Table 4.3.4: Heart Failure Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	40
Table 4.3.5: Heart Failure Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals.....	41
Table 4.3.6: Heart Failure Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	41
Table 4.3.7: Heart Failure Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions.....	42
Table 4.3.8: Shifts in RSRR Hospital Performance Quintile Rankings for Heart Failure, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	43
Table 4.3.9: Shifts in RSRR Hospital Performance Quintile Rankings for Heart Failure, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022	43
Table 4.4.1: Number of Admissions and Observed 30-Day Readmission Rate for Pneumonia, FFS versus MA Admissions, CY 2022	44
Table 4.4.2: Frequency of CC-Based Risk Variables in the Pneumonia Cohort, FFS versus MA Admissions, CY 2022.....	44
Table 4.4.3: Frequency of ICD-10-Based Risk Variables in the Pneumonia Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the Pneumonia Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022.....	46
Table 4.4.4: Pneumonia Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	51

Table 4.4.5: Pneumonia Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals	51
Table 4.4.6: Pneumonia Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	52
Table 4.4.7: Pneumonia Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions.....	52
Table 4.4.8: Shifts in RSRR Hospital Performance Quintile Rankings for Pneumonia, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	53
Table 4.4.9: Shifts in RSRR Hospital Performance Quintile Rankings for Pneumonia, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022.....	54
Table 4.5.1: Number of Admissions and Observed 30-Day Readmission Rate for CABG, FFS versus MA Admissions, CY 2022.....	55
Table 4.5.2: Frequency of CC-Based Risk Variables in the CABG Cohort, FFS versus MA Admissions, CY 2022.....	55
Table 4.5.3: Frequency of ICD-10-Based Risk Variables in the CABG Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the CABG Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022	57
Table 4.5.4: CABG Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	60
Table 4.5.5: CABG Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals	60
Table 4.5.6: CABG Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	61
Table 4.5.7: CABG Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions.....	61
Table 4.5.8: Shifts in RSRR Hospital Performance Quintile Rankings for CABG, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	62
Table 4.5.9: Shifts in RSRR Hospital Performance Quintile Rankings for CABG, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022.....	63
Table 4.6.1: Number of Admissions and Observed Readmission Rate for THA/TKA, FFS versus MA Admissions, CY 2022.....	64

Table 4.6.2: Frequency of CC-Based Risk Variables in the THA/TKA Cohort, FFS versus MA Admissions, CY 2022.....	64
Table 4.6.3: Frequency of ICD-10-Based Risk Variables in the THA/TKA Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the THA/TKA Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022.....	66
Table 4.6.4: THA/TKA Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022	69
Table 4.6.5: THA/TKA Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals	69
Table 4.6.6: THA/TKA Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions	70
Table 4.6.7: THA/TKA Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions.....	70
Table 4.6.8: Shifts in RSRR Hospital Performance Quintile Rankings for THA/TKA, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022	71
Table 4.6.9: Shifts in RSRR Hospital Performance Quintile Rankings for THA/TKA, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022.....	72

Center for Outcomes Research and Evaluation Project Team

Medicare Advantage Team:

Kelly Kyanko, MD, MHS – Project Lead
Wanda Johnson, BS, RN – Team Coordinator
Shu-Xia Li, PhD – Analytic Leadership, Associate Director of Data Management and Analytics
Jacqueline Grady, MS – Division Director
Hiral Dudhwala, RN, MSN/MPH – Division Lead
Jennifer Falcone, BA – Project Manager
Elizabeth Triche, PhD - Associate Director, Quality Measurement Programs
Yongfei Wang*, MS – Lead Analyst
Jing Zhang*, MBA, MPhil, MS – Data Manager
Isabella Epshtein, MA – Research Associate
Lisa G. Suter*, MD – Contract Director

Risk Model Respecification Team:

Chenxi Huang*, PhD – Project Lead
Jennifer Falcone, BA – Project Manager
Philippa Chadwick, MPH – Team Coordinator
Zhenqiu Lin, PhD – Analytic Leadership, Senior Director of Data Management and Analytics
Shu-Xia Li, PhD – Analytic Leadership, Associate Director of Data Management and Analytics
Jacqueline Grady, MS – Division Director
Elizabeth Triche, PhD – Associate Director, Quality Measurement Programs
Yongfei Wang*, MS – Lead Analyst
Ji Chen*, PhD – Data Analyst
Peizheng Chen*, MS – Data Analyst
Samantha Mancuso, MPH – Research Associate
Lisa G. Suter*, MD – Contract Director

* Yale School of Medicine

Acknowledgements

This work is a collaborative effort, and the authors gratefully acknowledge Jinghong Gao from YNHSC/CORE and Raquel Myers, Vinitha Meyyur, Melissa Hager, Ngozi Uzokwe, Julia Venanzi, Grace Snyder, Traci Archibald, Lang Le and John Green at CMS for their contributions to this work.

NOTE: This supplemental methodology report is not meant to replace the original measure methodology reports, but to provide additional information and results based on the addition of Medicare Advantage (MA) admissions to the cohorts and the modification of the risk adjustment models. The original methodology reports for the measures are available on QualityNet [here](#).

1. EXECUTIVE SUMMARY

In this supplemental methodology report, we present the rationale and testing results of two updates to the condition- and procedure-specific readmission measures: 1) integrating Medicare Advantage (MA) beneficiaries into the cohorts and, 2) the reselection of risk adjustment variables. Measure results in this report include: hospital-level 30-day risk-standardized readmission rates (RSRRs) following acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), pneumonia, coronary artery bypass graft (CABG) surgery and elective total hip arthroplasty and/or total knee arthroplasty (THA/TKA) admissions.

Changes to the current readmission measures include the addition of MA admissions into the cohorts and the reevaluation of the risk adjustment models; all other specifications remain the same. For testing purposes, the cohorts include hospital admissions with discharge dates from January 1 to December 30, 2022. Inpatient, outpatient, and professional claims for Medicare Fee-For-Service (FFS) and MA beneficiaries were extracted from the Centers for Medicare & Medicaid Services (CMS) Integrated Data Repository (IDR). The MA claims data comprise Medicare Advantage Organization (MAO)-submitted encounter data (Encounter Data Records and Chart Review Records for all settings) and hospital-submitted inpatient MA claims.¹

The addition of MA admissions into the condition- and procedure-specific readmission measures roughly doubled the number of admissions in the cohorts and led to improved measure reliability (with the exception of THA/TKA) and more hospitals and beneficiaries included for measure calculation. Across measures, unadjusted 30-day readmission rates were generally similar for MA versus FFS admissions for condition-specific measures (AMI, COPD, HF, pneumonia) and higher for MA for the CABG and THA/TKA measures. The prevalence of comorbidities was generally higher in the MA cohort as compared to FFS.

A new approach to variable reselection was implemented to leverage the specificity of individual International Classification of Diseases (ICD)-10 codes in place of Condition Categories (CCs) to improve performance of the risk adjustment models. Previous work found that model performance for the condition- and procedure-specific mortality and complication measures improved with the new approach.² With this new variable selection strategy, the discriminative performance of the models for the readmission measures as measured by c-statistics remained similar. However, to align methods across all measures, we adopted the new ICD-10-based risk variable selection approach for the readmission measures included in this report. Overall model performance proved to be satisfactory using the new approach. After the two measure updates, we observed meaningful shifts in hospital performance.

2. BACKGROUND AND OBJECTIVES

2.1. Importance of Including MA Beneficiaries in Hospital Outcome Measures

Including MA beneficiaries in CMS hospital outcome measures helps ensure that hospital quality is measured across all Medicare beneficiaries and not just the FFS population. MA beneficiary enrollment has been rapidly expanding as a share of Medicare beneficiaries. In 2023, nearly 51% of the eligible Medicare beneficiaries — or 30.8 million people — were covered by MA plans.³ The Congressional Budget Office projects that by 2030, 62% of beneficiaries will be covered by MA plans.⁴ Consequently, using FFS-only beneficiaries may exclude a large segment of the focus population for CMS quality measures, which are intended to measure the quality of care of all Medicare beneficiaries.

Inclusion of MA beneficiaries has several important benefits for the reliability and validity of the hospital outcome measures. The addition of MA beneficiaries to FFS significantly increases the size of the measure's cohort, which enhances the reliability of the measure scores, leads to more hospitals receiving results, and increases the chance of identifying meaningful differences in quality for some low-volume hospitals. Moreover, this update addresses stakeholder concerns about differences in quality for MA and FFS beneficiaries.^{5,6} The addition of MA inpatient admissions also allows for inclusion in the measure of beneficiaries who switch between FFS and MA. CMS's current claims-based measures require enrollment in FFS Part A and Part B for the 12 months prior to the date of admission and Part A during the index admission.

2.2. Importance of Risk Adjustment Model Changes

The goal of risk-adjustment models is to adjust for case-mix differences across the hospitals. Risk adjustment supports fair and accurate comparison of outcomes across measured entities by including an adjustment for factors such as age, comorbid diseases, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome.

The original process for clinical risk adjustment for the current measures involved reviewing CCs for clinical relevance and evaluating the CCs for statistical association with the outcome. The CCs are part of CMS's Hierarchical Condition Categories (HCC), and the HCC system groups the ICD-10 diagnosis codes into larger clinically relevant diagnostic categories.^{7,8} Mappings which show the assignment of ICD-10 codes to the CCs are available on [QualityNet](#). In pursuing an approach that best leverages the data and analytical advancements since initial measure development, we developed and evaluated a framework to use individual ICD-10 codes for risk adjustment. The main advantage of leveraging ICD-10 codes in place of CCs is the ability to address the clinical heterogeneity found in the broadly defined CCs. Our previous research indicates that the model performance of the mortality measures is significantly improved by using individual codes instead of CCs.² Therefore, this new approach has also been applied to each of the readmission measures in this report.

2.3. Objectives

We had two main objectives: 1) To assess the impact of incorporating MA inpatient admissions into the claims-based condition- and procedure-specific readmission measures, and 2) To improve the

performance of risk adjustment models for these measures by leveraging the individual ICD-10 codes rather than CCs.

3. METHODS

3.1. Data Sources

For testing of these measure updates, we extracted all claims and beneficiary data for FFS and MA beneficiaries as well as Medicare provider data from the CMS IDR. The condition- and procedure-specific readmission measures use inpatient claims and enrollment data for cohort construction and outcome derivation and use inpatient and outpatient facility, professional, and durable medical equipment (DME) claims data for risk adjustment. We downloaded claims data for index admissions with the claim discharge date from January 1 to December 30, 2022 (calendar year [CY] 2022) as well as historical claims up to 12 months prior to the index admission and inpatient claims data up to 30-days post-index admission based on the claim types in [Table 1](#). We also downloaded beneficiary enrollment information needed for cohort inclusion and exclusion criteria. We downloaded provider history data that details the association between the CMS Certification Number (CCN) and National Provider Identifier (NPI).

Most MA beneficiary inpatient admissions had two claim submission sources: MAO-submitted encounter claims and hospital-submitted claims. MAO-submitted encounter claims are information-only (i.e., not billing) claims for items and services provided under the plan that are required to be submitted by MAOs to CMS.¹ Hospitals that receive disproportionate-share hospital or medical education payments from Medicare are also required to submit information-only claims for inpatient stays for MA beneficiaries.

To create the combined FFS+MA cohort, we included both MAO-submitted and hospital-submitted MA admission claims. While most hospitals submit MA inpatient claims, not all hospitals are required to submit claims for MA beneficiaries (i.e., those that do not receive disproportionate-share hospital or medical education payments from Medicare), so MAO-submitted claims capture additional admissions not found in the hospital-submitted claims. However, there are benefits in including the hospital-submitted claims. Hospital-submitted claims are timelier than MAO-submitted claims, which is advantageous for reporting deadlines for CMS hospital outcome measures. In addition, a small proportion of admissions were only found in the hospital-submitted claims. Further, unlike MAO-submitted claims which are associated with NPI, hospital-submitted claims are already associated with a CCN used to identify hospitals in the CMS outcome measures. Therefore, if an admission was found in both datasets, we used the claim found in the hospital-submitted data. For a small portion of admissions with only MAO-submitted claims, we obtained the CCN using the IDR provider history data through NPI, claim discharge date, provider history begin (effective) date, and provider history end (obsolete) date.

Admissions with only MAO-submitted claims not associated with a CCN were excluded from analyses (<5% of all admissions).

Hospital measures used for public reporting are limited to short-term acute care hospitals and critical access hospitals. In a last step, we used the CCN taxonomy to restrict the claims to those filed by acute care hospitals (3rd and 4th digit as '01') and critical access hospitals (3rd and 4th digit as '13').

Table 1: Claim Type Codes

Type of Claim	FFS	Hospital-submitted MA	MAO-submitted (encounter) MA
Inpatient	60	62, 63, 64	4011, 4041
Outpatient Facility	40	-	4012 – 4014, 4022, 4023, 4034, 4043, 4071 – 4077, 4079, 4083, 4085, 4089
Professional	71, 72	-	4700
DME	81, 82	-	4800

3.2. Cohort and Outcomes

The cohorts included hospital admissions with discharge dates from January 1 to December 30, 2022 (CY 2022). The risk adjustment data were derived from both FFS and MA inpatient and outpatient claims one year prior to and during the index claims. We followed the methodology for the current FFS-only readmission measures for cohort inclusion/exclusion criteria, risk factor derivations from inpatient, outpatient, DME, and professional claims diagnoses/procedures during the 12 months prior to admission or present on admission (POA) at the index hospitalization, outcome definitions, and measure score calculation. After adding the MA beneficiaries, the enrollment requirement was updated to include patients with 12 months FFS or MA enrollment prior to the index admission and at least one-month post-index admission. Information on the FFS-only measures, including measure specifications and calculation methodology, is available on [QualityNet](https://qualitynet.cms.gov) at:

- 2023 Condition-Specific Readmission Measure Updates and Specifications Report: <https://qualitynet.cms.gov/inpatient/measures > Readmission Measures > Methodology>
- 2023 Procedure-Specific Readmission Measure Updates and Specifications Report: <https://qualitynet.cms.gov/inpatient/measures > Readmission Measures > Methodology>

3.3. Risk Model Reselection

For candidate risk variables, we included all secondary ICD-10 codes documented as POA during the index admission (with the exception of the palliative care code Z51.5 which, effective October 1, 2021, was considered POA-exempt) and both principal and secondary ICD-10 codes in the 12 months prior to admission from any inpatient, outpatient, and professional provider claims. For procedure-specific measures, we additionally considered the principal discharge diagnosis code for the index admission. We also considered age, frailty, sex, an indicator for whether the admission was MA vs. FFS, and other non-individual-ICD variables in the existing publicly reported CMS readmission measures. The variable selection of individual ICD codes mainly relied on data-driven methodologies involving three key steps:

1) pre-processing, 2) evaluating association with outcome, and 3) consideration of associations between other non-individual-code variables, including frailty, with the outcome.

In pre-processing, we screened and included index and history (pre-index) codes if their prevalence exceeded 0.5% and 2.5%, respectively. Further, pairs of index and pre-index codes that had a correlation larger than 0.8 were combined into one risk variable. Specific ICD-10 codes for social risk factors were removed from the candidate list to be consistent with how the measures currently address social risk. Finally, pairs of index and pre-index ICD-10 codes where the difference in association with the outcome, measured by Odds Ratio (OR), was less than 0.2 were merged.

In the second step, we included the remaining candidate variables with age in a multivariable logistic regression model and underwent variable selection through 1,000 iterations of bootstrapping. We selected variables which were statistically significantly associated with outcome ($p < 0.05$) greater than a certain cutoff value of frequency over the bootstrapped samples. The cutoff value was chosen for each measure based on empirical evaluation of the model performance. We forced age into the model if it was not selected into the model through the bootstrapping process.

Lastly, based on literature evidence, specific suggestions and guidance from the consensus-based entity for measure endorsement, the Assistant Secretary for Planning and Evaluation, other stakeholders as well as prior testing results, we included a claims-based indicator of frailty that was developed for CMS's Multiple Chronic Conditions (MCC) measure⁹ in the final model for all measures. We generally did not include sex as a variable since sex can be considered a socio-demographic variable. However, there remains some evidence that females are at higher risk of readmission after CABG due to them having smaller coronary vessels and requiring more challenging CABG procedures.¹⁰ Therefore, sex was included for the CABG readmission measure only. There were other non-individual-ICD variables currently included in the publicly reported CMS readmission measures that may contain additional predictive information. For example, for the CABG readmission measure, the current risk model includes a variable that accounts for the history of prior CABG and/or valve surgery, which is defined by a combination of diagnosis and procedure codes. Such variables were included in the final models if their regression coefficients were statistically significant when added to the models. We also added into the model for all measures the history of coronavirus disease 2019 (COVID-19) variable to be consistent with current CMS policy.

For the combined MA and FFS cohort, the risk adjustment model was updated to include an MA indicator (versus FFS) as a main effect. This was to adjust for the generally higher prevalence of comorbidities in the MA cohort, especially among the pre-index variables that were derived from services in the outpatient setting (e.g. physician visits).

3.4. Statistical Analyses

We first compared between MA and FFS admissions the number of admissions and observed (unadjusted) readmission rates for each condition (AMI, COPD, HF, and pneumonia) and procedure (CABG, THA/TKA). We then examined risk variable prevalence in MA and FFS admissions for both the CC-based (original) and ICD-10-based (reselected) risk variables. For MA+FFS admissions with reselected

ICD-10-based variables, we calculated the adjusted OR and 95% confidence intervals (CIs) for the hierarchical logistic regression model.

To evaluate the impact of adding MA admissions and risk variable reselection on model performance metrics, we compared c-statistics and predictive ability for three different combinations of cohorts and risk models: 1) FFS-only admissions with the original CC-based risk model, 2) FFS+MA admissions with the original CC-based risk model, and 3) FFS+MA admissions with reselected ICD-10-based variables. Calibration performance was also assessed by calibration slope and intercept and visually by calibration plots, both in the overall cohort and in subgroups stratified by sex, MA indicator, and hospital volume.

