Coronary Artery Bypass (CABG) Excess Days in Acute Care (EDAC) Measure Submission to PQM: supplemental Attachment

Table of Contents

Figures

Figure 1. Planned Readmission Algorithm Version 4.0 2024 Flowchart

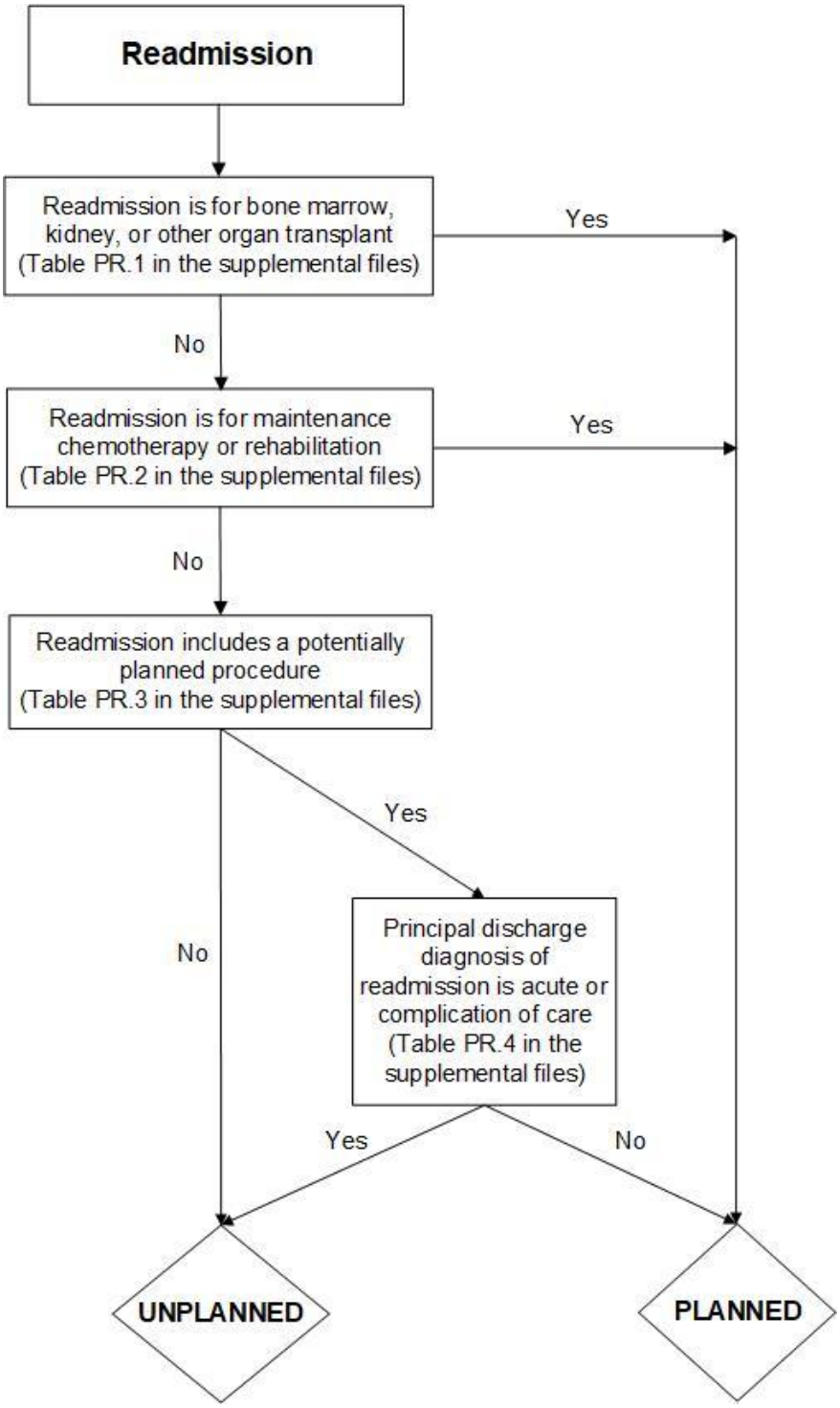
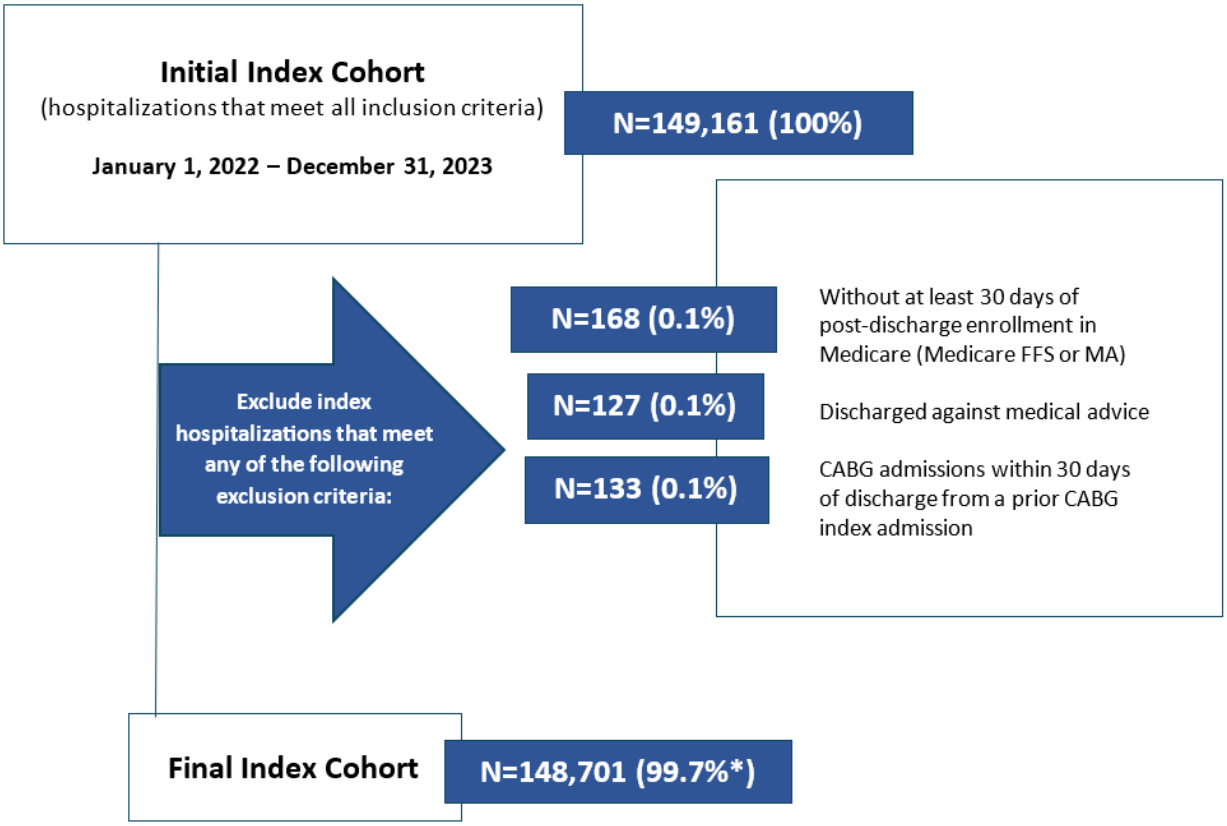