We used hierarchical logistic models with a random effect for hospitals to calculate hospital risk-standardized readmission ratios and rates (SRRs and RSRRs) for each condition and procedure and compared these and the number of hospitals using the three different combinations of cohort and risk model variables listed above. We show the distribution of measure scores among all hospitals and among reporting hospitals with at least 25 admissions. We also calculated and compared signal-to-noise reliability (STNR) for hospitals with at least 25 admissions based on between-hospital variance and hospital volume. The volume threshold of 25 admissions used here was to align with the public reporting volume cutoff.

To assess the overall impact of adding MA data to hospital measure scores, using original CC-based risk variables we examined shifts in hospital RSRR quintiles in the FFS-only cohort versus the combined FFS+MA cohort among hospitals with at least 25 FFS admissions. To examine the associations between hospital characteristics and the addition of MA admissions, we examined quintile shifts in hospital RSRR by quintiles of the proportion of hospital MA admissions and by quintiles of overall hospital volume. We then repeated these analyses to assess the impact of adding both MA and updated risk model variables, examining hospital performance shifts in the FFS-only cohort with the original CC-based variables and the FFS+MA cohort with the reselected ICD-10-based variables.

4. RESULTS

4.1. Acute Myocardial Infarction (AMI) Readmission Results

AMI Admission Volume and Observed Readmission Rate

As presented in [Table 4.1.1](#), the FFS+MA cohort included 226,980 unique admissions from January 1 – December 30, 2022 (111,616 FFS and 115,364 MA). The observed (unadjusted) 30-day readmission rate for the FFS+MA cohort for AMI was 13.1%. The observed readmission rate was 13.2% among FFS beneficiaries compared to 13.0% among MA beneficiaries (difference 0.2%).

Table 4.1.1: Number of Admissions and Observed 30-Day Readmission Rate for AMI, FFS versus MA Admissions, CY 2022

AMI	MA + FFS	FFS	MA	Difference FFS – MA
N	226,980	111,616	115,364	NA
Readmission Rate (%)	13.1	13.2	13.0	0.2

Frequency of AMI Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.1.2](#), and the reselected ICD-10-based variables in [Table 4.1.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -1.7% for CC-based variables with a range from -10.9% to 1.6%. The risk variable prevalence differences between FFS and MA for ICD-10-based variables ranged from -5.4% to 1.8% with no difference at the median, however for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.1.3](#) also presents adjusted OR and 95% CIs for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.1.2: Frequency of CC-Based Risk Variables in the AMI Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N=226,980)	FFS (N=111,616)	MA (N=115,364)	FFS - MA
Age, mean (SD)	76.9 (7.7)	77.4 (7.9)	76.4 (7.5)	1.0
Male	55.5	56.3	54.8	1.6
History of coronary artery bypass graft (CABG) surgery	15.5	15.1	15.8	-0.7
History of percutaneous transluminal coronary angioplasty (PTCA)	27.4	26.7	27.9	-1.2
Angina pectoris/old myocardial infarction (CC 88)	26.1	23.2	29.0	-5.7
Congestive heart failure (CC 85)	54.2	52.0	56.3	-4.3
Coronary atherosclerosis/other chronic ischemic heart disease (CC 89)	83.2	82.0	84.4	-2.4
Acute coronary syndrome (CC 86,87)	86.4	84.8	88.1	-3.3
Arrhythmias (CC 96, 97)	56.1	56.5	55.7	0.8
Valvular or rheumatic heart disease (CC 91)	36.8	36.0	37.6	-1.5
Cerebrovascular disease (CC 101,102, 105)	22.5	21.5	23.5	-2.0
Stroke (CC 99 – 100)	7.4	6.8	8.1	-1.3
Vascular or circulatory disease (CC 106 – 109)	48.3	42.7	53.6	-10.9
Hemiplegia, paralysis, functional disability (CC 70 – 74, 103,104, 189,190)	7.2	6.2	8.1	-1.9
Diabetes and DM complications (CC 17 – 19, 122, 123)	51	47.3	54.6	-7.3
Renal failure (CC 135 – 140)	47.8	45.2	50.3	-5.1
End-stage renal disease or dialysis (CC 134)	3.9	3.9	3.9	-0.1
Other urinary tract disorders (CC 145)	17.4	15.9	18.8	-2.9
Chronic obstructive pulmonary disease (CC 111)	26.2	23.3	29	-5.7
Pneumonia (CC 114 – 116)	19.4	18.1	20.7	-2.6
Asthma (CC 113)	9.4	8.2	10.5	-2.3

Variable (% unless otherwise indicated)	MA + FFS (N=226,980)	FFS (N=111,616)	MA (N=115,364)	FFS - MA
Disorders of fluid/electrolyte/acid-base (CC23, 24)	41.1	39.7	42.4	-2.7
History of infection (CC1, 3 – 7)	24.2	23.9	24.6	-0.7
Metastatic cancer and acute leukemia (CC 8)	2.4	2.5	2.3	0.2
Cancer (CC9 – 14)	19.7	20.4	19.2	1.2
Iron deficiency and other/unspecified anemias and blood disease (CC 49)	42.4	41.3	43.5	-2.2
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	6.9	6.9	6.9	0.0
Dementia or other specified brain disorders (CC 51 – 53)	16.6	15.6	17.6	-2.1
Protein-calorie malnutrition (CC 21)	6.6	6.4	6.9	-0.5
Anterior myocardial infarction	7.5	7.7	7.4	0.3
Other location of myocardial infarction	14.3	14.4	14.2	0.1
History of COVID-19	15.2	15.1	15.3	-0.2

Table 4.1.3: Frequency of ICD-10-Based Risk Variables in the AMI Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the AMI Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N= 226,980)	FFS (%) (N= 111,616)	MA (%) (N= 115,364)	FFS – MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	76.9 (7.7)	77.4 (7.9)	76.4 (7.5)	1.0	1.01 (1.01,1.01)
ICD-10 codes during the index admission						
D631	Anemia in chronic kidney disease	6.3	6.4	6.1	0.3	1.27 (1.21,1.33)
D638	Anemia in other chronic diseases classified elsewhere	1.8	1.8	1.8	0.0	1.30 (1.20,1.41)
D649	Anemia, unspecified	7.8	7.6	8.0	-0.5	1.22 (1.17, 1.28)
D72829	Elevated white blood cell count, unspecified	4.3	4.2	4.3	-0.1	1.11 (1.05,1.18)
E43	Unspecified severe protein-calorie malnutrition	1.5	1.5	1.4	0.1	1.10 (1.01,1.21)
E782	Mixed hyperlipidemia	8.7	8.8	8.7	0.0	0.91 (0.87,0.95)
E785	Hyperlipidemia, unspecified	60.8	60.5	61.1	-0.6	0.92 (0.89,0.94)
E871	Hypo-osmolality and hyponatremia	6.8	7.0	6.6	0.4	1.27 (1.22,1.33)
G250	Essential tremor	0.5	0.5	0.5	0.0	0.75 (0.62,0.91)
G40909	Epilepsy, unspecified, not intractable, without status epilepticus	1.3	1.4	1.3	0.0	1.29 (1.17,1.42)
I10	Essential (primary) hypertension	36.1	36.5	35.8	0.7	0.79 (0.77,0.82)
I120	Hypertensive chronic kidney disease with stage 5 chronic kidney disease or end stage renal disease	1.1	1.1	1.0	0.0	1.33 (1.20,1.47)
I313	Pericardial effusion (noninflammatory)	0.7	0.7	0.7	0.0	1.43 (1.26,1.61)
I429	Cardiomyopathy, unspecified	3.7	3.6	3.7	0.0	1.09 (1.03,1.16)
I4891	Unspecified atrial fibrillation	6.4	6.6	6.1	0.5	1.13 (1.07,1.18)
I5021	Acute systolic (congestive) heart failure	5.4	5.5	5.3	0.3	1.25 (1.18,1.31)
I5023	Acute on chronic systolic (congestive) heart failure	6.3	6.1	6.4	-0.3	1.28 (1.22,1.34)
I5033	Acute on chronic diastolic (congestive) heart failure	4.0	4.1	4.0	0.1	1.24 (1.17,1.31)
I5043	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure	3.6	3.6	3.6	-0.1	1.26 (1.19,1.34)
I513	Intracardiac thrombosis, not elsewhere classified	0.5	0.5	0.5	0.0	1.35 (1.16,1.58)
I5181	Takotsubo syndrome	1.5	1.6	1.4	0.2	0.78 (0.69, 0.87)
I739	Peripheral vascular disease, unspecified	4.6	4.7	4.5	0.2	1.15 (1.08,1.21)

Variable	Description	MA + FFS (%) (N= 226,980)	FFS (%) (N= 111,616)	MA (%) (N= 115,364)	FFS – MA (%)	FFS + MA OR (95% CI)
N170	Acute kidney failure with tubular necrosis	1.4	1.4	1.5	-0.1	1.32 (1.21,1.44)
N179	Acute kidney failure, unspecified	17.0	16.5	17.4	-1.0	1.15 (1.11,1.19)
R338	Other retention of urine	0.8	0.8	0.8	0.0	1.28 (1.13,1.45)
R54	Age-related physical debility	0.7	0.8	0.6	0.1	1.26 (1.10,1.44)
R7303	Prediabetes	2.9	2.7	3.0	-0.3	0.77 (0.70,0.84)
Z515	Encounter for palliative care	3.0	3.2	2.7	0.5	0.50 (0.46,0.54)
Z66	Do not resuscitate	9.0	9.9	8.1	1.8	0.91 (0.87,0.95)
ICD-10 codes in the 12 months prior to admission						
D509	Iron deficiency anemia, unspecified	9.0	9.0	9.0	0.0	1.24 (1.19,1.30)
D649	Anemia, unspecified	18.1	16.6	19.5	-2.9	1.22 (1.18,1.26)
F17210	Nicotine dependence, cigarettes, uncomplicated	9.0	7.3	10.6	-3.2	1.26 (1.21,1.32)
I10	Essential (primary) hypertension	77.4	71.5	83.1	-11.6	1.17 (1.13,1.21)
I160	Hypertensive urgency	4.5	3.5	5.4	-1.9	1.29 (1.23,1.36)
I2111	ST elevation (STEMI) myocardial infarction involving right coronary artery	4.7	4.6	4.8	-0.2	0.86 (0.79,0.92)
I213	ST elevation (STEMI) myocardial infarction of unspecified site	17.8	17.3	18.3	-1.0	1.05 (1.00,1.10)
J90	Pleural effusion, not elsewhere classified	11.8	10.4	13.1	-2.7	1.25 (1.21, 1.30)
Z888	Allergy status to other drugs, medicaments and biological substances	7.2	7.7	6.6	1.1	1.21 (1.16,1.27)
ICD-10 codes either during the index admission or 12 months prior to admission						
E1122	Type 2 diabetes mellitus with diabetic chronic kidney disease	23.6	20.8	26.2	-5.4	1.22 (1.18,1.26)
I130	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease	20.1	18.7	21.4	-2.7	1.11 (1.07,1.15)
I350	Nonrheumatic aortic (valve) stenosis	9.3	9.4	9.2	0.2	1.10 (1.06,1.15)
I480	Paroxysmal atrial fibrillation	18.2	18.7	17.6	1.1	1.21 (1.17,1.25)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	7.2	6.2	8.2	-2.1	1.33 (1.28, 1.39)

Variable	Description	MA + FFS (%) (N= 226,980)	FFS (%) (N= 111,616)	MA (%) (N= 115,364)	FFS – MA (%)	FFS + MA OR (95% CI)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	22.5	21.7	23.3	-1.6	1.27 (1.23,1.31)
AMI_ANT	Anterior myocardial infarction	7.5	7.7	7.4	0.3	1.21 (1.14,1.28)
AMI_OTH	Other location of myocardial infarction	14.3	14.4	14.2	0.1	1.05 (1.00,1.11)
HXPTCA	History of PTCA	27.4	26.7	27.9	-1.2	1.05 (1.02,1.08)
HXCABG	History of CABG	15.5	15.1	15.8	-0.7	1.04 (1.01,1.08)
HX_COVID	History of COVID-19	15.2	15.1	15.3	-0.2	1.02 (0.99,1.06)
MA	MA (versus FFS)	50.8	NA	NA	NA	0.92 (0.89,0.94)

AMI Model Performance

Table 4.1.4 presents model performance for the AMI measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables also had a similar c-statistic and predictive ability compared to the original CC-based model. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.1.4: AMI Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	4.8 – 27.0	4.4 – 26.7	5.3 – 27.6
c-statistic	0.66	0.66	0.67

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for AMI

Tables 4.1.5 and 4.1.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.1.5) and for hospitals with 25 or more eligible admissions (Table 4.1.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 204 additional hospitals were included in the measure (3,333 versus 3,129) and 384 additional hospitals met the 25 or more admissions cutoff for public reporting (1,728 versus 1,344). For all hospitals, the mean RSRR was 13.2% for the FFS-only cohort with CC-based risk variables, 13.1% for the FFS+MA cohort with CC-based risk variables, and 13.1% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 13.2%, 13.1%, and 13.1%, respectively.

Table 4.1.5: AMI Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 3,129 hospitals)		FFS+MA cohort with CC-based risk variables (N= 3,333 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 3,333 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	35.7 (47.7)	16 (2, 52)	68.1 (91.6)	29 (3, 102)	68.1 (91.6)	29 (3, 102)
SRR	1.00 (0.03)	1.00 (0.99, 1.01)	1.00 (0.04)	1.00 (0.99, 1.02)	1.00 (0.05)	1.00 (0.98,1.02)
RSRR (%)	13.2 (0.5)	13.1 (13.0, 13.4)	13.1 (0.6)	13.0 (12.9, 13.3)	13.1 (0.6)	13.0 (12.9, 13.3)

Table 4.1.6: AMI Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 1,344 hospitals)		FFS+MA cohort with CC-based risk variables (N= 1,728 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 1,728 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	75.0 (50.3)	59 (40, 95)	126.2 (95.6)	98 (59, 164)	126.2 (95.6)	98 (59, 164)
SRR	1.00 (0.05)	1.00 (0.97, 1.03)	1.00 (0.06)	1.00 (0.97, 1.03)	1.00 (0.06)	1.00 (0.96, 1.04)
RSRR (%)	13.2 (0.6)	13.1 (12.8, 13.6)	13.1 (0.8)	13.1 (12.6, 13.5)	13.1 (0.8)	13.1 (12.6, 13.6)

Measure Reliability for AMI

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.1.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.290 for the FFS-only cohort with CC-based risk variables, 0.403 for the FFS+MA cohort with CC-based risk variables, and 0.416 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.1.7: AMI Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	1,344	1,728	1,728
Between Hospital Variance	0.023	0.023	0.024
STNR: Median (Q1, Q3)	0.290 (0.217, 0.397)	0.403 (0.289, 0.531)	0.416 (0.300, 0.544)

Change in Hospital Performance for AMI

Tables 4.1.8 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the AMI measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, about half (47.5%) of hospitals remained in the same performance quintile, and 84.4% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.78. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (56.7% among hospitals in the lowest quintile of percent MA admissions; 41.9% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, there was not a notable trend in RSRR shifts.

Table 4.1.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the AMI measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 46.4% of hospitals remained in the same performance quintile and 84.2% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.78. Stratified by proportion of MA admissions in a hospital, 57.5% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 38.9% in the highest quintile.

Table 4.1.8: Shifts in RSRR Hospital Performance Quintile Rankings for AMI, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	47.5	84.4	0.78
By Percent of MA Admissions			
Q1: 0.0% – 34.4%	56.7	92.5	0.90
Q2: 34.4% – 44.0%	53.5	92.6	0.84
Q3: 44.0% – 51.7%	45.7	84.0	0.82
Q4: 51.8% – 59.9%	39.6	76.5	0.66
Q5: 60.0% – 95.2%	41.9	76.7	0.69
By MA+FFS Admission Volume			
Q1: 28 – 72 admissions	48.9	93.8	0.79
Q2: 73 – 102 admissions	48.5	88.5	0.79
Q3: 103 – 141 admissions	44.4	81.6	0.75
Q4: 142 – 207 admissions	44.4	80.2	0.74
Q5: 208 – 818 admissions	51.1	78.0	0.80

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions.

Total N=1,344, representing hospitals with 25 or more FFS admissions

Table 4.1.9: Shifts in RSRR Hospital Performance Quintile Rankings for AMI, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	46.4	84.2	0.78
By Percent of MA Admissions			
Q1: 0.0% – 34.4%	57.5	92.9	0.89
Q2: 34.4% – 44.0%	51.7	90.7	0.84
Q3: 44.0% – 51.7%	46.1	84.8	0.82
Q4: 51.8% – 59.9%	38.1	75.7	0.65
Q5: 60.0% – 95.2%	38.9	77.0	0.69
By MA+FFS Admission Volume			
Q1: 28 – 72 admissions	47.4	92.6	0.78
Q2: 73 – 102 admissions	47.8	88.9	0.79
Q3: 103 – 141 admissions	43.2	80.8	0.74
Q4: 142 – 207 admissions	43.7	78.7	0.74
Q5: 208 – 818 admissions	50.0	79.9	0.81

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables.

Total N=1,344, representing hospitals with 25 or more FFS admissions

4.2. Chronic Obstructive Pulmonary Disease (COPD) Readmission Results

COPD Admission Volume and Observed Readmission Rate

As presented in [Table 4.2.1](#), the FFS+MA cohort included 214,005 unique admissions from January 1 – December 30, 2022 (103,485 FFS and 110,520 MA). The observed (unadjusted) 30-day readmission rate for the FFS+MA cohort for COPD was 18.1%. The observed readmission rate was 18.1% among FFS beneficiaries compared to 18.0% among MA beneficiaries (difference 0.1%).