Figure 2. CABG EDAC: Index Cohort (January 1, 2022 – December 31, 2023)



** Admissions may have been counted in more than one exclusion category because they are not mutually exclusive.*

Figure 3. CABG EDAC: Histogram Displaying Hospital Distribution of Risk-Adjusted Measure Scores per 100 Discharges, January 1, 2022 - December 31, 2023 (N = 1,114)

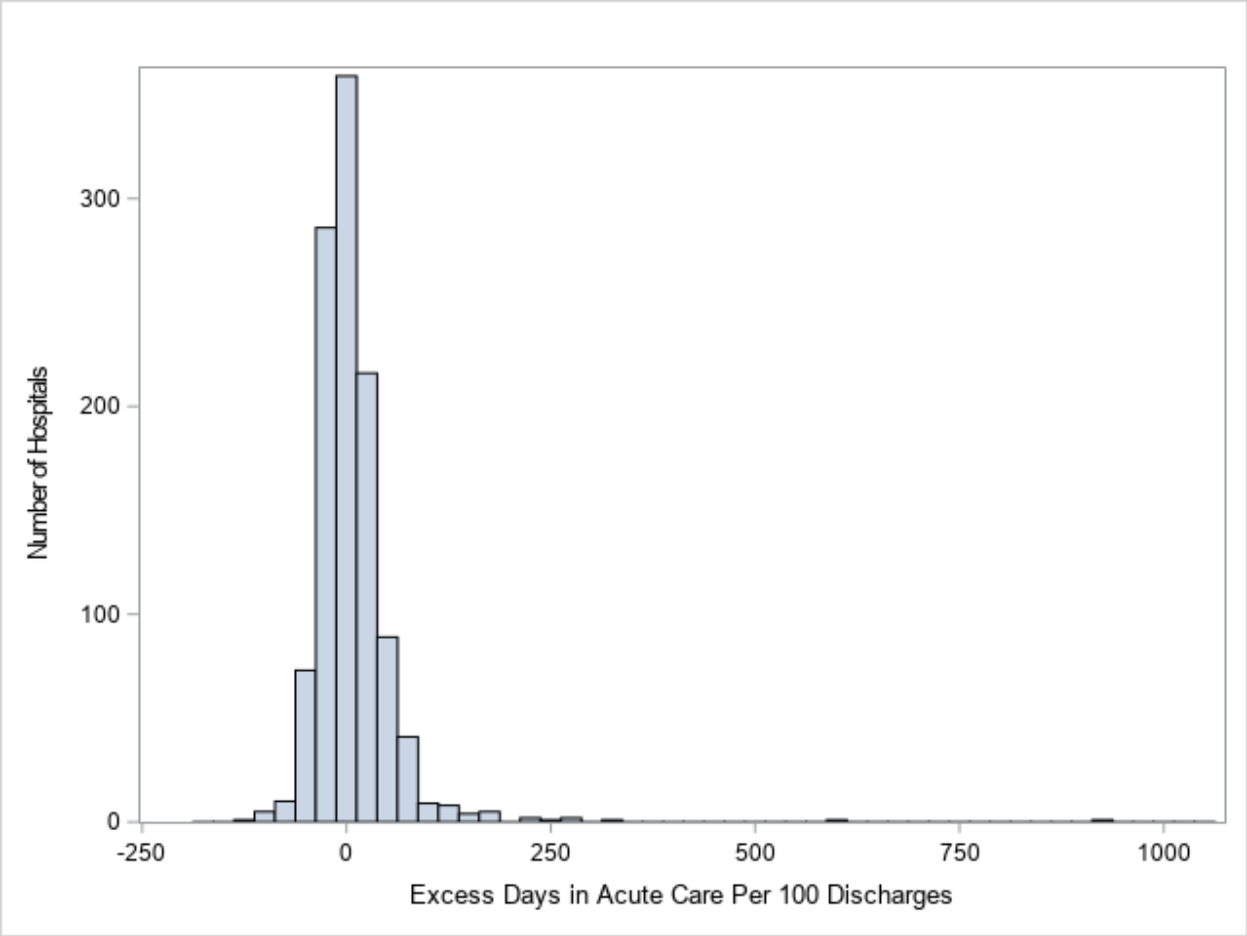


Figure 4. Signal-To-Noise Formula

$$\frac{\sigma^2_{facility-to-facility}}{\sigma^2_{facility-to-facility}+\frac{\sigma^2_{facility-error}}{n}}.$$

Figure 5. CABG EDAC: Daily Percentage of Index Admissions with an Acute Care Hospital Visit, by Post-Discharge Day (CY2022/2023 Data)

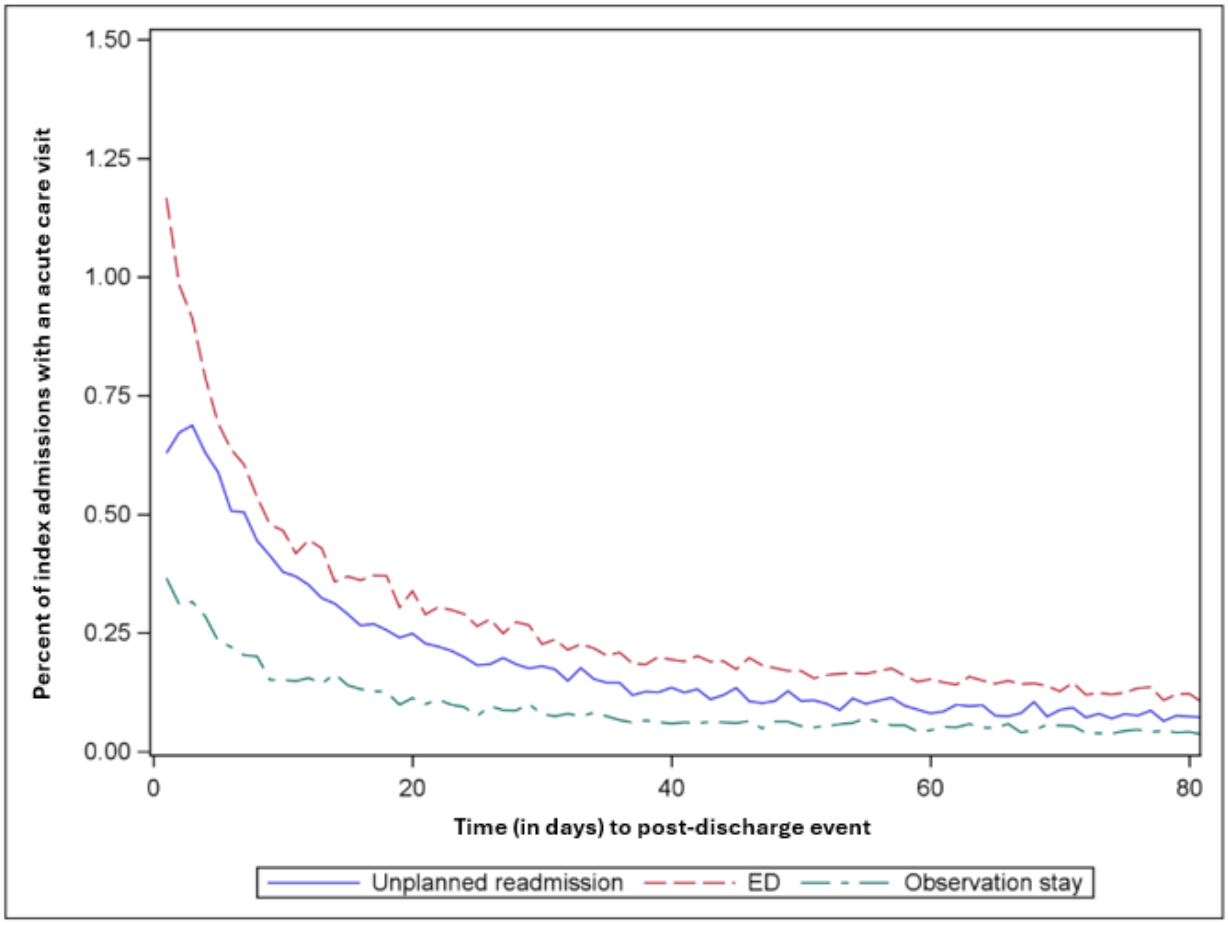
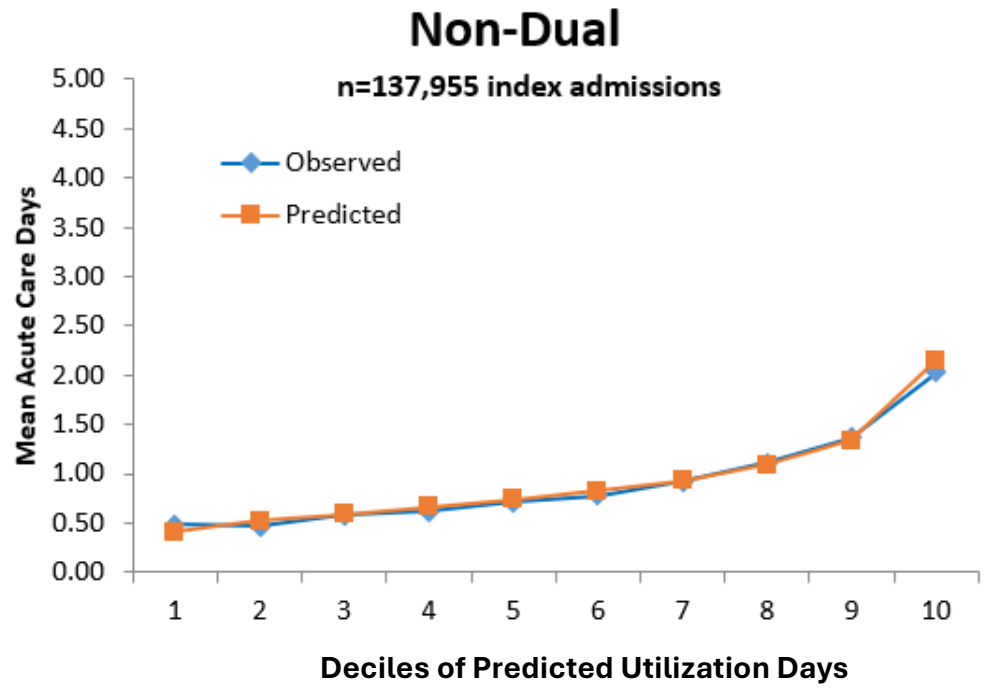