Table 4.2.1: Number of Admissions and Observed 30-Day Readmission Rate for COPD, FFS versus MA Admissions, CY 2022

COPD	MA + FFS	FFS	MA	Difference FFS - MA
N	214,005	103,485	110,520	NA
Readmission Rate (%)	18.1	18.1	18.0	0.1

Frequency of COPD Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.2.2](#), and the reselected ICD-10-based variables in [Table 4.2.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -1.5% for CC-based variables with a range from -10.3% to 1.6%. There was less of a difference overall in risk variable prevalence between FFS and MA for ICD-10-based variables with a median difference of -1.4% (range from -12.8% to 3.6%), however, for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.2.3](#) also presents adjusted OR and 95% confidence intervals for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.2.2: Frequency of CC-Based Risk Variables in the COPD Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N= 214,005)	FFS (N= 103,485)	MA (N= 110,520)	FFS - MA
Age, mean (SD)	75.5 (7.2)	76.3 (7.3)	74.7 (6.9)	1.6
Sleep apnea	27.2	26.5	27.8	-1.3
History of mechanical ventilation	15.5	14.9	16.1	-1.2
Respirator dependence/respiratory arrest (CC 82 – 83)	2.6	1.9	3.2	-1.3
Cardio-respiratory failure and shock (CC 84)	85.2	83.4	86.9	-3.5
Congestive heart failure (CC 85)	58.3	56.5	59.9	-3.4
Acute coronary syndrome (CC 86 – 87)	18.8	17.7	19.9	-2.2
Chronic atherosclerosis (CC 88-89)	51.4	49.8	53.0	-3.2
Arrhythmias (CC 96 – 97)	49.8	50.4	49.3	1.1
Other and unspecified heart disease (CC 98)	26.6	22.7	30.3	-7.6
Vascular or circulatory disease (CC 106 – 109)	55.3	50.0	60.3	-10.3
Fibrosis of lung and other chronic lung disorder (CC 112)	16.6	15.0	18.1	-3.0
Pneumonia (CC 114 – 116)	51.1	49.7	52.4	-2.7

Variable (% unless otherwise indicated)	MA + FFS (N= 214,005)	FFS (N= 103,485)	MA (N= 110,520)	FFS - MA
History of infection (CC 1, 3 – 7)	36.8	36.7	36.9	-0.2
Metastatic cancer and acute leukemia (CC 8)	3.8	3.8	3.9	-0.1
Lung, upper digestive tract, and other severe cancers (CC 9)	9.1	9.4	8.9	0.5
Lymphatic, head and neck, brain, and other major cancers; breast, colorectal and other cancers and tumors; other respiratory and heart neoplasms (CC 10 – 13)	13.6	13.6	13.5	0.0
Other digestive and urinary neoplasms (CC 14)	6.9	6.5	7.2	-0.7
Diabetes and DM complications (CC 17 – 19, 122 – 123)	42.8	39.8	45.5	-5.7
Protein-calorie malnutrition (CC 21)	16.9	16.2	17.6	-1.4
Disorders of fluid/electrolyte/acid-base (CC 23 – 24)	59.7	58.3	60.9	-2.6
Obesity/disorders of thyroid, cholesterol, lipids (CC 22,25 – 26)	88.2	86.7	89.5	-2.9
Pancreatic disease (CC 34)	0.7	0.6	0.8	-0.2
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	14.9	14.1	15.6	-1.5
Other gastrointestinal disorders (CC 38)	68.8	66.7	70.8	-4.1
Severe hematological disorders (CC 46)	0.8	0.8	0.9	0.0
Iron deficiency and other/unspecified anemia and blood disease (CC 49)	54.4	53.4	55.3	-1.8
Dementia or senility (CC 51 – 53)	19.5	19.1	19.9	-0.8
Drug/alcohol induced dependence/psychosis (CC 54 – 55)	10.8	7.9	13.6	-5.6
Major psychiatric disorders (CC 57 – 59)	23.4	18.3	28.1	-9.8
Depression (CC 61)	31.7	29.9	33.4	-3.5
Anxiety disorders (CC 62)	16.2	14.1	18.2	-4.1
Other psychiatric disorders (CC 63)	39.9	38.9	40.8	-1.9
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74,103 – 104,189 – 190)	7.2	6.6	7.8	-1.2
Polyneuropathy (CC 75,81)	28.1	26.0	30.0	-4.1
Stroke (CC 99 – 100)	6.7	6.1	7.2	-1.0
Renal failure (CC 135 – 140)	43.1	41.1	44.9	-3.9
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	9.6	10.2	9.1	1.2
Cellulitis, local skin infection (CC 164)	12.4	12.5	12.4	0.1
Vertebral fractures (CC 169)	5.6	5.8	5.4	0.4
History of COVID-19	23.5	23.4	23.6	-0.2

Table 4.2.3: Frequency of ICD-10-Based Risk Variables in the COPD Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the COPD Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N=21,4005)	FFS (%) (N=103,485)	MA (%) (N=110,520)	FFS - MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	75.5 (7.2)	76.3 (7.3)	74.7 (6.9)	1.6	1.00 (1.00, 1.00)
ICD-10 codes during the index admission						
B9789	Other viral agents as the cause of diseases classified elsewhere	0.9	0.9	0.9	0.0	0.79 (0.69, 0.90)
C3411	Malignant neoplasm of upper lobe, right bronchus or lung	0.5	0.5	0.5	0.0	1.29 (1.12, 1.49)
D649	Anemia, unspecified	8.9	9.2	8.7	0.4	1.12 (1.08, 1.17)
D751	Secondary polycythemia	0.7	0.7	0.8	-0.1	0.82 (0.70, 0.95)
E875	Hyperkalemia	5.1	5.1	5.2	-0.2	1.23 (1.18, 1.29)
F17210	Nicotine dependence, cigarettes, uncomplicated	23.8	21.4	26.1	-4.7	0.93 (0.89, 0.96)
G629	Polyneuropathy, unspecified	2.8	3.0	2.7	0.3	1.12 (1.05, 1.20)
G928	Other toxic encephalopathy	1.1	1.1	1.1	0.0	0.89 (0.80, 0.98)
I480	Paroxysmal atrial fibrillation	11.2	12.0	10.5	1.5	1.20 (1.16, 1.24)
I4891	Unspecified atrial fibrillation	8.0	8.6	7.4	1.2	1.14 (1.09, 1.19)
I5031	Acute diastolic (congestive) heart failure	0.9	0.9	0.9	0.0	1.22 (1.09, 1.36)
J101	Influenza due to other identified influenza virus with other respiratory manifestations	1.6	1.6	1.6	0.0	0.82 (0.74, 0.91)
J209	Acute bronchitis, unspecified	5.6	5.6	5.5	0.1	0.87 (0.83, 0.92)
J90	Pleural effusion, not elsewhere classified	2.4	2.5	2.3	0.2	1.14 (1.06, 1.22)
Z515	Encounter for palliative care	4.0	4.2	3.9	0.4	0.55 (0.52, 0.59)
Z66	Do not resuscitate	14.0	15.6	12.6	3.0	0.90 (0.87, 0.93)
Z720	Tobacco use	1.0	0.9	1.0	-0.1	0.85 (0.75, 0.96)
Z7984	Long term (current) use of oral hypoglycemic drugs	10.3	9.5	11.0	-1.5	0.91 (0.87, 0.95)
Z87891	Personal history of nicotine dependence	42.9	44.8	41.2	3.6	0.94 (0.91, 0.96)
ICD-10 codes in the 12 months prior to admission						
D649	Anemia, unspecified	26.9	4.8	27.8	-1.8	1.15 (1.12, 1.18)

Variable	Description	MA + FFS (%) (N=21,4005)	FFS (%) (N=103,485)	MA (%) (N=110,520)	FFS - MA (%)	FFS + MA OR (95% CI)
E440	Moderate protein-calorie malnutrition	3.7	2.6	4.1	-0.8	1.15 (1.09, 1.22)
E871	Hypo-osmolality and hyponatremia	14.6	4.8	15.1	-1.0	1.12 (1.09, 1.16)
F17210	Nicotine dependence, cigarettes, uncomplicated	29.5	2.6	33.4	-8.0	1.10 (1.07, 1.13)
F32A	Depression, unspecified	16.8	4.8	18.4	-3.4	1.10 (1.07, 1.14)
F410	Panic disorder [episodic paroxysmal anxiety]	2.6	2.1	3.0	-0.9	1.15 (1.08, 1.23)
F419	Anxiety disorder, unspecified	28.1	26.4	29.6	-3.2	1.05 (1.03, 1.08)
H9190	Unspecified hearing loss, unspecified ear	3.2	3.3	3.0	0.2	1.09 (1.03, 1.16)
I160	Hypertensive urgency	3.9	3.2	4.6	-1.3	1.13 (1.08, 1.20)
I509	Heart failure, unspecified	32.5	28.9	35.9	-7.0	1.18 (1.15, 1.21)
J440	Chronic obstructive pulmonary disease with (acute) lower respiratory infection	25.6	24.5	26.6	-2.2	1.08 (1.05, 1.11)
J449	Chronic obstructive pulmonary disease, unspecified	82.8	78.8	86.5	-7.7	1.10 (1.06, 1.14)
J8410	Pulmonary fibrosis, unspecified	6.5	5.4	7.5	-2.1	1.13 (1.08, 1.18)
J90	Pleural effusion, not elsewhere classified	19.2	17.6	20.7	-3.1	1.19 (1.15, 1.22)
J9600	Acute respiratory failure, unspecified whether with hypoxia or hypercapnia	9.3	7.3	11.1	-3.7	1.07 (1.03, 1.11)
J9602	Acute respiratory failure with hypercapnia	12.4	9.2	15.4	-6.2	1.10 (1.06, 1.14)
J9620	Acute and chronic respiratory failure, unspecified whether with hypoxia or hypercapnia	7.8	6.6	8.9	-2.3	1.09 (1.04, 1.13)
J9621	Acute and chronic respiratory failure with hypoxia	31.7	29.6	33.7	-4.1	1.09 (1.06, 1.13)
J9622	Acute and chronic respiratory failure with hypercapnia	16.2	14.3	18.0	-3.7	1.11 (1.07, 1.16)
M542	Cervicalgia	9.4	8.5	10.4	-1.9	1.00 (0.97, 1.04)
M7989	Other specified soft tissue disorders	11.2	10.0	12.3	-2.3	1.12 (1.08, 1.16)
R0689	Other abnormalities of breathing	5.6	4.3	6.9	-2.6	1.10 (1.05, 1.15)
R079	Chest pain, unspecified	38.2	35.0	41.2	-6.2	1.11 (1.08, 1.14)
R0902	Hypoxemia	32.1	25.5	38.3	-12.8	0.97 (0.95, 0.99)
R1084	Generalized abdominal pain	5.1	4.3	5.9	-1.6	1.15 (1.10, 1.20)

Variable	Description	MA + FFS (%) (N=21,4005)	FFS (%) (N=103,485)	MA (%) (N=110,520)	FFS - MA (%)	FFS + MA OR (95% CI)
R627	Adult failure to thrive	2.7	2.6	2.8	-0.2	1.15 (1.08, 1.23)
R918	Other nonspecific abnormal finding of lung field	46.1	42.6	49.4	-6.8	1.10 (1.07, 1.12)
T380X5A	Adverse effect of glucocorticoids and synthetic analogues, initial encounter	6.1	5.7	6.4	-0.7	1.14 (1.09, 1.19)
Z0000	Encounter for general adult medical examination without abnormal findings	19.8	14.7	24.6	-10.0	0.94 (0.91, 0.97)
Z1231	Encounter for screening mammogram for malignant neoplasm of breast	12.4	11.4	13.5	-2.1	0.85 (0.82, 0.88)
Z515	Encounter for palliative care	5.3	4.5	5.9	-1.4	1.16 (1.10, 1.21)
Z716	Tobacco abuse counseling	3.3	2.3	4.3	-2.0	1.07 (1.01, 1.14)
Z7951	Long term (current) use of inhaled steroids	24.6	22.9	26.2	-3.3	1.08 (1.05, 1.11)
Z7952	Long term (current) use of systemic steroids	11.9	11.6	12.1	-0.6	1.18 (1.14, 1.22)
Z9114	Patient's other noncompliance with medication regimen	4.2	3.5	4.9	-1.4	1.21 (1.15, 1.27)
Z9119	Patient's noncompliance with other medical treatment and regimen	5.5	4.7	6.3	-1.6	1.19 (1.13, 1.24)
Z9981	Dependence on supplemental oxygen	34.4	33.0	35.8	-2.7	1.09 (1.06, 1.12)
ICD-10 codes either during the index admission or 12 months prior to admission						
C3490	Malignant neoplasm of unspecified part of unspecified bronchus or lung	5.8	5.8	5.8	0.0	1.23 (1.17, 1.28)
E1122	Type 2 diabetes mellitus with diabetic chronic kidney disease	16.1	14.4	17.7	-3.3	1.17 (1.13, 1.21)
N184	Chronic kidney disease, stage 4 (severe)	5.1	4.8	5.3	-0.6	1.19 (1.14, 1.26)
N2581	Secondary hyperparathyroidism of renal origin	3.0	2.6	3.3	-0.7	1.28 (1.21, 1.36)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	61.6	60.9	62.3	-1.4	1.19 (1.16, 1.23)
HX_SA	Sleep-disordered breathing	27.2	26.5	27.8	-1.3	0.96 (0.93, 0.98)
HX_MV	History of mechanical ventilation	15.5	14.9	16.1	-1.2	1.11 (1.08, 1.15)
HX_COVID	History of COVID-19	23.5	23.4	23.6	-0.2	1.03 (1.00, 1.06)
MA	MA (versus FFS)	51.6	NA	NA	NA	0.89 (0.87, 0.91)

COPD Model Performance

Table 4.2.4 presents model performance for the COPD measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables had a slightly higher c-statistic compared to the original CC-based model and wider predictive ability. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.2.4: COPD Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	8.4 – 35.6	8.2 – 35.6	7.3 – 38.4
c-statistic	0.65	0.65	0.67

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for COPD

Tables 4.2.5 and 4.2.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.2.5) and for hospitals with 25 or more eligible admissions (Table 4.2.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 132 additional hospitals were included in the measure (4,269 versus 4,137) and 827 additional hospitals met the 25 or more admissions cutoff for public reporting (2,269 versus 1,442). For all hospitals, the mean RSRR was 18.1% for the FFS-only cohort with CC-based risk variables, 18.1% for the FFS+MA cohort with CC-based risk variables, and 18.1% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 18.2%, 18.1%, and 18.1%, respectively.

Table 4.2.5: COPD Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 4,137 hospitals)		FFS+MA cohort with CC-based risk variables (N= 4,269 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 4,269 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	25.0 (28.9)	15 (5, 35)	50.1 (57.9)	28 (9, 74)	50.1 (57.9)	28 (9,74)
SRR	1.00 (0.03)	1.00 (0.99, 1.01)	1.00 (0.04)	1.00 (0.98, 1.02)	1.00 (0.04)	1.00 (0.98, 1.02)
RSRR (%)	18.1 (0.5)	18.1 (17.9, 18.4)	18.1 (0.7)	18.0 (17.7, 18.4)	18.1 (0.7)	18.0 (17.7, 18.4)

Table 4.2.6: COPD Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 1,442 hospitals)		FFS+MA cohort with CC-based risk variables (N= 2,269 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 2,269 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	54.6 (31.2)	45 (33, 65)	85.9 (59.6)	70 (44, 108)	85.9 (59.6)	70 (44, 108)
SRR	1.00 (0.04)	1.00 (0.97, 1.03)	1.00 (0.05)	1.00 (0.97, 1.03)	1.00 (0.05)	1.00 (0.97, 1.03)
RSRR (%)	18.2 (0.8)	18.1 (17.6, 18.6)	18.1 (1.0)	18.0 (17.5, 18.7)	18.1 (0.9)	18.0 (17.5, 18.6)

Measure Reliability for COPD

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.2.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.222 for the FFS-only cohort with CC-based risk variables, 0.322 for the FFS+MA cohort with CC-based risk variables, and 0.309 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.2.7: COPD Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	1,442	2,269	2,269
Between Hospital Variance	0.021	0.022	0.021
STNR: Median (Q1, Q3)	0.222 (0.173, 0.292)	0.322 (0.230, 0.423)	0.309 (0.219, 0.408)

Change in Hospital Performance for COPD

Table 4.2.8 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the COPD measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, about half (44.0%) of hospitals remained in the same performance quintile, and 83.4% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.73. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (53.1% among hospitals in the lowest quintile of percent MA admissions; 31.9% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, the trend in RSRR shifts was less pronounced.

Table 4.2.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the COPD measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 41.3% of hospitals remained in the same performance quintile and 81.3% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.71. Stratified by proportion of MA admissions in a hospital, 49.0% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 32.3% in the highest quintile.

Table 4.2.8: Shifts in RSRR Hospital Performance Quintile Rankings for COPD, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	44.0	83.4	0.73
By Percent of MA Admissions			
Q1: 0.0% – 34.2%	53.1	94.1	0.88
Q2: 34.3% – 44.7%	52.1	86.8	0.82
Q3: 44.7% – 52.5%	42.2	86.9	0.79
Q4: 52.5% – 60.9%	40.8	79.9	0.70
Q5: 60.9% – 85.5%	31.9	69.4	0.54
By MA+FFS Admission Volume			
Q1: 25 – 61 admissions	53.5	93.0	0.85
Q2: 62 – 83 admissions	44.7	84.7	0.76
Q3: 84 – 106 admissions	38.8	81.1	0.71
Q4: 107 – 145 admissions	39.2	78.5	0.72
Q5: 146 – 670 admissions	43.9	79.8	0.68

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions. Total N=1,442, representing hospitals with 25 or more FFS admissions

Table 4.2.9: Shifts in RSRR Hospital Performance Quintile Rankings for COPD, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	41.3	81.3	0.71
By Percent of MA Admissions			
Q1: 0.0% – 34.2%	49.0	89.2	0.85
Q2: 34.3% – 44.7%	46.2	83.0	0.78
Q3: 44.7% – 52.5%	42.6	84.1	0.77
Q4: 52.5% – 60.9%	36.7	79.9	0.65
Q5: 60.9% – 85.5%	32.3	70.5	0.52
By MA+FFS Admission Volume			
Q1: 25 – 61 admissions	49.0	89.9	0.83
Q2: 62 – 83 admissions	41.7	81.4	0.72
Q3: 84 – 106 admissions	38.8	81.1	0.69
Q4: 107 – 145 admissions	36.8	78.5	0.71
Q5: 146 – 670 admissions	40.4	76.0	0.65

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables. Total N=1,442, representing hospitals with 25 or more FFS admissions

4.3. Heart Failure Readmission Results

Heart Failure Admission Volume and Observed Readmission Rate

As presented in [Table 4.3.1](#), the FFS+MA cohort included 635,204 unique admissions from January 1 – December 30, 2022 (326,130 FFS and 309,074 MA). The observed (unadjusted) 30-day readmission rate for the FFS+MA cohort for Heart Failure was 19.4%. The observed readmission rate was 19.2% among FFS beneficiaries compared to 19.5% among MA beneficiaries (difference -0.3%).