Figure 6. CABG EDAC: Calibration Plots for Non-Dual Eligible and Dual Eligible Patients at the Index Admission in CABG EDAC Cohort (January 1, 2022 – December 31, 2023)



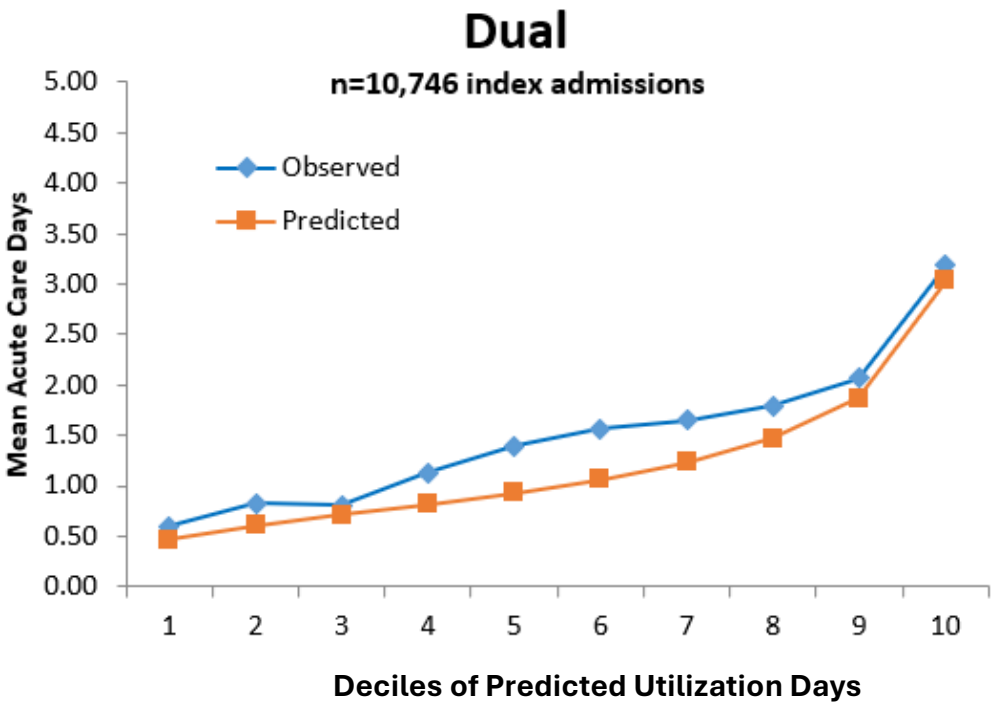


Figure 7. CABG EDAC: Measure Scores Calculated with and Without Dual Eligibility