Table 4.3.1: Number of Admissions and Observed 30-Day Readmission Rate for Heart Failure, FFS versus MA Admissions, CY 2022

Heart Failure	MA + FFS	FFS	MA	Difference FFS – MA
N	635,204	326,130	309,074	NA
Readmission Rate (%)	19.4	19.2	19.5	-0.3

Frequency of Heart Failure Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.3.2](#), and the reselected ICD-10-based variables in [Table 4.3.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -2.0% for CC-based variables with a range from -12.8% to 2.0%. There was less of a difference overall in risk variable prevalence between FFS and MA for ICD-10-based variables with a median difference of -0.7% (range from -7.9% to 12.6%), however, for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.3.3](#) also presents adjusted OR and 95% confidence intervals for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.3.2: Frequency of CC-Based Risk Variables in the Heart Failure Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N= 635,204)	FFS (N= 326,130)	MA (N= 309,074)	FFS - MA
Age, mean (SD)	79.7 (8.4)	80.7 (8.4)	78.7 (8.3)	2.0
Male	45.7	45.5	45.9	-0.4
Coronary artery bypass graft surgery	18.0	18.2	17.8	0.4
Diabetes and DM complications (CC 17 to 19, 122, 123)	58.7	55.1	62.6	-7.5
Disorders of fluid/electrolyte/acid-base (CC23, 24)	57.5	54.2	61.0	-6.8
Iron deficiency and other/unspecified anemias and blood disease (CC 49)	66.8	66.2	67.4	-1.2
Cardio-respiratory failure and shock (CC 84)	53.2	48.9	57.6	-8.7
Congestive heart failure (CC 85)	91.1	88.8	93.5	-4.7
Vascular or circulatory disease (CC 106 – 109)	60.3	55.1	65.8	-10.8
Chronic obstructive pulmonary disease (CC 111)	45.6	42.7	48.7	-6.0
Pneumonia (CC 114 – 116)	44.7	41.6	47.9	-6.3

Variable (% unless otherwise indicated)	MA + FFS (N= 635,204)	FFS (N= 326,130)	MA (N= 309,074)	FFS - MA
Renal failure (CC 135 – 140)	70.5	68.2	72.9	-4.7
Other urinary tract disorders (CC 145)	26.9	24.5	29.5	-5.0
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	15.9	16.3	15.5	0.9
Other gastrointestinal disorders (CC 38)	69.3	67.7	70.9	-3.3
Acute coronary syndrome (CC 86, 87)	25.8	23.3	28.3	-5.0
Valvular or rheumatic heart disease (CC 91)	59.9	59.3	60.6	-1.2
Arrhythmias (CC 96, 97)	74.5	74.5	74.5	0.0
Asthma (CC 113)	13.7	12.0	15.6	-3.6
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 36)	17.7	17.0	18.5	-1.5
Cancer (CC 9 – 14)	22.6	22.8	22.4	0.4
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56)	19.9	16.3	23.7	-7.4
Major psychiatric disorders (CC 57 – 59)	16.2	12.5	20.1	-7.5
End-stage renal disease or dialysis (CC 134)	6.0	5.7	6.2	-0.5
Severe hematological disorders (CC 46)	1.8	1.9	1.8	0.1
Nephritis (CC141)	1.6	1.4	1.8	-0.4
Liver and biliary disease (CC 27 – 32)	17.7	16.1	19.4	-3.3
Metastatic cancer and acute leukemia (CC 8)	2.9	3.0	2.8	0.2
Dementia and senility (CC 51 – 53)	9.6	8.8	10.4	-1.5
Stroke (CC 99 – 100)	24.1	23.4	24.8	-1.4
Chronic atherosclerosis (CC 88, 89)	69.3	67.8	70.9	-3.1
Other and unspecified heart disease (CC 98)	42.3	36.1	48.8	-12.8
Other psychiatric disorders (CC 63)	27.4	27.1	27.7	-0.6
Hemiplegia, paralysis, functional disability (CC 70 – 74, 103,104, 189,190)	9.2	8.2	10.3	-2.1
Fibrosis of lung and other chronic lung disorders (CC 112)	10.7	9.8	11.7	-1.9
Protein-calorie malnutrition (CC 21)	13.1	13.0	13.1	-0.1
Depression (CC 61)	23.5	22.5	24.5	-2.1
History of COVID-19	21.4	21.2	21.6	-0.3

Table 4.3.3: Frequency of ICD-10-Based Risk Variables in the Heart Failure Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the Heart Failure Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N= 635,204)	FFS (%) (N= 326,130)	MA (%) (N= 309,074)	FFS – MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	79.7 (8.4)	80.7 (8.4)	78.7 (8.3)	2.0	1.00 (1.00, 1.00)
ICD-10 codes during the index admission						
B961	Klebsiella pneumoniae as the cause of diseases classified elsewhere	0.7	0.7	0.6	0.1	1.11 (1.04, 1.20)
C7951	Secondary malignant neoplasm of bone	0.6	0.6	0.5	0.1	1.32 (1.22, 1.43)
D469	Myelodysplastic syndrome, unspecified	0.5	0.6	0.4	0.2	1.30 (1.20, 1.41)
D539	Nutritional anemia, unspecified	2.0	2.2	1.9	0.1	1.09 (1.04, 1.14)
D631	Anemia in chronic kidney disease	14.4	14.2	14.5	-0.3	1.09 (1.07, 1.11)
D638	Anemia in other chronic diseases classified elsewhere	3.9	3.9	3.8	0.0	1.12 (1.08, 1.15)
D649	Anemia, unspecified	11.5	11.6	11.4	0.2	1.07 (1.05, 1.09)
E119	Type 2 diabetes mellitus without complications	9.5	9.2	9.9	-0.7	0.94 (0.92, 0.97)
E440	Moderate protein-calorie malnutrition	2.1	2.1	2.0	0.1	1.05 (1.01, 1.10)
E6601	Morbid (severe) obesity due to excess calories	10.3	9.3	11.3	-2.0	0.92 (0.90, 0.94)
E669	Obesity, unspecified	12.2	11.9	12.7	-0.8	0.92 (0.90, 0.94)
E871	Hypo-osmolality and hyponatremia	10.9	11.7	10.2	1.5	1.17 (1.14, 1.19)
E875	Hyperkalemia	7.4	7.3	7.6	-0.3	1.09 (1.07, 1.12)
E8809	Other disorders of plasma-protein metabolism, not elsewhere classified	1.7	1.7	1.6	0.2	1.13 (1.08, 1.18)
F319	Bipolar disorder, unspecified	0.8	0.7	0.8	-0.1	1.17 (1.09, 1.25)
G40909	Epilepsy, unspecified, not intractable, without status epilepticus	1.7	1.7	1.6	0.1	1.10 (1.05, 1.15)
I160	Hypertensive urgency	4.2	3.9	4.5	-0.5	0.88 (0.85, 0.91)
I161	Hypertensive emergency	2.9	2.5	3.3	-0.8	0.92 (0.88, 0.95)
I214	Non-ST elevation (NSTEMI) myocardial infarction	2.5	2.4	2.6	-0.2	1.13 (1.09, 1.18)
I21A1	Myocardial infarction type 2	7.3	7.1	7.4	-0.2	1.07 (1.04, 1.09)
I248	Other forms of acute ischemic heart disease	6.3	6.2	6.3	-0.1	1.04 (1.02, 1.07)
I428	Other cardiomyopathies	6.5	6.1	6.9	-0.8	0.92 (0.90, 0.95)

Variable	Description	MA + FFS (%) (N= 635,204)	FFS (%) (N= 326,130)	MA (%) (N= 309,074)	FFS – MA (%)	FFS + MA OR (95% CI)
I493	Ventricular premature depolarization	2.9	2.9	2.9	0.0	0.92 (0.88, 0.96)
I5021	Acute systolic (congestive) heart failure	3.3	3.3	3.4	-0.1	0.91 (0.87, 0.95)
I5031	Acute diastolic (congestive) heart failure	5.3	5.5	5.1	0.4	0.92 (0.89, 0.95)
I5041	Acute combined systolic (congestive) and diastolic (congestive) heart failure	1.0	1.0	1.0	-0.1	0.87 (0.81, 0.94)
I959	Hypotension, unspecified	2.9	3.0	2.8	0.3	1.11 (1.07, 1.15)
J189	Pneumonia, unspecified organism	7.8	7.9	7.8	0.1	1.05 (1.02, 1.08)
J440	Chronic obstructive pulmonary disease with (acute) lower respiratory infection	3.8	3.7	3.9	-0.2	0.94 (0.90, 0.97)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	9.9	9.0	10.7	-1.7	1.12 (1.09, 1.14)
J918	Pleural effusion in other conditions classified elsewhere	3.6	3.8	3.4	0.4	1.13 (1.09, 1.17)
J9611	Chronic respiratory failure with hypoxia	3.6	3.6	3.6	0.0	1.09 (1.06, 1.13)
J9621	Acute and chronic respiratory failure with hypoxia	12.7	12.5	12.9	-0.4	1.07 (1.05, 1.09)
K219	Gastro-esophageal reflux disease without esophagitis	23.8	24.3	23.2	1.1	0.98 (0.97, 1.00)
K5900	Constipation, unspecified	4.1	4.1	4.0	0.1	1.08 (1.05, 1.12)
N170	Acute kidney failure with tubular necrosis	1.4	1.3	1.4	-0.1	1.21 (1.15, 1.28)
N179	Acute kidney failure, unspecified	28.3	27.6	29.0	-1.4	1.16 (1.14, 1.17)
N189	Chronic kidney disease, unspecified	7.6	7.7	7.6	0.1	1.04 (1.01, 1.06)
R001	Bradycardia, unspecified	2.2	2.3	2.2	0.1	0.90 (0.86, 0.94)
R1310	Dysphagia, unspecified	1.7	1.9	1.6	0.3	1.12 (1.07, 1.18)
R7303	Prediabetes	1.2	1.1	1.3	-0.3	0.88 (0.83, 0.94)
R791	Abnormal coagulation profile	1.9	2.0	1.8	0.2	1.09 (1.04, 1.14)
Z515	Encounter for palliative care	5.4	5.7	5.0	0.7	0.47 (0.46, 0.49)
Z66	Do not resuscitate	17.1	18.9	15.1	3.8	0.88 (0.86, 0.90)
Z7401	Bed confinement status	0.9	0.9	0.9	0.0	1.13 (1.06, 1.20)
Z794	Long term (current) use of insulin	15.2	14.0	16.5	-2.5	1.03 (1.01, 1.05)
Z7984	Long term (current) use of oral hypoglycemic drugs	12.9	12.0	14.0	-2.0	0.96 (0.94, 0.98)
Z79899	Other long term (current) drug therapy	30.8	31.3	30.3	1.1	0.95 (0.94, 0.97)

Variable	Description	MA + FFS (%) (N= 635,204)	FFS (%) (N= 326,130)	MA (%) (N= 309,074)	FFS – MA (%)	FFS + MA OR (95% CI)
Z85118	Personal history of other malignant neoplasm of bronchus and lung	1.0	1.1	0.9	0.2	1.08 (1.02, 1.15)
Z87891	Personal history of nicotine dependence	30.3	30.7	29.9	0.8	0.95 (0.94, 0.97)
ICD-10 codes in the 12 months prior to admission						
A419	Sepsis, unspecified organism	11.9	11.3	12.6	-1.3	1.08 (1.06, 1.10)
D509	Iron deficiency anemia, unspecified	19.7	19.5	20.0	-0.5	1.07 (1.05, 1.08)
D649	Anemia, unspecified	37.4	35.1	39.7	-4.6	1.06 (1.04, 1.07)
E11649	Type 2 diabetes mellitus with hypoglycemia without coma	5.5	4.9	6.2	-1.4	1.08 (1.05, 1.11)
E871	Hypo-osmolality and hyponatremia	18.4	18.3	18.5	-0.2	1.06 (1.04, 1.08)
E875	Hyperkalemia	16.9	15.6	18.3	-2.7	1.08 (1.06, 1.10)
E876	Hypokalemia	20.4	19.5	21.3	-1.9	1.07 (1.05, 1.08)
F17200	Nicotine dependence, unspecified, uncomplicated	5.2	3.7	6.7	-2.9	1.10 (1.07, 1.14)
F17210	Nicotine dependence, cigarettes, uncomplicated	9.5	7.6	11.4	-3.8	1.08 (1.06, 1.11)
F32A	Depression, unspecified	12.5	11.7	13.5	-1.8	1.08 (1.06, 1.10)
G4733	Obstructive sleep apnea (adult) (pediatric)	21.3	20.9	21.7	-0.8	0.96 (0.94, 0.98)
I120	Hypertensive chronic kidney disease with stage 5 chronic kidney disease or end-stage renal disease	5.3	4.8	5.9	-1.2	1.14 (1.10, 1.18)
I1310	Hypertensive heart and chronic kidney disease without heart failure, with stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease	3.2	2.2	4.3	-2.1	0.94 (0.90, 0.97)
I132	Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease	6.1	5.7	6.5	-0.7	1.09 (1.05, 1.12)
I214	Non-ST elevation (NSTEMI) myocardial infarction	13.2	11.3	15.1	-3.8	1.07 (1.05, 1.09)
I248	Other forms of acute ischemic heart disease	6.6	6.2	7.1	-0.9	1.12 (1.09, 1.15)
I2510	Atherosclerotic heart disease of native coronary artery without angina pectoris	56.4	54.3	58.6	-4.4	1.04 (1.02, 1.06)
I350	Nonrheumatic aortic (valve) stenosis	13.1	13.0	13.3	-0.3	1.08 (1.06, 1.10)
I4891	Unspecified atrial fibrillation	48.6	47.8	49.4	-1.7	1.03 (1.01, 1.04)

Variable	Description	MA + FFS (%) (N= 635,204)	FFS (%) (N= 326,130)	MA (%) (N= 309,074)	FFS – MA (%)	FFS + MA OR (95% CI)
I5022	Chronic systolic (congestive) heart failure	22.3	19.9	24.8	-4.9	1.07 (1.05, 1.09)
I5032	Chronic diastolic (congestive) heart failure	28.2	26.8	29.7	-3.0	1.06 (1.05, 1.08)
I5043	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure	15.7	14.1	17.4	-3.3	1.06 (1.04, 1.08)
I6782	Cerebral ischemia	4.4	3.7	5.0	-1.3	1.07 (1.04, 1.10)
I959	Hypotension, unspecified	12.9	12.0	13.8	-1.9	1.08 (1.06, 1.10)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	16.7	14.2	19.4	-5.1	1.09 (1.07, 1.11)
J449	Chronic obstructive pulmonary disease, unspecified	34.8	31.1	38.7	-7.6	1.07 (1.06, 1.09)
J811	Chronic pulmonary edema	19.7	15.8	23.7	-7.9	1.06 (1.04, 1.07)
J9622	Acute and chronic respiratory failure with hypercapnia	4.4	3.8	4.9	-1.1	1.13 (1.10, 1.17)
K5730	Diverticulosis of large intestine without perforation or abscess without bleeding	10.1	8.5	11.8	-3.3	0.98 (0.96, 1.00)
K7460	Unspecified cirrhosis of liver	3.6	3.2	4.1	-0.8	1.16 (1.12, 1.20)
K921	Melena	5.9	5.5	6.3	-0.8	1.09 (1.06, 1.11)
L309	Dermatitis, unspecified	2.9	2.7	3.1	-0.4	1.05 (1.01, 1.09)
M542	Cervicalgia	8.7	8.1	9.3	-1.2	1.07 (1.05, 1.09)
N179	Acute kidney failure, unspecified	40.1	37.2	43.2	-5.9	1.11 (1.09, 1.13)
R000	Tachycardia, unspecified	11.4	9.8	13.1	-3.3	1.07 (1.05, 1.09)
R001	Bradycardia, unspecified	12.2	11.4	12.9	-1.5	0.96 (0.95, 0.98)
R0603	Acute respiratory distress	4.6	3.6	5.6	-2.0	1.09 (1.06, 1.12)
R072	Precordial pain	3.5	2.9	4.0	-1.1	1.08 (1.05, 1.12)
R0789	Other chest pain	19.9	17.4	22.4	-5.0	1.08 (1.06, 1.10)
R079	Chest pain, unspecified	40.0	36.7	43.4	-6.7	1.05 (1.03, 1.06)
R188	Other ascites	5.0	4.1	5.8	-1.7	1.11 (1.08, 1.14)
W19XXA	Unspecified fall, initial encounter	4.7	1.0	8.6	-7.6	0.98 (0.96, 1.01)
Z006	Encounter for examination for normal comparison and control in clinical research program	2.6	2.8	2.3	0.5	0.89 (0.85, 0.92)
Z1231	Encounter for screening mammogram for malignant neoplasm of breast	8.9	8.3	9.7	-1.4	0.96 (0.93, 0.98)