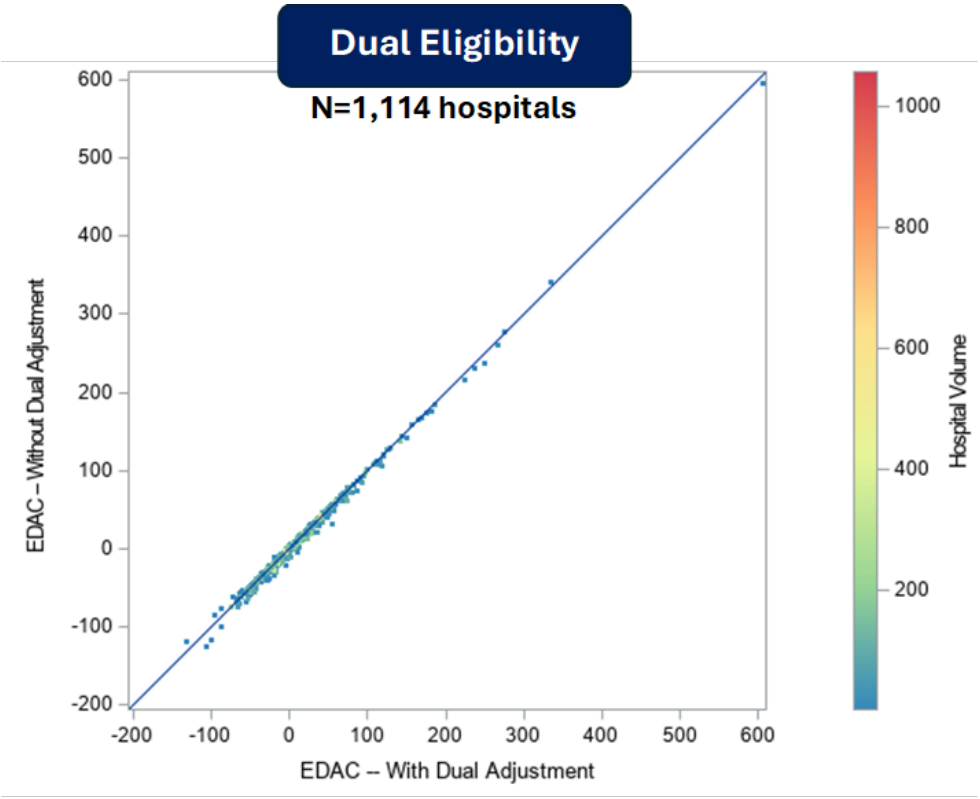


Figure 8. CABG EDAC: Measure Scores by Hospital-Proportion of Patients with Dual Eligibility

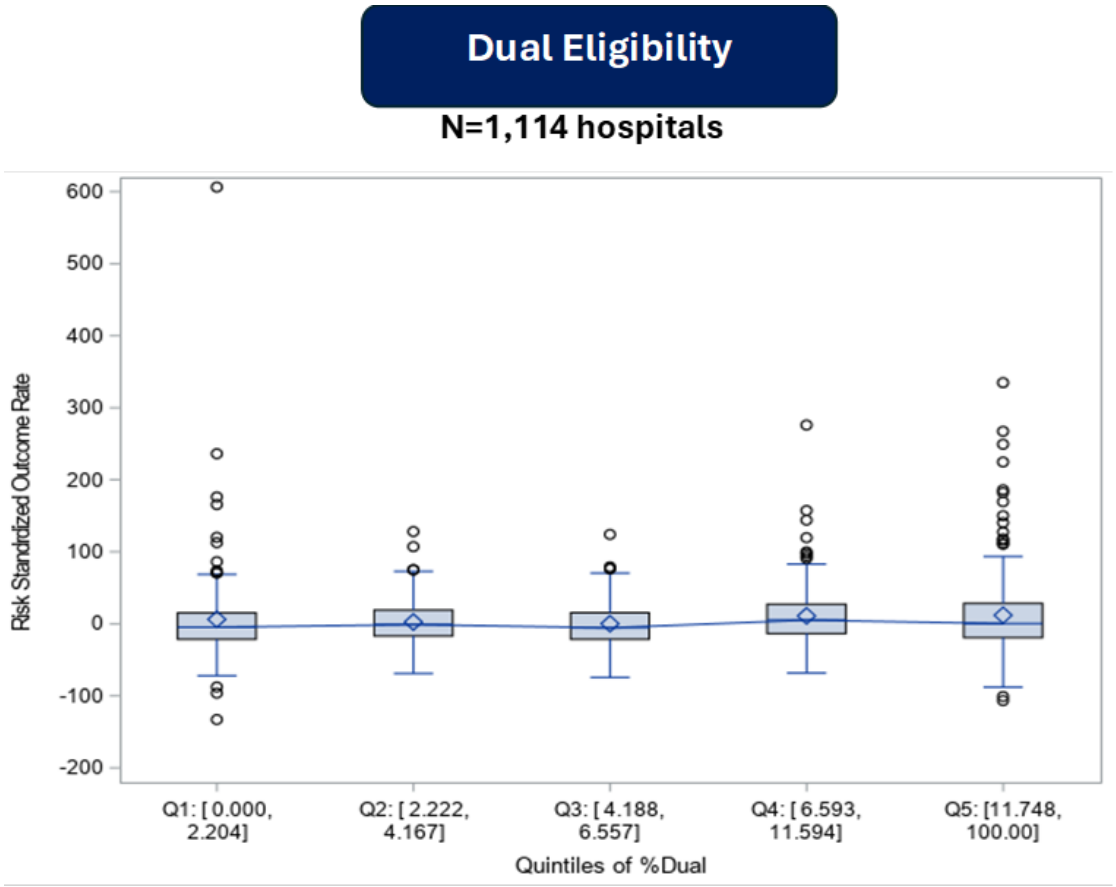


Figure 9. CABG EDAC: Initial Cohort Calibration Plot (January 1, 2022 – December 30, 2022)