Variable	Description	MA + FFS (%) (N= 635,204)	FFS (%) (N= 326,130)	MA (%) (N= 309,074)	FFS – MA (%)	FFS + MA OR (95% CI)
Z23	Encounter for immunization	61.0	67.2	54.6	12.6	1.01 (1.00, 1.03)
Z515	Encounter for palliative care	5.2	4.5	5.9	-1.4	1.10 (1.07, 1.13)
Z66	Do not resuscitate	13.6	14.9	12.3	2.6	0.98 (0.96, 1.00)
Z7952	Long term (current) use of systemic steroids	4.4	4.4	4.3	0.1	1.12 (1.09, 1.15)
Z87891	Personal history of nicotine dependence	38.3	37.6	39.0	-1.4	1.06 (1.04, 1.07)
Z888	Allergy status to other drugs, medicaments and biological substances	11.6	12.4	10.9	1.5	1.07 (1.05, 1.09)
Z9114	Patient's other noncompliance with medication regimen	5.0	4.0	6.0	-2.0	1.14 (1.11, 1.17)
Z9119	Patient's noncompliance with other medical treatment and regimen	4.5	3.6	5.5	-1.9	1.15 (1.12, 1.18)
ICD-10 codes either during the index admission or 12 months prior to admission						
E1122	Type 2 diabetes mellitus with diabetic chronic kidney disease	38.4	35.0	41.9	-6.9	1.10 (1.09, 1.12)
I480	Paroxysmal atrial fibrillation	41.1	41.5	40.7	0.8	1.03 (1.02, 1.05)
I4820	Chronic atrial fibrillation, unspecified	23.2	23.4	22.9	0.6	1.01 (0.99, 1.03)
J90	Pleural effusion, not elsewhere classified	44.0	41.3	46.9	-5.6	1.08 (1.07, 1.10)
N184	Chronic kidney disease, stage 4 (severe)	18.9	17.8	20.0	-2.2	1.07 (1.05, 1.09)
N185	Chronic kidney disease, stage 5	4.3	3.7	4.9	-1.2	0.92 (0.89, 0.96)
Z952	Presence of prosthetic heart valve	8.6	9.2	7.9	1.2	1.09 (1.06, 1.11)
Z95810	Presence of automatic (implantable) cardiac defibrillator	11.4	10.8	12.0	-1.3	1.10 (1.08, 1.12)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	49.3	48.9	49.7	-0.9	1.12 (1.10, 1.14)
HX_COVID	History of COVID-19	21.4	21.2	21.6	-0.3	1.02 (1.01, 1.04)
MA	MA (versus FFS)	48.7	NA	NA	NA	0.92 (0.91, 0.93)

Heart Failure Model Performance

Table 4.3.4 presents model performance for the Heart Failure measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables had a slightly higher c-statistic compared to the original CC-based model and wider predictive ability. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.3.4: Heart Failure Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	10.6 – 32.4	10.6 – 33.1	9.1 – 35.9
c-statistic	0.62	0.62	0.64

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for Heart Failure

Tables 4.3.5 and 4.3.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.3.5) and for hospitals with 25 or more eligible admissions (Table 4.3.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 86 additional hospitals were included in the measure (4,304 versus 4,218) and 434 additional hospitals met the 25 or more admissions cutoff for public reporting (2,799 versus 2,365). For all hospitals, the mean RSRR was 19.2% for the FFS-only cohort with CC-based risk variables, 19.4% for the FFS+MA cohort with CC-based risk variables, and 19.4% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 19.2%, 19.4%, and 19.4%, respectively.

Table 4.3.5: Heart Failure Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 4,218 hospitals)		FFS+MA cohort with CC-based risk variables (N= 4,304 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 4,304 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	77.3 (104.9)	34 (8, 110)	147.6 (197.7)	65 (13, 215)	147.6 (197.7)	65 (13, 215)
SRR	1.00 (0.03)	1.00 (0.99, 1.01)	1.00 (0.05)	1.00 (0.98, 1.02)	1.00 (0.04)	1.00 (0.98, 1.02)
RSRR (%)	19.2 (0.6)	19.2 (19.0, 19.5)	19.4 (0.9)	19.3 (19.0, 19.7)	19.4 (0.8)	19.3 (19.0, 19.7)

Table 4.3.6: Heart Failure Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 2,365 hospitals)		FFS+MA cohort with CC-based risk variables (N= 2,799 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 2,799 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	131.0 (114.2)	96 (51, 172)	222.0 (210.4)	159 (71, 310)	222.0 (210.4)	159 (71, 310)
SRR	1.00 (0.04)	1.00 (0.98, 1.03)	1.00 (0.06)	1.00 (0.97, 1.04)	1.00 (0.05)	1.00 (0.97, 1.03)
RSRR (%)	19.2 (0.8)	19.2 (18.8, 19.7)	19.4 (1.1)	19.3 (18.7, 20.1)	19.4 (1.0)	19.3 (18.8, 19.9)

Measure Reliability for Heart Failure

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.3.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.293 for the FFS-only cohort with CC-based risk variables, 0.450 for the FFS+MA cohort with CC-based risk variables, and 0.410 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.3.7: Heart Failure Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	2,365	2,799	2,799
Between Hospital Variance	0.014	0.017	0.014
STNR: Median (Q1, Q3)	0.293 (0.180, 0.426)	0.450 (0.267, 0.614)	0.410 (0.237, 0.576)

Change in Hospital Performance for Heart Failure

Table 4.3.8 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the Heart Failure measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, about half (45.6%) of hospitals remained in the same performance quintile, and 85.7% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.76. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (62.2% among hospitals in the lowest quintile of percent MA admissions; 30.7% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, there was not a notable trend in RSRR shifts.

Table 4.3.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the Heart Failure measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 44.9% of hospitals remained in the same performance quintile and 84.0% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.74. Stratified by proportion of MA admissions in a hospital, 58.6% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 32.6% in the highest quintile.

Table 4.3.8: Shifts in RSRR Hospital Performance Quintile Rankings for Heart Failure, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	45.6	85.7	0.76
By Percent of MA Admissions			
Q1: 0.0% – 31.9%	62.2	95.3	0.92
Q2: 31.9% – 41.7%	47.8	89.9	0.84
Q3: 41.7% – 50.2%	44.0	86.0	0.76
Q4: 50.2% – 58.7%	43.6	84.1	0.75
Q5: 58.8.% – 90.4.2%	30.7	72.9	0.55
By MA+FFS Admission Volume			
Q1: 25 – 87 admissions	48.1	94.1	0.81
Q2: 88 – 150 admissions	43.1	86.6	0.77
Q3: 151 – 236 admissions	43.8	82.7	0.74
Q4: 237 – 373 admissions	44.7	82.9	0.76
Q5: 374 – 2,693admissions	48.3	81.9	0.75

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions.

Total N=2,365, representing hospitals with 25 or more FFS admissions

Table 4.3.9: Shifts in RSRR Hospital Performance Quintile Rankings for Heart Failure, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	44.9	84.0	0.74
By Percent of MA Admissions			
Q1: 0.0% – 31.9%	58.6	95.3	0.90
Q2: 31.9% – 41.7%	45.9	87.7	0.81
Q3: 41.7% – 50.2%	42.1	84.8	0.75
Q4: 50.2% – 58.7%	45.2	81.2	0.75
Q5: 58.8% – 90.4%	32.6	70.8	0.54
By MA+FFS Admission Volume			
Q1: 25 – 87 admissions	48.1	93.7	0.80
Q2: 88 – 150 admissions	41.6	86.2	0.76
Q3: 151 – 236 admissions	43.4	79.4	0.71
Q4: 237 – 373 admissions	43.9	81.6	0.74
Q5: 374 – 2,693 admissions	47.3	78.9	0.75

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables.

Total N= 2,365, representing hospitals with 25 or more FFS admissions

4.4. Pneumonia Readmission Results

Pneumonia Admission Volume and Observed Readmission Rate

As presented in [Table 4.4.1](#), the FFS+MA cohort included 559,333 unique admissions from January 1 – December 30, 2022 (308,882 FFS and 250,451 MA). The observed (unadjusted) 30-day readmission rate for the FFS+MA cohort for Pneumonia was 15.6%. The observed readmission rate was 15.7% among FFS beneficiaries compared to 15.5% among MA beneficiaries (difference 0.2%).

Table 4.4.1: Number of Admissions and Observed 30-Day Readmission Rate for Pneumonia, FFS versus MA Admissions, CY 2022

Pneumonia	MA + FFS	FFS	MA	Difference FFS - MA
N	559,333	308,882	250,451	NA
Readmission Rate (%)	15.6	15.7	15.5	0.2

Frequency of Pneumonia Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.4.2](#), and the reselected ICD-10-based variables in [Table 4.4.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -1.6% for CC-based variables with a range from -11.5% to 1.6%. There was less of a difference overall in risk variable prevalence between FFS and MA for ICD-10-based variables with a median difference of -0.2% (range from -10.9% to 3.7%), however, for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.4.3](#) also presents adjusted OR and 95% confidence intervals for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.4.2: Frequency of CC-Based Risk Variables in the Pneumonia Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N= 559,333)	FFS (N= 308,882)	MA (N= 250,451)	FFS - MA
Age, mean (SD)	79.1 (8.4)	79.8 (8.5)	78.2 (8.2)	1.5
Male	47.3	47.7	46.7	1.0
Coronary artery bypass graft surgery	8.9	8.8	8.9	1.0
History of infection (CC 1, 3 – 7)	38.6	38.9	38.2	1.0
Septicemia/shock (CC 2)	34.1	32.2	36.5	1.0
Metastatic cancer and acute leukemia (CC 8)	7.1	7.0	7.3	1.0
Lung cancer (CC 9)	9.6	9.4	9.9	1.0
Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors (CC 10 – 12)	18.8	18.9	18.6	1.0
Diabetes and DM complications (CC 17 – 19, 122, 123)	46.4	43.7	49.8	-6.0
Protein-calorie malnutrition (CC 21)	21.5	21.3	21.7	-0.4

Variable (% unless otherwise indicated)	MA + FFS (N= 559,333)	FFS (N= 308,882)	MA (N= 250,451)	FFS - MA
Disorders of fluid/electrolyte/acid-base (CC 23, 24)	50.6	48.1	53.8	-5.7
Other gastrointestinal disorders (CC 38)	72.7	71.3	74.4	-3.2
Severe hematological disorders (CC 46)	1.9	2.0	1.9	0.1
Iron deficiency and other/unspecified anemias and blood disease (CC 49)	60.9	60.0	62.0	-1.9
Dementia and senility (CC 51 – 53)	33.6	33.9	33.3	0.6
Drug/alcohol abuse/dependence/psychosis (CC 54 – 56)	23.8	19.5	29.0	-9.5
Major psychiatric disorders (CC 57 – 59)	20.9	17.7	24.9	-7.2
Other psychiatric disorders (CC 63)	30.6	30.0	31.4	-1.4
Hemiplegia, paralysis, functional disability (CC 70 – 74, 103, 104, 189, 190)	11.6	11.2	12.0	-0.8
Respirator dependency/tracheostomy (CC 82)	53.6	48.6	59.7	-11.1
Congestive heart failure (CC 85)	44.6	41.9	48.0	-6.1
Acute coronary syndrome (CC 86, 87)	13.5	12.4	14.9	-2.6
Chronic atherosclerosis (CC 88,8 9)	48.2	46.6	50.2	-3.6
Valvular or rheumatic heart disease (CC 91)	31.3	30.6	32.1	-1.4
Arrhythmias (CC 96, 97)	50.7	50.7	50.6	0.1
Stroke (CC 99 –100)	11.0	10.7	11.4	-0.8
Vascular or circulatory disease (CC 106 –109)	53.4	48.5	59.4	-11.0
Chronic obstructive pulmonary disease (CC 111)	51.8	48.6	55.7	-7.1
Fibrosis of lung and other chronic lung disorders (CC 112)	15.4	14.2	17.0	-2.8
Asthma (CC 113)	14.4	12.9	16.3	-3.4
Pneumonia (CC 114 – 116)	73.0	67.8	79.4	-11.5
Pleural effusion/pneumothorax (CC 117)	26.8	24.7	29.3	-4.5
Other lung disorders (CC 118)	55.3	52.8	58.3	-5.6
End-stage renal disease or dialysis (CC 134)	3.9	3.7	4.0	-0.3
Renal failure (CC 135 – 140)	49.9	47.2	53.1	-5.9
Urinary tract infection (CC 144)	29.5	29.6	29.4	0.3
Other urinary tract disorders (CC 145)	23.5	21.5	25.8	-4.3
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	14.7	15.4	13.8	1.6
Vertebral fractures (CC 169)	6.2	6.2	6.1	0.2
Other injuries (CC 174)	38.7	37.9	39.6	-1.8
Cardio-respiratory failure and shock (CC 83, 84)	2.2	1.9	2.5	-0.5
History of COVID-19	24.5	24.7	24.2	0.5

Table 4.4.3: Frequency of ICD-10-Based Risk Variables in the Pneumonia Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the Pneumonia Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N= 559,333)	FFS (%) (N= 308,882)	MA (%) (N= 250,451)	FFS – MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	79.1 (8.4)	79.8 (8.5)	78.2 (8.2)	1.5	1.00 (1.00, 1.00)
ICD-10 codes during the index admission						
A0472	Enterocolitis due to Clostridium difficile, not specified as recurrent	0.5	0.6	0.5	0.1	1.31 (1.20, 1.43)
B965	Pseudomonas (aeruginosa) (mallei) (pseudomallei) as the cause of diseases classified elsewhere	0.7	0.7	0.6	0.1	1.18 (1.09, 1.28)
B9789	Other viral agents as the cause of diseases classified elsewhere	0.8	0.8	0.8	0.0	0.77 (0.70, 0.85)
C7800	Secondary malignant neoplasm of unspecified lung	0.5	0.6	0.5	0.1	1.22 (1.12, 1.34)
C787	Secondary malignant neoplasm of liver and intrahepatic bile duct	1.0	1.0	1.0	0.0	1.20 (1.12, 1.29)
D469	Myelodysplastic syndrome, unspecified	0.6	0.6	0.5	0.1	1.30 (1.19, 1.43)
D61818	Other pancytopenia	1.3	1.4	1.3	0.0	1.29 (1.22, 1.37)
D62	Acute posthemorrhagic anemia	1.5	1.4	1.5	-0.1	1.19 (1.13, 1.26)
D638	Anemia in other chronic diseases classified elsewhere	3.9	3.9	3.8	0.2	1.13 (1.09, 1.17)
D649	Anemia, unspecified	12.1	12.3	12.0	0.3	1.10 (1.08, 1.13)
E11649	Type 2 diabetes mellitus with hypoglycemia without coma	1.3	1.2	1.4	-0.2	1.19 (1.12, 1.26)
E222	Syndrome of inappropriate secretion of antidiuretic hormone	1.2	1.2	1.2	0.0	1.20 (1.12, 1.28)
E43	Unspecified severe protein-calorie malnutrition	6.8	6.9	6.7	0.1	1.10 (1.07, 1.13)
E440	Moderate protein-calorie malnutrition	3.5	3.5	3.5	0.0	1.10 (1.06, 1.14)
E870	Hyperosmolality and hypernatremia	3.3	3.6	2.9	0.7	1.12 (1.08, 1.17)
E875	Hyperkalemia	4.7	4.7	4.8	-0.2	1.18 (1.14, 1.22)
E876	Hypokalemia	12.4	12.3	12.5	-0.2	0.94 (0.92, 0.96)
G893	Neoplasm related pain (acute) (chronic)	0.5	0.5	0.5	0.0	1.32 (1.20, 1.44)
I080	Rheumatic disorders of both mitral and aortic valves	0.8	0.9	0.8	0.1	1.24 (1.15, 1.33)

Variable	Description	MA + FFS (%) (N= 559,333)	FFS (%) (N= 308,882)	MA (%) (N= 250,451)	FFS – MA (%)	FFS + MA OR (95% CI)
I130	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease	13.9	13.7	14.3	-0.6	1.06 (1.04, 1.09)
I4891	Unspecified atrial fibrillation	10.6	11.1	9.9	1.2	1.05 (1.03, 1.08)
I5023	Acute on chronic systolic (congestive) heart failure	2.9	2.8	3.0	-0.1	1.20 (1.15, 1.25)
I5031	Acute diastolic (congestive) heart failure	1.4	1.4	1.4	-0.1	1.21 (1.14, 1.29)
I5033	Acute on chronic diastolic (congestive) heart failure	7.6	7.7	7.5	0.1	1.16 (1.13, 1.19)
I5042	Chronic combined systolic (congestive) and diastolic (congestive) heart failure	1.5	1.5	1.5	0.3	1.14 (1.08, 1.21)
I5043	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure	2.0	1.9	2.1	-0.1	1.19 (1.14, 1.25)
J13	Pneumonia due to Streptococcus pneumoniae	0.5	0.5	0.6	-0.1	0.74 (0.66, 0.83)
J159	Unspecified bacterial pneumonia	3.9	3.9	3.9	0.0	0.93 (0.89, 0.97)
J40	Bronchitis, not specified as acute or chronic	0.6	0.6	0.5	0.0	0.80 (0.71, 0.89)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	16.8	15.3	18.7	-3.4	1.05 (1.03, 1.07)
J45909	Unspecified asthma, uncomplicated	3.4	3.4	3.4	0.0	0.94 (0.90, 0.98)
J90	Pleural effusion, not elsewhere classified	5.4	5.5	5.3	0.2	1.26 (1.22, 1.30)
J910	Malignant pleural effusion	0.5	0.5	0.5	0.0	1.52 (1.38, 1.66)
J918	Pleural effusion in other conditions classified elsewhere	2.2	2.2	2.1	0.1	1.21 (1.16, 1.27)
J9601	Acute respiratory failure with hypoxia	33.0	32.8	33.3	-0.4	0.97 (0.95, 0.98)
J9602	Acute respiratory failure with hypercapnia	2.5	2.3	2.7	-0.4	1.12 (1.07, 1.17)
J9622	Acute and chronic respiratory failure with hypercapnia	4.7	4.4	5.1	-0.7	1.14 (1.10, 1.18)
K5900	Constipation, unspecified	4.7	4.8	4.5	0.3	1.07 (1.03, 1.10)
K7460	Unspecified cirrhosis of liver	1.2	1.1	1.4	-0.2	1.17 (1.10, 1.24)
L89154	Pressure ulcer of sacral region, stage 4	0.6	0.7	0.5	0.2	1.23 (1.13, 1.33)
N170	Acute kidney failure with tubular necrosis	1.6	1.6	1.7	-0.1	1.20 (1.13, 1.26)
N179	Acute kidney failure, unspecified	21.8	21.3	22.3	-0.9	1.07 (1.05, 1.09)

Variable	Description	MA + FFS (%) (N= 559,333)	FFS (%) (N= 308,882)	MA (%) (N= 250,451)	FFS – MA (%)	FFS + MA OR (95% CI)
R0902	Hypoxemia	6.7	7.0	6.3	0.7	0.91 (0.88, 0.94)
R1310	Dysphagia, unspecified	6.7	7.3	6.0	1.4	1.10 (1.07, 1.14)
R1312	Dysphagia, oropharyngeal phase	2.1	2.2	1.9	0.3	1.16 (1.10, 1.22)
R188	Other ascites	0.7	0.7	0.8	0.0	1.19 (1.10, 1.29)
R338	Other retention of urine	1.3	1.3	1.3	0.0	1.18 (1.11, 1.25)
R339	Retention of urine, unspecified	1.6	1.6	1.5	0.1	1.12 (1.05, 1.18)
T451X5A	Adverse effect of antineoplastic and immunosuppressive drugs, initial encounter	1.3	1.3	1.2	0.1	1.17 (1.09, 1.24)
Z515	Encounter for palliative care	7.5	7.9	7.1	0.8	0.43 (0.41, 0.44)
Z66	Do not resuscitate	19.8	21.5	17.8	3.7	0.86 (0.84, 0.88)
Z6820	Body mass index [BMI] 20.0 – 20.9, adult	0.7	0.8	0.7	0.1	1.04 (0.96, 1.13)
Z6843	Body mass index [BMI] 50.0 – 59.9, adult	0.8	0.7	0.9	-0.2	1.09 (1.01, 1.18)
Z7401	Bed confinement status	2.2	2.3	2.1	0.2	1.19 (1.14, 1.25)
Z7901	Long term (current) use of anticoagulants	20.0	20.7	19.1	1.6	1.03 (1.01, 1.05)
Z9981	Dependence on supplemental oxygen	10.8	10.4	11.4	-1.0	1.05 (1.02, 1.08)
ICD-10 codes in the 12 months prior to admission						
D649	Anemia, unspecified	31.4	30.1	32.9	-2.7	1.11 (1.09, 1.13)
D72829	Elevated white blood cell count, unspecified	12.8	10.5	15.7	-5.2	1.06 (1.04, 1.09)
E860	Dehydration	16.0	15.9	16.2	-0.2	1.07 (1.05, 1.09)
E871	Hypo-osmolality and hyponatremia	16.9	16.1	17.9	-1.8	1.10 (1.08, 1.13)
E875	Hyperkalemia	10.9	10.2	11.7	-1.5	1.08 (1.05, 1.10)
E876	Hypokalemia	17.7	16.9	18.7	-1.8	1.05 (1.03, 1.07)
F17210	Nicotine dependence, cigarettes, uncomplicated	11.3	9.1	14.1	-5.0	1.11 (1.08, 1.13)
F419	Anxiety disorder, unspecified	20.1	18.9	21.4	-2.5	1.06 (1.04, 1.08)
I120	Hypertensive chronic kidney disease with stage 5 chronic kidney disease or end stage renal disease	3.5	3.2	3.8	-0.6	1.22 (1.17, 1.27)
I160	Hypertensive urgency	3.5	3.1	4.0	-1.0	1.13 (1.09, 1.17)
I5033	Acute on chronic diastolic (congestive) heart failure	9.3	8.8	10.0	-1.2	1.08 (1.05, 1.10)
I509	Heart failure, unspecified	28.4	25.7	31.6	-5.8	1.09 (1.07, 1.11)
I6529	Occlusion and stenosis of unspecified carotid artery	2.7	2.1	3.4	-1.3	0.94 (0.90, 0.99)
J069	Acute upper respiratory infection, unspecified	7.2	6.6	8.0	-1.4	0.93 (0.90, 0.95)

Variable	Description	MA + FFS (%) (N= 559,333)	FFS (%) (N= 308,882)	MA (%) (N= 250,451)	FFS – MA (%)	FFS + MA OR (95% CI)
J101	Influenza due to other identified influenza virus with other respiratory manifestations	2.6	2.0	3.3	-1.3	0.78 (0.74, 0.83)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	21.4	18.1	25.5	-7.4	1.09 (1.06, 1.11)
J690	Pneumonitis due to inhalation of food and vomit	11.1	11.3	10.9	0.4	1.09 (1.06, 1.11)
J849	Interstitial pulmonary disease, unspecified	4.3	3.8	4.9	-1.0	1.09 (1.05, 1.13)
J90	Pleural effusion, not elsewhere classified	25.6	23.7	28.1	-4.4	1.14 (1.12, 1.16)
J9622	Acute and chronic respiratory failure with hypercapnia	4.2	3.7	4.9	-1.2	1.17 (1.13, 1.21)
M47812	Spondylosis without myelopathy or radiculopathy, cervical region	5.5	4.6	6.5	-1.8	1.00 (0.97, 1.04)
M7989	Other specified soft tissue disorders	10.9	10.0	12.0	-2.1	1.06 (1.04, 1.09)
N179	Acute kidney failure, unspecified	26.7	24.6	29.3	-4.7	1.04 (1.02, 1.06)
N390	Urinary tract infection, site not specified	26.2	26.3	26.1	0.1	1.06 (1.04, 1.08)
R000	Tachycardia, unspecified	14.6	13.2	16.4	-3.2	1.09 (1.07, 1.11)
R0600	Dyspnea, unspecified	24.2	21.7	27.2	-5.5	1.05 (1.03, 1.07)
R0602	Shortness of breath	55.3	51.6	59.9	-8.3	1.08 (1.06, 1.10)
R0789	Other chest pain	15.4	13.8	17.3	-3.5	1.06 (1.04, 1.08)
R079	Chest pain, unspecified	31.7	29.2	34.8	-5.6	1.05 (1.03, 1.07)
R109	Unspecified abdominal pain	17.1	15.9	18.7	-2.8	1.09 (1.07, 1.11)
R4182	Altered mental status, unspecified	22.6	22.4	22.9	-0.6	1.08 (1.06, 1.10)
R509	Fever, unspecified	15.9	13.7	18.7	-5.0	0.97 (0.95, 0.99)
R627	Adult failure to thrive	4.5	4.4	4.7	-0.2	1.09 (1.06, 1.13)
R630	Anorexia	3.5	3.0	4.0	-1.1	1.08 (1.04, 1.12)
R918	Other nonspecific abnormal finding of lung field	50.5	46.8	55.1	-8.3	1.06 (1.04, 1.07)
R9389	Abnormal findings on diagnostic imaging of other specified body structures	4.0	3.1	5.1	-2.0	1.10 (1.06, 1.14)
R9431	Abnormal electrocardiogram [ECG] [EKG]	22.3	20.4	24.7	-4.3	1.06 (1.04, 1.08)
Z0000	Encounter for general adult medical examination without abnormal findings	19.1	14.2	25.1	-10.9	0.98 (0.96, 1.00)

Variable	Description	MA + FFS (%) (N= 559,333)	FFS (%) (N= 308,882)	MA (%) (N= 250,451)	FFS – MA (%)	FFS + MA OR (95% CI)
Z1211	Encounter for screening for malignant neoplasm of colon	4.4	3.2	5.7	-2.5	0.92 (0.89, 0.96)
Z1231	Encounter for screening mammogram for malignant neoplasm of breast	10.1	9.3	10.9	-1.6	0.85 (0.83, 0.88)
Z5111	Encounter for antineoplastic chemotherapy	4.6	4.5	4.7	-0.2	1.18 (1.14, 1.23)
Z7952	Long term (current) use of systemic steroids	6.3	6.2	6.3	0.0	1.14 (1.11, 1.17)
Z87440	Personal history of urinary (tract) infections	4.7	5.0	4.3	0.6	1.09 (1.06, 1.13)
Z87891	Personal history of nicotine dependence	36.9	35.7	38.5	-2.9	1.05 (1.04, 1.07)
Z881	Allergy status to other antibiotic agents	6.0	6.5	5.3	1.3	1.07 (1.04, 1.11)
Z95810	Presence of automatic (implantable) cardiac defibrillator	2.9	2.8	3.1	-0.3	1.11 (1.06, 1.15)
ICD-10 codes either during the index admission or 12 months prior to admission						
C3490	Malignant neoplasm of unspecified part of unspecified bronchus or lung	4.8	4.4	5.2	-0.8	1.19 (1.15, 1.23)
D631	Anemia in chronic kidney disease	12.7	12.3	13.2	-0.9	1.11 (1.08, 1.14)
E1122	Type 2 diabetes mellitus with diabetic chronic kidney disease	21.1	19.0	23.8	-4.8	1.10 (1.07, 1.12)
I480	Paroxysmal atrial fibrillation	24.5	24.7	24.1	0.6	1.07 (1.05, 1.09)
J8410	Pulmonary fibrosis, unspecified	6.3	5.4	7.4	-1.9	1.11 (1.08, 1.14)
N184	Chronic kidney disease, stage 4 (severe)	7.7	7.2	8.4	-1.2	1.07 (1.04, 1.10)
Z931	Gastrostomy status	3.6	4.0	3.1	0.9	1.36 (1.31, 1.41)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	52.4	51.8	53.0	-1.2	1.19 (1.17, 1.21)
HX_COVID	History of COVID-19	24.5	24.7	24.2	0.5	0.98 (0.97, 1.00)
MA	MA (versus FFS)	44.8	NA	NA	NA	0.90 (0.89, 0.91)

Pneumonia Model Performance

Table 4.4.4 presents model performance for the Pneumonia measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables had a slightly higher c-statistic compared to the original CC-based model and wider predictive ability. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.4.4: Pneumonia Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	7.5 – 29.4	7.3 – 29.3	6.0 – 32.3
c-statistic	0.64	0.64	0.66

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for Pneumonia

Tables 4.4.5 and 4.4.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.4.5) and for hospitals with 25 or more eligible admissions (Table 4.4.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 53 additional hospitals were included in the measure (4,390 versus 4,337) and 492 additional hospitals met the 25 or more admissions cutoff for public reporting (3,121 versus 2,629). For all hospitals, the mean RSRR was 15.7% for the FFS-only cohort with CC-based risk variables, 15.6% for the FFS+MA cohort with CC-based risk variables, and 15.6% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 15.8%, 15.7%, and 15.6%, respectively.

Table 4.4.5: Pneumonia Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 4,337 hospitals)		FFS+MA cohort with CC-based risk variables (N= 4,390 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 4,390 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	71.2 (86.9)	38 (14, 101)	127.4 (152.1)	69 (21, 188)	127.4 (152.1)	69 (21, 188)
SRR	1.00 (0.05)	1.00 (0.98, 1.02)	1.00 (0.05)	1.00 (0.97, 1.02)	1.00 (0.04)	1.00 (0.98, 1.02)
RSRR (%)	15.7 (0.7)	15.7 (15.3, 16.0)	15.6 (0.8)	15.6 (15.2, 16.0)	15.6 (0.7)	15.6 (15.3, 15.9)

Table 4.4.6: Pneumonia Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 2,629 hospitals)		FFS+MA cohort with CC-based risk variables (N= 3,121 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 3,121 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	110.2 (92.6)	83 (46, 144)	174.4 (157.8)	131 (59, 239)	174.4 (157.8)	131 (59, 239)
SRR	1.00 (0.06)	1.00 (0.97, 1.04)	1.00 (0.06)	1.00 (0.96, 1.04)	1.00 (0.05)	1.00 (0.97, 1.03)
RSRR (%)	15.8 (0.9)	15.7 (15.2, 16.3)	15.7 (1.0)	15.6 (15.0, 16.2)	15.6 (0.8)	15.6 (15.1, 16.1)

Measure Reliability for Pneumonia

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.4.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.356 for the FFS-only cohort with CC-based risk variables, 0.447 for the FFS+MA cohort with CC-based risk variables, and 0.401 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.4.7: Pneumonia Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	2,629	3,121	3,121
Between Hospital Variance	0.022	0.020	0.017
STNR: Median (Q1, Q3)	0.356 (0.234, 0.489)	0.447 (0.267, 0.596)	0.401 (0.232, 0.550)

Change in Hospital Performance for Pneumonia

[Table 4.4.8](#) shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the Pneumonia measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, half (50.0%) of hospitals remained in the same performance quintile, and 88.4% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.81. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (64.9% among hospitals in the lowest quintile of percent MA admissions; 40.1% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, there was not a notable trend in RSRR shifts.

Table 4.4.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the Pneumonia measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 48.3% of hospitals remained in the same performance quintile and 86.3% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.78. Stratified by proportion of MA admissions in a hospital, 61.5% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 38.6% in the highest quintile.

Table 4.4.8: Shifts in RSRR Hospital Performance Quintile Rankings for Pneumonia, Overall and Based on Hospitals’ Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	50.0	88.4	0.81
By Percent of MA Admissions			
Q1: 0.0% – 28.1%	64.9	96.8	0.93
Q2: 28.2% – 38.2%	52.3	91.8	0.88
Q3: 38.2% – 46.9%	48.7	88.8	0.82
Q4: 46.9% – 55.0%	44.1	85.7	0.77
Q5: 55.0% – 86.3%	40.1	78.9	0.67
By MA+FFS Admission Volume			
Q1: 25 – 71 admissions	55.5	94.7	0.85
Q2: 72 – 125 admissions	48.0	89.7	0.78
Q3: 126 – 193 admissions	46.8	86.0	0.77
Q4: 194 – 298 admissions	46.8	86.1	0.79
Q5: 299 – 2414 admissions	53.1	85.5	0.85

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions. Total N=2,629, representing hospitals with 25 or more FFS admissions

Table 4.4.9: Shifts in RSRR Hospital Performance Quintile Rankings for Pneumonia, Overall and Based on Hospitals’ Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	48.3	86.3	0.78
By Percent of MA Admissions			
Q1: 0.0% – 28.1%	61.5	94.5	0.90
Q2: 28.2% – 38.2%	48.9	89.1	0.84
Q3: 38.2% – 46.9%	46.0	87.1	0.80
Q4: 46.9% – 55.0%	46.4	83.7	0.75
Q5: 55.0% – 86.3%	38.6	77.0	0.65
By MA+FFS Admission Volume			
Q1: 25 – 40 admissions	53.0	94.3	0.83
Q2: 41 – 66 admissions	45.9	85.5	0.76
Q3: 67 – 102 admissions	43.9	83.9	0.74
Q4: 103 – 164 admissions	46.2	82.4	0.76
Q5: 165 –1256 admissions	52.3	85.1	0.82

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables.

Total N=2,629, representing hospitals with 25 or more FFS admissions

4.5. Isolated Coronary Artery Bypass Graft (CABG) Surgery Readmission Results

CABG Admission Volume and Observed Readmission Rate

As presented in [Table 4.5.1](#), the FFS+MA cohort included 71,873 unique admissions from January 1 – December 30, 2022 (36,121 FFS and 35,752 MA). The observed (unadjusted) 30-day readmission rate for the FFS+MA cohort for CABG was 10.1%. The observed readmission rate was 9.7% among FFS beneficiaries compared to 10.5% among MA beneficiaries (difference -0.7%).

Table 4.5.1: Number of Admissions and Observed 30-Day Readmission Rate for CABG, FFS versus MA Admissions, CY 2022

CABG	MA + FFS	FFS	MA	Difference FFS - MA
N	71,873	36,121	35,752	NA
Readmission Rate (%)	10.1	9.7	10.5	-0.7

Frequency of CABG Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.5.2](#), and the reselected ICD-10-based variables in [Table 4.5.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -1.7% for CC-based variables with a range from -11.4% to 2.9%. There was less of a difference overall in risk variable prevalence between FFS and MA for ICD-10-based variables with a median difference of -0.3% (range from -13.4% to 2.9%), however, for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.5.3](#) also presents adjusted OR and 95% confidence intervals for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.5.2: Frequency of CC-Based Risk Variables in the CABG Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N= 71,873)	FFS (N= 36,121)	MA (N= 35,752)	FFS - MA
Age, mean (SD)	73.3 (5.2)	73.5 (5.2)	73.1 (5.1)	0.4
Male	74.3	75.7	72.8	2.9
Cardiogenic shock	15.9	12.5	19.4	-6.9
History of prior CABG or valve surgery	7.8	7.7	8.0	-0.3
Chronic obstructive pulmonary disease (CC 111)	22.3	19.4	25.1	-5.7
Cancer (CC 8 – 14)	19.4	19.8	19.0	0.8
Diabetes and DM complications (CC 17 – 19, 122 – 123)	55.7	52.4	59.0	-6.7
Protein-calorie malnutrition (CC 21)	3.2	2.8	3.6	-0.8
Disorders of fluid/electrolyte/acid-base (CC 23 – 24)	29.7	27.7	31.8	-4.2
Obesity/disorders of thyroid, cholesterol, lipids (CC 22, 25 – 26)	97.3	96.8	97.7	-0.9
Severe hematological disorders (CC 46)	0.5	0.4	0.5	0.0
Dementia or senility (CC 51 – 53)	6.4	5.3	7.6	-2.3

Variable (% unless otherwise indicated)	MA + FFS (N= 71,873)	FFS (N= 36,121)	MA (N= 35,752)	FFS - MA
Major psychiatric disorders (CC 57 – 59)	8.3	5.2	11.4	-6.2
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	4.6	3.8	5.5	-1.7
Polyneuropathy (CC 75, 81)	18.5	16.6	20.3	-3.7
Congestive heart failure (CC 85)	43.1	40.0	46.2	-6.2
Arrhythmias (CC 96 – 97)	51.9	51.5	52.2	-0.6
Stroke (CC 99 – 100)	5.2	4.5	5.8	-1.3
Cerebrovascular disease (CC 101 – 102, 105)	41.0	39.4	42.5	-3.1
Vascular or circulatory disease (CC 106 – 109)	49.9	44.2	55.6	-11.4
Fibrosis of lung and other chronic lung disorders (CC 112)	5.4	4.5	6.2	-1.7
Pneumonia (CC 114 – 116)	11.9	10.2	13.6	-3.4
Other lung disorders (CC 118)	40.0	38.1	41.9	-3.8
End-stage renal disease or dialysis (CC 134)	2.3	2.3	2.3	0.0
Renal failure (CC 135 – 140)	37.7	34.7	40.7	-6.0
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	3.6	3.4	3.8	-0.4
History of COVID-19	16.7	16.6	16.7	-0.1