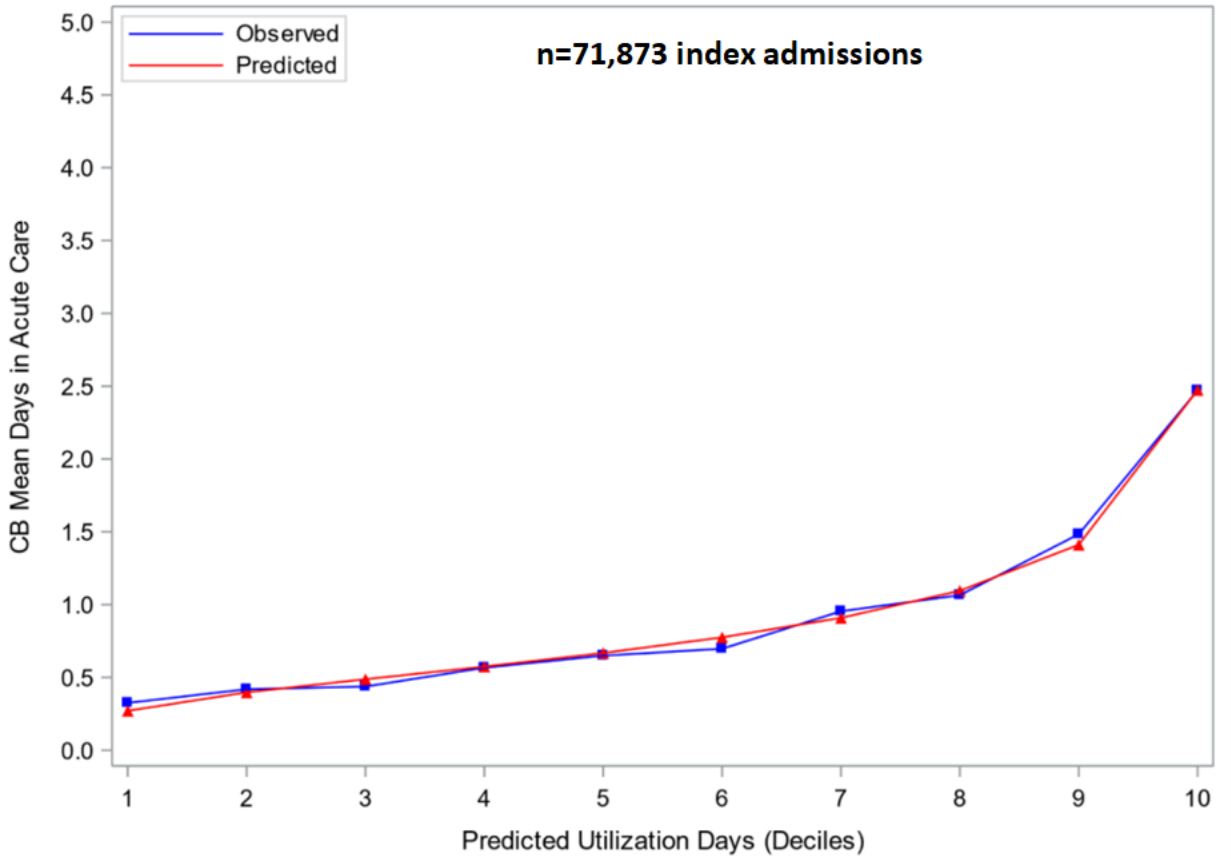


Figure 10. CABG EDAC: Final Validation Cohort Calibration Plot (January 1, 2022 – December 31, 2023; 50% sample)

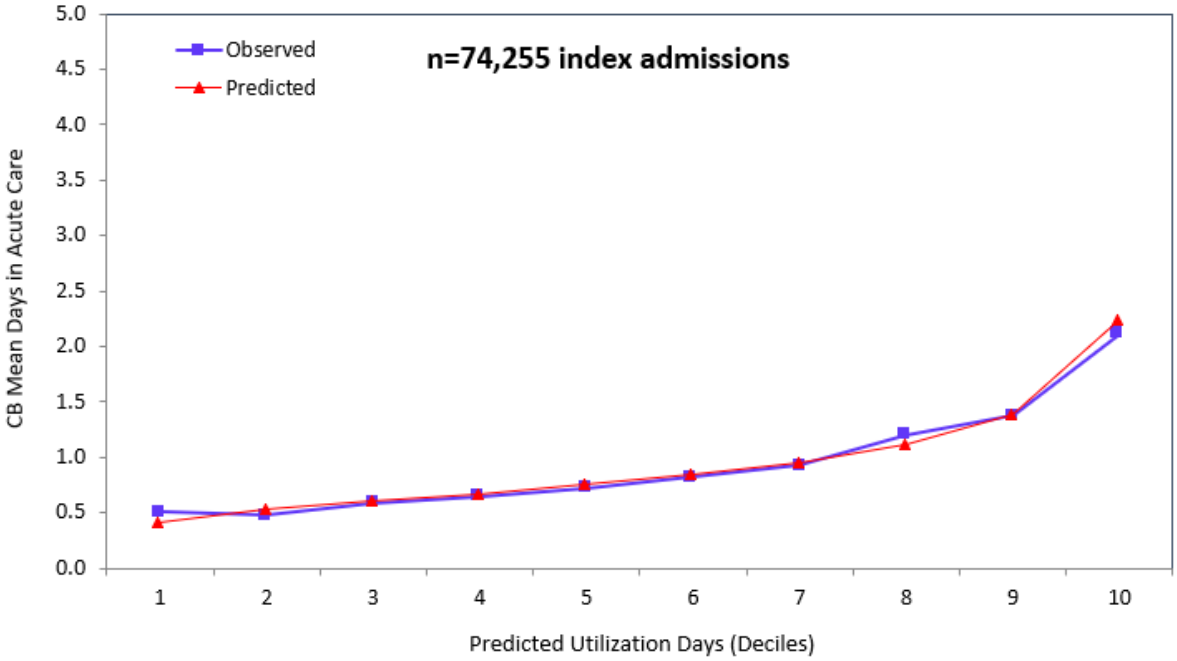
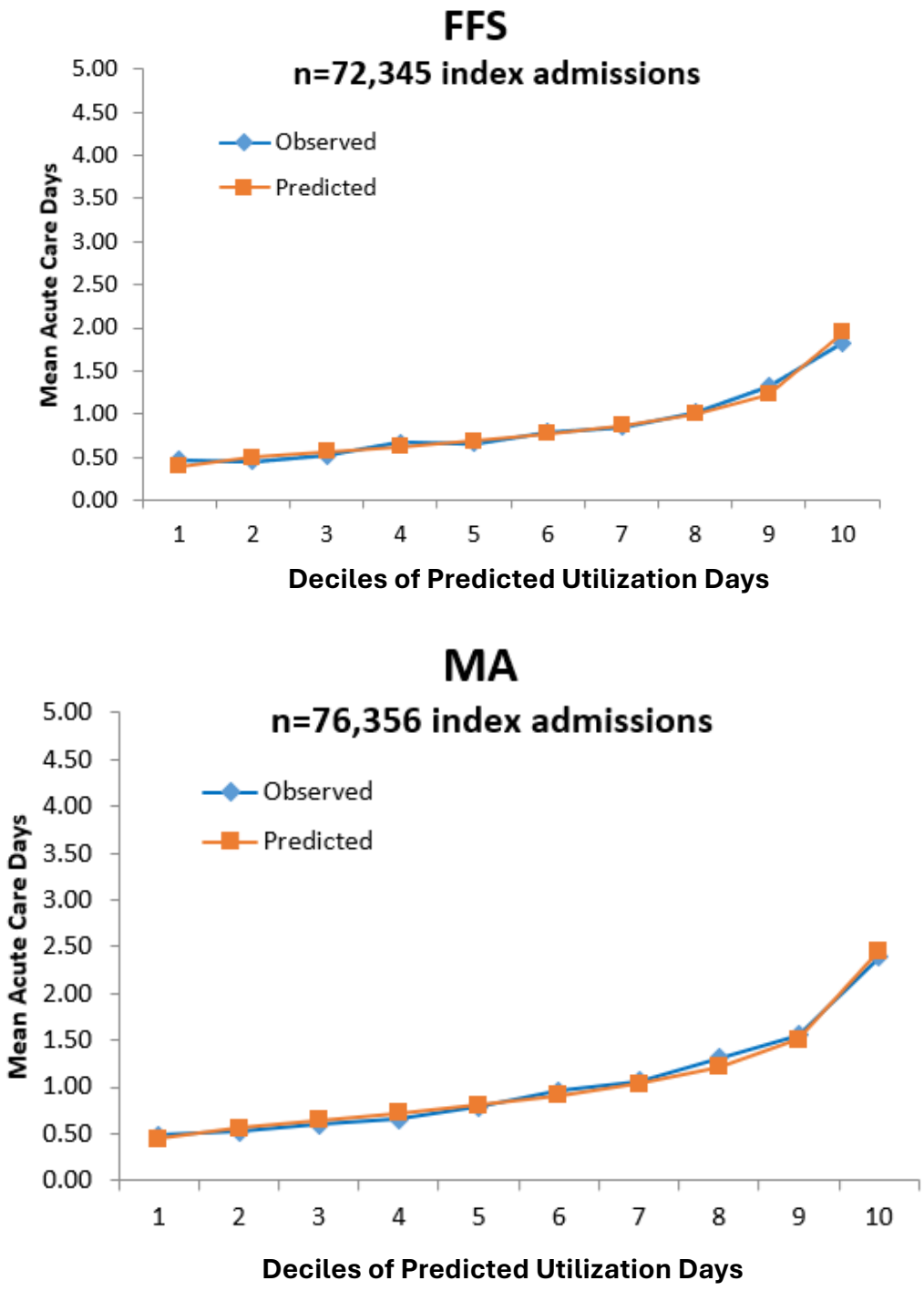


Figure 11. CABG EDAC: Calibration Plot for Fee-for-Service (FFS) and Medicare Advantage (MA) and Patients at the Index Admission (January 1, 2022 – December 31, 2023)



Logic Model

The CABG EDAC measure assesses days spent in acute care within 30 days of discharge from an inpatient hospitalization for CABG surgery. This measure is intended to capture the care transition quality provided to discharged patients hospitalized for isolated CABG surgery by collectively measuring a set of adverse acute care outcomes that can occur post-discharge: emergency department (ED) visits, observation stays, and unplanned readmissions at any time during the 30 days post-discharge. To aggregate all three events, each event is measured in terms of days. The outcome is adjusted to account for age, sex, and comorbidities and incorporates exposure time to account for survival times shorter than 30 days (for patients who die within 30 days of discharge). The measure cohort includes admissions for patients who are 65 years or older, are enrolled in Medicare Fee-For-Service (FFS) or Medicare Advantage (MA) and are hospitalized in non-federal short-term acute care hospitals. The final risk-adjusted measure scores are reported as the difference of the predicted minus the expected number of days in acute care per 100 discharges. We note that because this is an outcome measure, the goal is to have data for hospitals to use that informs their quality improvement processes, but the outcome results do not dictate which processes hospitals choose to put in place. Below in the “activities” column we state that hospitals should “apply the evidence base” because each hospital will need to address the root cause of any performance issues they see in their outcomes data against the existing processes they have in place.