Table 4.5.3: Frequency of ICD-10-Based Risk Variables in the CABG Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the CABG Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N=71,873)	FFS (%) (N=36,121)	MA (%) (N=35,752)	FFS – MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	73.3 (5.2)	73.5 (5.2)	73.1 (5.1)	0.4	1.02 (1.02, 1.03)
ICD-10 codes during the index admission						
E8339	Other disorders of phosphorus metabolism	1.0	0.9	1.0	-0.1	1.46 (1.19, 1.79)
I10	Essential (primary) hypertension	47.0	48.2	45.8	2.4	0.87 (0.82, 0.92)
I161	Hypertensive emergency	1.2	1.0	1.3	-0.3	1.35 (1.12, 1.63)
I2109	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall	0.7	0.8	0.7	0.0	1.45 (1.13, 1.85)
I313	Pericardial effusion (noninflammatory)	0.6	0.6	0.7	-0.1	1.38 (1.06, 1.79)
I319	Disease of pericardium, unspecified	0.6	0.5	0.6	-0.1	1.39 (1.05, 1.85)
J189	Pneumonia, unspecified organism	1.2	1.0	1.3	-0.3	1.33 (1.11, 1.59)
J441	Chronic obstructive pulmonary disease with (acute) exacerbation	0.6	0.5	0.7	-0.2	1.43 (1.11, 1.84)
J449	Chronic obstructive pulmonary disease, unspecified	11.4	10.6	12.1	-1.6	1.13 (1.04, 1.23)
K5900	Constipation, unspecified	2.6	2.6	2.7	-0.1	1.15 (1.00, 1.33)
M1990	Unspecified osteoarthritis, unspecified site	8.2	8.6	7.9	0.6	0.84 (0.76, 0.93)
N170	Acute kidney failure with tubular necrosis	1.1	1.1	1.2	-0.1	1.27 (1.05, 1.53)
N179	Acute kidney failure, unspecified	7.9	7.2	8.6	-1.5	1.17 (1.08, 1.27)
Z6842	Body mass index [BMI] 45.0 – 49.9, adult	0.9	0.8	0.9	0.0	1.33 (1.06, 1.67)
Z7901	Long term (current) use of anticoagulants	9.3	9.7	8.8	0.9	1.36 (1.26, 1.47)
Z7982	Long term (current) use of aspirin	48.1	48.8	47.4	1.4	0.83 (0.78, 0.87)
Z79899	Other long term (current) drug therapy	32.8	33.4	32.1	1.3	0.88 (0.83, 0.94)
Z87891	Personal history of nicotine dependence	33.6	34.6	32.6	2.0	0.92 (0.87, 0.97)
Z9114	Patient's other noncompliance with medication regimen	0.7	0.6	0.8	-0.2	1.51 (1.18, 1.93)
ICD-10 codes in the 12 months prior to admission						
D649	Anemia, unspecified	12.5	10.8	14.2	-3.3	1.21 (1.13, 1.30)

Variable	Description	MA + FFS (%) (N=71,873)	FFS (%) (N=36,121)	MA (%) (N=35,752)	FFS – MA (%)	FFS + MA OR (95% CI)
E1140	Type 2 diabetes mellitus with diabetic neuropathy, unspecified	7.3	5.6	9.0	-3.4	1.21 (1.11, 1.32)
E1169	Type 2 diabetes mellitus with other specified complication	8.5	4.5	12.6	-8.1	1.08 (0.99, 1.18)
E860	Dehydration	3.4	3.2	3.6	-0.4	1.27 (1.13, 1.42)
I081	Rheumatic disorders of both mitral and tricuspid valves	3.5	3.4	3.5	0.0	1.16 (1.02, 1.31)
I160	Hypertensive urgency	3.1	2.4	3.9	-1.4	1.26 (1.12, 1.43)
I739	Peripheral vascular disease, unspecified	14.2	11.1	17.2	-6.1	1.10 (1.03, 1.18)
I959	Hypotension, unspecified	3.7	3.0	4.3	-1.3	1.22 (1.09, 1.36)
J449	Chronic obstructive pulmonary disease, unspecified	13.4	10.7	16.2	-5.5	1.22 (1.13, 1.32)
N289	Disorder of kidney and ureter, unspecified	3.1	2.7	3.6	-0.9	0.91 (0.80, 1.04)
R059	Cough, unspecified	9.2	8.0	10.4	-2.5	1.15 (1.06, 1.24)
R0602	Shortness of breath	37.8	34.3	41.3	-7.1	1.12 (1.06, 1.18)
R109	Unspecified abdominal pain	7.6	6.5	8.7	-2.2	1.24 (1.14, 1.35)
R300	Dysuria	3.0	2.9	3.1	-0.2	0.95 (0.83, 1.09)
Z0000	Encounter for general adult medical examination without abnormal findings	24.8	18.2	31.6	-13.4	0.91 (0.86, 0.97)
Z125	Encounter for screening for malignant neoplasm of prostate	10.7	10.5	10.8	-0.3	0.92 (0.84, 1.01)
ICD-10 codes either during the index admission or 12 months prior to admission						
E1151	Type 2 diabetes mellitus with diabetic peripheral angiopathy without gangrene	12.0	9.5	14.4	-4.9	1.17 (1.09, 1.26)
E1165	Type 2 diabetes mellitus with hyperglycemia	26.6	23.7	29.5	-5.8	1.10 (1.03, 1.16)
E6601	Morbid (severe) obesity due to excess calories	11.2	9.3	13.1	-3.8	1.17 (1.08, 1.28)
E871	Hypo-osmolality and hyponatremia	8.1	7.7	8.5	-0.8	1.21 (1.11, 1.31)

Variable	Description	MA + FFS (%) (N=71,873)	FFS (%) (N=36,121)	MA (%) (N=35,752)	FFS – MA (%)	FFS + MA OR (95% CI)
I130	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease	12.3	10.9	13.7	-2.8	1.31 (1.21, 1.40)
I25118	Atherosclerotic heart disease of native coronary artery with other forms of angina pectoris	31.9	31.9	31.9	0.0	0.89 (0.84, 0.94)
Z6841	Body mass index [BMI] 40.0 – 44.9, adult	4.8	4.1	5.4	-1.2	1.26 (1.12, 1.42)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	7.2	6.4	8.0	-1.6	1.19 (1.09, 1.29)
MALE	Male	74.3	75.7	72.8	2.9	0.78 (0.74, 0.83)
HX_SHOCK	Cardiogenic Shock	7.8	7.7	8.0	-0.3	1.22 (1.12, 1.32)
HX_COVID	History of COVID-19	16.7	16.6	16.7	-0.1	0.98 (0.91, 1.05)
MA	MA (versus FFS)	49.7	NA	NA	NA	0.97 (0.92, 1.02)

CABG Model Performance

Table 4.5.4 presents model performance for the CABG measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables had a slightly higher c-statistic compared to the original CC-based model and slightly wider predictive ability. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.5.4: CABG Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	4.5 – 19.4	4.6 – 20.9	4.9 – 22.1
c-statistic	0.62	0.63	0.65

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for CABG

Tables 4.5.5 and 4.5.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.5.5) and for hospitals with 25 or more eligible admissions (Table 4.5.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 34 additional hospitals were included in the measure (1,070 versus 1,036) and 302 additional hospitals met the 25 or more admissions cutoff for public reporting (851 versus 549). For all hospitals, the mean RSRR was 9.8% for the FFS-only cohort with CC-based risk variables, 10.1% for the FFS+MA cohort with CC-based risk variables, and 10.1% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 9.8%, 10.1%, and 10.1%, respectively.

Table 4.5.5: CABG Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 1,036 hospitals)		FFS+MA cohort with CC-based risk variables (N= 1,070 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 1,070 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	34.9 (32.2)	26 (14, 45)	67.2 (57.7)	52 (28, 90)	67.2 (57.7)	52 (28, 90)
SRR	1.00 (0.08)	0.99 (0.95, 1.04)	1.00 (0.10)	0.99 (0.94, 1.06)	1.00 (0.10)	1.00 (0.94, 1.05)
RSRR (%)	9.8 (0.8)	9.7 (9.3, 10.2)	10.1 (1.0)	10.0 (9.5, 10.7)	10.1 (1.0)	10.1 (9.5, 10.6)

Table 4.5.6: CABG Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 549 hospitals)		FFS+MA cohort with CC-based risk variables (N= 851 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 851 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	54.6 (32.9)	43 (33, 64)	81.5 (56.3)	65 (42, 103)	81.5 (56.3)	65 (42, 103)
SRR	1.00 (0.10)	0.99 (0.93, 1.06)	1.00 (0.11)	0.99 (0.93, 1.06)	1.00 (0.10)	0.99 (0.93, 1.06)
RSRR (%)	9.8 (1.0)	9.6 (9.1, 10.3)	10.1 (1.1)	10.0 (9.4, 10.7)	10.1 (1.1)	10.0 (9.4, 10.7)

Measure Reliability for CABG

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.5.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.446 for the FFS-only cohort with CC-based risk variables, 0.524 for the FFS+MA cohort with CC-based risk variables, and 0.519 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.5.7: CABG Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	549	851	851
Between Hospital Variance	0.062	0.056	0.055
STNR: Median (Q1, Q3)	0.446 (0.382, 0.545)	0.524 (0.416, 0.636)	0.519 (0.411, 0.631)

Change in Hospital Performance for CABG

[Table 4.5.8](#) shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the CABG measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, about half (47.0%) of hospitals remained in the same performance quintile, and 86.7% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.81. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (58.7% among hospitals in the lowest quintile of percent MA admissions; 45.5% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, there was not a notable trend in RSRR shifts.

Table 4.5.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the CABG measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 47.0% of hospitals remained in the same performance quintile and 86.0% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.81. Stratified by proportion of MA admissions in a hospital, 59.6% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 48.2% in the highest quintile.

Table 4.5.8: Shifts in RSRR Hospital Performance Quintile Rankings for CABG, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	47.0	86.7	0.81
By Percent of MA Admissions			
Q1: 0.0% – 32.6%	58.7	95.4	0.93
Q2: 32.7% – 41.1%	46.4	90.0	0.82
Q3: 41.3% – 49.5%	43.6	83.6	0.77
Q4: 49.5 – 56.9%	40.9	81.8	0.81
Q5: 57.0% – 84.5%	45.5	82.7	0.74
By MA+FFS Admission Volume			
Q1: 27 – 59 admissions	50.0	94.5	0.82
Q2: 60 – 77 admissions	50.0	88.9	0.79
Q3: 78 – 100 admissions	38.1	79.6	0.75
Q4: 101 – 134 admissions	46.8	83.5	0.82
Q5: 136 – 491 admissions	50.5	87.2	0.85

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions. Total N=549, representing hospitals with 25 or more FFS admissions

Table 4.5.9: Shifts in RSRR Hospital Performance Quintile Rankings for CABG, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	47.0	86.0	0.81
By Percent of MA Admissions			
Q1: 0.0% – 32.6%	59.6	95.4	0.92
Q2: 32.7% – 41.1%	45.5	88.2	0.82
Q3: 41.3% – 49.5%	41.8	85.5	0.76
Q4: 49.5% – 56.9%	40.0	80.9	0.80
Q5: 57.0% – 84.5%	48.2	80.0	0.75
By MA+FFS Admission Volume			
Q1: 27 – 59 admissions	51.8	95.5	0.82
Q2: 60 – 77 admissions	43.5	89.8	0.78
Q3: 78 – 100 admissions	40.7	78.8	0.75
Q4: 101 – 134 admissions	45.0	81.7	0.83
Q5: 136 – 491 admissions	54.1	84.4	0.85

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables.

Total N=549, representing hospitals with 25 or more FFS admissions

4.6. Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) Readmission Results

THA/TKA Admission Volume and Observed Readmission Rate

As presented in [Table 4.6.1](#), the FFS+MA cohort included 170,841 unique admissions from January 1 – December 30, 2022 (106,894 FFS and 63,947 MA). The observed (unadjusted) readmission rate for the FFS+MA cohort for THA/TKA was 4.7%. The observed readmission rate was 4.5% among FFS beneficiaries compared to 5.0% among MA beneficiaries (difference -0.5%).

Table 4.6.1: Number of Admissions and Observed Readmission Rate for THA/TKA, FFS versus MA Admissions, CY 2022

THA/TKA	MA + FFS	FFS	MA	Difference FFS – MA
N	170,841	106,894	63,947	NA
Readmission Rate (%)	4.7	4.5	5.0	-0.5

Frequency of THA/TKA Risk Variables

We examined the frequencies of variables used for risk adjustment in FFS and MA admissions. The variables from the original CC-based risk model are presented in [Table 4.6.2](#), and the reselected ICD-10-based variables in [Table 4.6.3](#). Frequencies of model variables were generally higher in MA than FFS admissions for both the CC- and ICD-10-based variables. The median difference in risk variable prevalence between FFS and MA (%FFS – %MA) was -1.6% for CC-based variables with a range from -12.2% to 1.8%. There was less of a difference overall in risk variable prevalence between FFS and MA for ICD-10-based variables with a median difference of -0.8% (range from -7.8% to 1.5%), however, for ICD-10 codes in the 12 months prior to admission (pre-index codes), the differences were more pronounced. [Table 4.6.3](#) also presents adjusted OR and 95% confidence intervals for the hierarchical logistic regression model using FFS+MA admissions.

Table 4.6.2: Frequency of CC-Based Risk Variables in the THA/TKA Cohort, FFS versus MA Admissions, CY 2022

Variable (% unless otherwise indicated)	MA + FFS (N= 170,841)	FFS (N= 106,894)	MA (N= 63,947)	FFS - MA
Age, mean (SD)	75.1 (6.3)	75.3 (6.3)	74.9 (6.3)	0.4
Male	34.0	34.7	32.9	1.8
Elective THA procedure	43.7	20.4	45.3	-2.6
Number of procedures (two vs. one)	1.8	29.4	1.9	-0.1
Morbid (severe) obesity (CC 22)	14.6	1.9	18.7	-6.6
Severe infection; other infectious diseases (CC 1, 3 – 7)	20.8	21.4	21.9	-1.8
Metastatic cancer or acute leukemia (CC 8)	1.4	20.4	1.4	0.0
Cancer (CC 9 – 14)	20.2	20.4	20.0	0.4
Diabetes mellitus (DM) or DM complications (CC 17 – 19, 122 – 123)	32.4	29.4	37.5	-8.1
Protein-calorie malnutrition (CC 21)	2.2	1.9	2.8	-0.8

Variable (% unless otherwise indicated)	MA + FFS (N= 170,841)	FFS (N= 106,894)	MA (N= 63,947)	FFS - MA
Other significant endocrine and metabolic disorders; disorders of fluid/electrolyte/acid-base balance (CC 23 – 24)	22.5	21.4	24.3	-2.9
Rheumatoid arthritis and inflammatory connective tissue disease (CC 40)	12.9	11.8	14.7	-2.9
Severe hematological disorders (CC 46)	0.6	0.5	0.7	-0.2
Dementia or other specified brain disorders (CC 51 – 53)	8.7	7.6	10.5	-2.9
Major psychiatric disorders (CC 57 – 59)	13.0	9.4	19.1	-9.7
Hemiplegia, paraplegia, paralysis, functional disability (CC 70 – 74, 103 – 104, 189 – 190)	3.2	2.7	4.1	-1.4
Polyneuropathy; other neuropathies (CC 75, 81)	23.9	22.6	26.0	-3.4
Congestive heart failure (CC 85)	17.3	15.3	20.5	-5.2
Coronary atherosclerosis or angina (CC 88 – 89)	28.3	27.9	29.0	-1.1
Hypertension and hypertensive disease (CC 95)	80.7	78.9	83.6	-4.7
Specified arrhythmias and other heart rhythm disorders (CC 96 – 97)	33.5	33.6	33.3	0.3
Stroke (CC 99 – 100)	3.3	3.0	3.7	-0.7
Vascular or circulatory disease (CC 106 – 109)	34.8	30.2	42.4	-12.2
Chronic obstructive pulmonary disease (COPD) (CC 111)	15.1	13.1	18.6	-5.5
Pneumonia (CC 114 – 116)	4.9	4.6	5.5	-0.9
Dialysis status (CC 134)	0.5	0.4	0.5	-0.1
Renal failure (CC 135 – 140)	25.1	22.4	29.7	-7.3
Decubitus ulcer or chronic skin ulcer (CC 157 – 161)	3.5	3.4	3.7	-0.3
Cellulitis, local skin infection (CC 164)	7.3	7.3	7.5	-0.2
Other injuries (CC 174)	31.7	29.9	34.7	-4.8
Major symptoms, abnormalities (CC 178)	76.0	73.2	80.7	-7.5
Skeletal deformities (ICD-9 code 755.63, ICD-10 code Q65.89, Q65.9 – CC 204)	3.4	1.1	7.2	-6.1
Post traumatic osteoarthritis (ICD-9 codes 716.15, 716.16, ICD-10 code M12.551, M12.552, M12.559 – CC 205)	1.8	1.7	1.9	-0.2
History of COVID-19	13.7	14.1	12.9	1.2

Table 4.6.3: Frequency of ICD-10-Based Risk Variables in the THA/TKA Cohort, FFS versus MA Admissions, and Adjusted OR and 95% Confidence Intervals for the THA/TKA Hierarchical Logistic Regression Model Using FFS+MA Admissions, CY 2022

Variable	Description	MA + FFS (%) (N=170,841)	FFS (%) (N=106,894)	MA (%) (N=63,947)	FFS - MA (%)	FFS + MA OR (95% CI)
AGE	Age, mean (SD)	75.1 (6.3)	75.3 (6.3)	74.9 (6.3)	0.4	1.03 (1.03, 1.04)
ICD-10 codes during the index admission						
E7800	Pure hypercholesterolemia, unspecified	13.4	14.0	12.5	1.5	0.90 (0.83, 0.96)
F0390	Unspecified dementia without behavioral disturbance	1.7	1.6	1.8	-0.2	1.35 (1.18, 1.54)
F17210	Nicotine dependence, cigarettes, uncomplicated	3.3	2.7	4.2	-1.4	1.15 (1.01, 1.31)
F319	Bipolar disorder, unspecified	0.9	0.8	1.0	-0.2	1.58 (1.30, 1.92)
G20	Parkinson's disease	1.3	1.4	1.2	0.2	1.44 (1.23, 1.69)
G40909	Epilepsy, unspecified, not intractable, without status epilepticus	1.0	0.9	1.1	-0.1	1.33 (1.10, 1.60)
H3530	Unspecified macular degeneration	0.7	0.8	0.6	0.2	1.23 (0.99, 1.54)
I110	Hypertensive heart disease with heart failure	4.2	4.0	4.4	-0.3	1.30 (1.18, 1.44)
I509	Heart failure, unspecified	2.1	2.1	2.2	-0.1	0.98 (0.85, 1.12)
M25761	Osteophyte, right knee	1.8	1.9	1.5	0.4	0.71 (0.56, 0.89)
N179	Acute kidney failure, unspecified	2.5	2.2	3.0	-0.8	1.83 (1.65, 2.02)
R338	Other retention of urine	0.8	0.8	0.8	0.0	1.26 (1.03, 1.54)
R339	Retention of urine, unspecified	0.8	0.8	0.8	0.0	1.46 (1.21, 1.78)
Z6842	Body mass index [BMI] 45.0 – 49.9, adult	1.3	1.2	1.4	-0.1	1.39 (1.16, 1.66)
Z955	Presence of coronary angioplasty implant and graft	5.5	5.7	5.1	0.6	1.19 (1.09, 1.30)
Z9981	Dependence on supplemental oxygen	0.8	0.8	0.9	-0.1	1.26 (1.05, 1.51)
ICD-10 codes in the 12 months prior to admission						
D649	Anemia, unspecified	13.6	12.7	15.2	-2.5	1.22 (1.15, 1.29)
E875	Hyperkalemia	2.6	2.4	3.0	-0.6	1.47 (1.32, 1.64)
F17210	Nicotine dependence, cigarettes, uncomplicated	3.6	2.9	4.7	-1.8	1.18 (1.04, 1.33)
F331	Major depressive disorder, recurrent, moderate	3.2	2.4	4.4	-2.0	1.19 (1.06, 1.33)
H2513	Age-related nuclear cataract, bilateral	10.2	9.6	11.2	-1.6	0.88 (0.80, 0.95)

Variable	Description	MA + FFS (%) (N=170,841)	FFS (%) (N=106,894)	MA (%) (N=63,947)	FFS - MA (%)	FFS + MA OR (95% CI)
H5203	Hypermetropia, bilateral	2.9	1.8	4.6	-2.8	0.84 (0.72, 0.98)
I10	Essential (primary) hypertension	74.6	71.7	79.5	-7.8	1.18 (1.11, 1.25)
M25552	Pain in left hip	18.5	17.4	20.3	-2.8	0.95 (0.89, 1.01)
M542	Cervicalgia	7.4	6.6	8.8	-2.2	1.02 (0.94, 1.11)
M545	Low back pain	8.5	7.7	9.8	-2.1	0.95 (0.88, 1.03)
M549	Dorsalgia, unspecified	5.1	4.5	6.0	-1.5	1.24 (1.14, 1.36)
M79605	Pain in left leg	4.9	4.3	5.8	-1.5	1.16 (1.06, 1.27)
N390	Urinary tract infection, site not specified	11.6	11.2	12.2	-1.0	1.13 (1.06, 1.21)
R000	Tachycardia, unspecified	3.3	3.0	3.9	-0.9	1.23 (1.11, 1.36)
R001	Bradycardia, unspecified	6.4	6.2	6.8	-0.6	0.97 (0.89, 1.05)
S0990XA	Unspecified injury of head, initial encounter	5.0	4.6	5.6	-1.1	1.28 (1.18, 1.39)
Z1231	Encounter for screening mammogram for malignant neoplasm of breast	29.9	30.2	29.4	0.8	0.79 (0.75, 0.83)
Z885	Allergy status to narcotic agent	4.1	4.3	3.6	0.7	1.23 (1.12, 1.36)
ICD-10 codes either during the index admission or 12 months prior to admission						
D696	Thrombocytopenia, unspecified	3.4	3.1	4.0	-0.9	1.25 (1.13, 1.39)
E6601	Morbid (severe) obesity due to excess calories	13.1	10.7	17.0	-6.2	1.21 (1.13, 1.30)
E871	Hypo-osmolality and hyponatremia	7.5	7.4	7.6	-0.2	1.28 (1.19, 1.38)
G2581	Restless legs syndrome	3.9	3.9	3.9	0.0	1.19 (1.07, 1.31)
I480	Paroxysmal atrial fibrillation	11.5	11.8	11.1	0.6	1.32 (1.24, 1.40)
I739	Peripheral vascular disease, unspecified	8.5	6.4	12.0	-5.5	1.25 (1.16, 1.34)
J449	Chronic obstructive pulmonary disease, unspecified	13.1	11.3	16.1	-4.8	1.37 (1.29, 1.46)
M069	Rheumatoid arthritis, unspecified	5.0	4.6	5.6	-1.0	1.24 (1.13, 1.36)
Z20822	Contact with and (suspected) exposure to COVID-19	56.9	56.1	58.1	-2.0	1.12 (1.06, 1.18)
Other risk variables						
MCCFI	Multiple Chronic Conditions Frailty Index	56.9	21.2	24.7	-3.5	1.16 (1.10, 1.22)
PROC_THA	Elective THA procedure	43.7	42.7	45.3	-2.6	1.15 (1.09, 1.21)

Variable	Description	MA + FFS (%) (N=170,841)	FFS (%) (N=106,894)	MA (%) (N=63,947)	FFS - MA (%)	FFS + MA OR (95% CI)
HX_COVID	History of COVID-19	13.7	14.1	12.9	1.2	1.00 (0.94, 1.07)
MA	MA (versus FFS)	37.4	NA	NA	NA	1.00 (0.95, 1.04)

THA/TKA Model Performance

Table 4.6.4 presents model performance for the THA/TKA measure across three scenarios: the FFS-only cohort with CC-based risk variables, the FFS+MA cohort with CC-based risk variables, and the FFS+MA cohort with ICD-10-based risk variables. Predictive ability and c-statistics were similar between the FFS-only and FFS+MA cohorts using the original CC-based variables. For the MA+FFS cohort, the model using reselected ICD-10-based risk variables also had a similar c-statistic and predictive ability compared to the original CC-based model. Calibration performance was generally acceptable across all modeling approaches in the overall cohort and in subgroups, including male versus female, MA versus FFS, and quartiles of hospital volume (figures not shown).

Table 4.6.4: THA/TKA Readmission: Predictive Ability and C-Statistics Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Predictive Ability, % (lowest decile – highest decile)	1.4 – 11.2	1.3 – 11.9	1.5 – 11.7
c-statistic	0.68	0.68	0.67

Note: These statistics were calculated using the patient-level logistic model.

Risk-Standardized Readmission Rates for THA/TKA

Tables 4.6.5 and 4.6.6 present distribution of hospital volume, SRR, and RSRR for all hospitals (Table 4.6.5) and for hospitals with 25 or more eligible admissions (Table 4.6.6). Numbers of hospitals and admissions were higher in the combined FFS+MA data compared to the FFS-only data. With the addition of MA data, 149 additional hospitals were included in the measure (3,116 versus 2,967) and 461 additional hospitals met the 25 or more admissions cutoff for public reporting (1,483 versus 1,022). For all hospitals, the mean RSRR was 4.5% for the FFS-only cohort with CC-based risk variables, 4.7% for the FFS+MA cohort with CC-based risk variables, and 4.7% for the FFS+MA cohort with reselected ICD-10-based risk variables. Among hospitals with 25 or more admissions, mean RSRRs were 4.5%, 4.7%, and 4.7%, respectively.

Table 4.6.5: THA/TKA Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for All Hospitals

Value	FFS-Only cohort with CC-based risk variables (N= 2,967 hospitals)		FFS+MA cohort with CC-based risk variables (N= 3,116 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 3,116 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	36.0 (89.4)	14 (5, 36)	54.8 (113.4)	23 (8, 58)	54.8 (113.4)	23 (8, 58)
SRR	1.00 (0.10)	0.99 (0.95, 1.05)	1.00 (0.09)	0.99 (0.96, 1.05)	1.00 (0.09)	0.99 (0.96, 1.04)
RSRR (%)	4.5 (0.5)	4.5 (4.3, 4.8)	4.7 (0.4)	4.7 (4.5, 4.9)	4.7 (0.4)	4.7 (4.5, 4.9)

Table 4.6.6: THA/TKA Readmission: Hospital Volume, Standardized Readmission Ratio (SRR), and Risk-Standardized Readmission Rate (RSRR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-Only cohort with CC-based risk variables (N= 1,022 hospitals)		FFS+MA cohort with CC-based risk variables (N= 1,483 hospitals)		FFS+MA cohort with ICD-10-based risk variables (N= 1,483 hospitals)	
	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)	Mean (SD)	Median (25% Q1, 75% Q3)
Hospital Volume	88.4 (137.7)	54 (34, 93)	104.5 (149.2)	61 (39, 113)	104.5 (149.2)	61 (39, 113)
SRR	1.00 (0.15)	0.98 (0.90, 1.07)	1.00 (0.12)	0.99 (0.92, 1.06)	1.00 (0.12)	0.99 (0.93, 1.06)
RSRR (%)	4.5 (0.7)	4.4 (4.1, 4.8)	4.7 (0.6)	4.6 (4.4, 5.0)	4.7 (0.5)	4.7 (4.4, 5.0)

Measure Reliability for THA/TKA

Between hospital variance and STNR for the measure score comparing the addition of MA admissions to the FFS-only cohort and reselected ICD-10-based variables to the CC-based variables in the FFS+MA cohort are noted in [Table 4.6.7](#). Median STNR, calculated based on between hospital variance and hospital volume, was 0.637 for the FFS-only cohort with CC-based risk variables, 0.580 for the FFS+MA cohort with CC-based risk variables, and 0.570 for the FFS+MA cohort with reselected ICD-10-based risk variables.

Table 4.6.7: THA/TKA Readmission: Between Hospital Variance and Signal-to-Noise Reliability (STNR) Comparing FFS-only and FFS+MA Cohorts with CC-Based and ICD-10-Based Risk Variables, CY 2022, for Hospitals with 25 or More Admissions

Value	FFS-only cohort with CC-based risk variables	FFS+MA cohort with CC-based risk variables	FFS+MA cohort with ICD-10-based risk variables
Number of Hospitals	1,022	1,483	1,483
Between Hospital Variance	0.107	0.075	0.072
STNR: Median (Q1, Q3)	0.637 (0.524, 0.751)	0.580 (0.469, 0.719)	0.570 (0.459, 0.711)

Change in Hospital Performance for THA/TKA

[Table 4.6.8](#) shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the THA/TKA measure in the combined FFS+MA cohort as compared to the FFS-only cohort in hospitals for the model with the original CC-based variables. After adding MA admissions to the FFS-only cohort, about half (52.3%) of hospitals remained in the same performance quintile, and 89.8% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.83. As hospitals' proportion of MA admissions increased, fewer hospitals remained in the same performance quintile (73.0% among hospitals in the lowest quintile of percent MA admissions; 36.8% of hospitals in the highest quintile of percent of MA admissions). As hospital volume increased, the trend in RSRR shifts was less pronounced.

Table 4.6.9 shows the quintile shifts in RSRR across hospitals with at least 25 FFS admissions for the THA/TKA measure after both measure updates, comparing the combined FFS+MA cohort using the reselected ICD-10-based risk variables to the FFS-only cohort using the CC-based variables. With the addition of the MA admissions and the ICD-10-based risk variables, 52.5% of hospitals remained in the same performance quintile and 89.1% remained within +/- 1 quintile. Correlation between hospital RSRRs was 0.82. Stratified by proportion of MA admissions in a hospital, 73.0% of hospitals in the lowest quintile of percent MA admissions remained in the same performance quintile versus 39.2% in the highest quintile.

Table 4.6.8: Shifts in RSRR Hospital Performance Quintile Rankings for THA/TKA, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-Only Cohort to the FFS+MA Cohort, CC-Based Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	52.3	89.8	0.83
By Percent of MA Admissions			
Q1: 0.0% – 15.6%	73.0	99.0	0.96
Q2: 15.8% – 26.2%	56.4	93.6	0.93
Q3: 26.3% – 35.4%	45.4	90.7	0.82
Q4: 35.5% – 46.6%	49.8	87.3	0.79
Q5: 46.7% – 88.7%	36.8	78.4	0.61
By MA+FFS Admission Volume			
Q1: 27 – 49 admissions	58.5	96.1	0.85
Q2: 50 – 69 admissions	50.2	91.5	0.83
Q3: 70 – 100 admissions	49.8	88.6	0.79
Q4: 101 – 174 admissions	49.3	86.6	0.84
Q5: 175 – 3,662 admissions	53.4	86.3	0.81

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions. Total N=1,022, representing hospitals with 25 or more FFS admissions

Table 4.6.9: Shifts in RSRR Hospital Performance Quintile Rankings for THA/TKA, Overall and Based on Hospitals' Percentages of MA Admissions and Total Admission Volume, Comparing FFS-only Cohort with CC-Based Variables to the FFS+MA Cohort with Reselected ICD-10-Based Risk Variables, CY 2022

Description	Same quintile (%)	±1 quintile (%)	Correlation
Overall	52.5	89.1	0.82
By Percent of MA Admissions			
Q1: 0.0% – 15.6%	73.0	99.0	0.95
Q2: 15.8% – 26.2%	57.4	94.1	0.92
Q3: 26.3% – 35.4%	45.4	89.8	0.81
Q4: 35.5% – 46.6%	47.8	85.4	0.79
Q5: 46.7% – 88.7%	39.2	77.5	0.60
By MA+FFS Admission Volume			
Q1: 27 – 49 admissions	56.1	96.1	0.84
Q2: 50 – 69 admissions	53.2	92.0	0.83
Q3: 70 – 100 admissions	48.3	88.2	0.77
Q4: 101 – 174 admissions	49.8	87.1	0.83
Q5: 175 – 3,662 admissions	55.4	82.4	0.81

Note: Quintile percentages represent the percent of hospitals that stayed in their same (1st column) or within one (2nd column) performance quintile ranking after the addition of MA admissions and with reselected ICD-10-based risk variables.

Total N=1,022, representing hospitals with 25 or more FFS admissions

5. REFERENCES

1. Centers for Medicare & Medicaid Services. Encounter Data Submission and Processing Guide 2022. Accessed January 31, 2024. [https://www.csscooperations.com/internet/csscw3_files.nsf/F2/2022ED_Submission_Processing_Guide_20221130.pdf/\\$FILE/2022ED_Submission_Processing_Guide_20221130.pdf](https://www.csscooperations.com/internet/csscw3_files.nsf/F2/2022ED_Submission_Processing_Guide_20221130.pdf/$FILE/2022ED_Submission_Processing_Guide_20221130.pdf)
2. Krumholz HM, Coppi AC, Warner F, et al. Comparative effectiveness of new approaches to improve mortality risk models from Medicare claims data. *JAMA Network Open*. 2019;2(7):e197314-e197314.
3. Ochieng N, Freed M, Biniek JF, Damico A, Neuman T. Medicare Advantage in 2023: Enrollment Update and Key Trends. Accessed January 31, 2024. <https://www.kff.org/medicare/issue-brief/medicare-advantage-in-2023-enrollment-update-and-key-trends/>
4. Congressional Budget Office. Congressional Budget Office Baseline Projections May 2022. Accessed January 31, 2024. <https://www.cbo.gov/system/files/2022-05/51302-2022-05-medicare.pdf>
5. Ochieng N, Biniek JF. Beneficiary Experience, Affordability, Utilization, and Quality in Medicare Advantage and Traditional Medicare: A Review of the Literature. KFF. Accessed January 31, 2024. <https://www.kff.org/medicare/report/beneficiary-experience-affordability-utilization-and-quality-in-medicare-advantage-and-traditional-medicare-a-review-of-the-literature/>
6. Medicare Payment Advisory Commission. March 2022 report to the Congress: Medicare Payment Policy: The Medicare Advantage program: Status Report and mandated report on dual-eligible special needs plans. Accessed January 31, 2024. https://www.medpac.gov/wp-content/uploads/2022/03/Mar22_MedPAC_ReportToCongress_Ch12_SEC.pdf
7. Pope GC, Ellis RP, Ash AS, et al. Diagnostic cost group hierarchical condition category models for Medicare risk adjustment. Final Report to the Health Care Financing Administration under Contract Number 500-95-048. 2000. Accessed January 31, 2024. http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf
8. Pope GC, Kautter J, Ingber MJ, Freeman S, Sekar R, Newhart C. Evaluation of the CMS-HCC Risk Adjustment Model: Final Report. 2011. Accessed January 31, 2024. https://www.cms.gov/Medicare/Health-Plans/MedicareAdvtgSpecRateStats/downloads/evaluation_risk_adj_model_2011.pdf
9. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). *Methodology Report, Measure Testing Report, and Risk-Adjustment Report: Clinician and Clinician Group Risk-standardized Hospital Admission Rates for Patients with Multiple Chronic Conditions*. 2019. Centers for Medicare & Medicaid Services: Measure Instrument Development and Support; Development, Reevaluation, and Implementation of Outpatient Outcome/Efficiency Measures; Contract Number HHSM-75FCMC18D0042, Task Order HHSM-75FCMC19F0002.
10. Gaudino M, Chadow D, Rahouma M, et al. Operative outcomes of women undergoing coronary artery bypass surgery in the US, 2011 to 2020. *JAMA surgery*. 2023;158(5):494-502.