Inputs	Activities	Outputs	Outcomes	Impacts
• Capacity to measure patient perspective and lived experience to create a patient centered education and self-management strategy for CABG surgery, treatment regimens, and post-discharge care. • CMS reports, hospital-level performance data, real-time dashboards, and Electronic Health Records (EHRs) for real-time tracking of CABG-related acute care utilization. • Capacity and implementation of validated risk calculators, such as the Society of Thoracic Surgeons (STS) Readmission Risk Model and the Virginia Cardiac Services Quality Initiative (VCSQI) and the Virginia Hospital & Healthcare Association (VHHA) (VCSQI-VHHA) Readmission Risk Calculator, to identify patients at high risk for readmission. • Commitment to quality improvement and financial investment in CABG care transition programs, with activities such as (but not limited to): allocation for quality improvement (QI) programs, patient support services, usage of national databases/registries, and staff training. • Capacity to adopt clinical guidelines (e.g., The 2021 American College of Cardiology (ACC)/ American Heart Association (AHA)/Society for Cardiovascular Angiography and Interventions (SCAI) Guideline for Coronary Artery Revascularization,	• Applying the evidence base to implement standardized discharge protocols, including comprehensive discharge instructions, medication reconciliation, and schedule follow-up appointments. • Post-discharge follow-up and care coordination with primary care, cardiology specialists and cardiac rehabilitation programs. • Providing structured education on lifestyle modifications, medication adherence, wound care, and recognition of warning signs to empower patients in self-care. • Reviewing hospital-level performance data and real-time dashboards to identify root causes of high EDAC rates, including gaps in discharge planning and medication adherence. • Assessing EHR data and utilizing Readmission Risk Calculators to identify high-risk CABG surgery patients and refine care transition strategies for special populations (e.g., older adults, those with comorbidities). • Training clinicians and care teams on guideline-directed CABG management and care coordination. • Transitional care and post-discharge checklists that are tailored to the needs of the patient, including mobile health	• Established post-discharge CABG surgery care protocols (and within hospital adherence measurement) with patient education, medication reconciliation, and outpatient follow-up protocols). • Early post-discharge follow-up with cardiology and cardiac surgery. • Real-time dashboard tracking of 30-day acute care utilization. • Established feedback mechanisms for continuous quality improvement based on patient outcomes, staff input, and registry metrics. • Staff trained in CABG surgery post-discharge management and transitions of care. • Expanded use of telehealth, mobile applications, and remote monitoring tools for high-risk patients with clinical workflows in place to respond to data indicating risk.	**Short-Term:** • Improved communication between hospital staff and patients at discharge about post-discharge CABG surgery management. • Increased adherence to evidence-based discharge planning. • Better functional status and short-term quality of life • Higher rates of medication reconciliation and prescription fill completion. • Increased outpatient follow-up attendance after discharge. **Intermediate-Term:** • More patients receive timely outpatient cardiac care. • Improved patient experience and satisfaction with care transitions. • Better identification and proactive management of patients identified as high-risk. **Long-Term:**	• Decreased variation in post-discharge acute care use across hospitals due to increased quality of care. • Lower healthcare costs associated with CABG-related hospitalizations. • Greater sustainability of cardiac care programs. • Enhanced overall quality of cardiac surgical care. • Improved long-term patient health outcomes. • Enhanced system-wide coordination between hospitals, outpatient providers, and community care resources. • Improved hospital performance metric and public reporting outcomes.

Inputs	Activities	Outputs	Outcomes	Impacts
2024 EACTS Guidelines on Perioperative Medication in Adult Cardiac Surgery), which provide comprehensive recommendations for CABG procedures and post-operative care. • Dedicated case management teams and sufficient ambulatory care infrastructure for seamless post-discharge care connections. • Capacity for a multidisciplinary “Heart Team” which includes cardiologists, cardiac surgeons, nurses, case managers, pharmacists, and rehabilitation specialists. • Capacity for telemonitoring and telehealth to track post-surgical complications at home.	applications and educational materials. • Engaging in national registries, such as the STS Adult Cardiac Surgery Database to benchmark performance and access QI resources. • Post-discharge remote monitoring for earlier detection of complications amenable to ambulatory care such as arrhythmia, surgical site pain, and superficial infections, as well as clinical deterioration. • Offering remote consultations and digital monitoring for patients with limited access to in-person care.		• Reduction in excess days in acute care within 30 days post-discharge (ED visits, readmissions, observation stays). • Improved cardiac management and fewer hospitalizations leading to improved quality of life and cardiovascular outcomes. • Better integration between hospital and outpatient settings. • Improved hospital performance on publicly reported quality measures (e.g., CMS Hospital Readmissions Reduction Program).	

Feedback Mechanisms
• Real-time dashboards to flag increases in acute care days post-CABG discharge. • Hospitals benchmark their performance against peer institutions to identify variation in patient post-discharge acute care utilization. • Patient-reported outcomes and experiences such as confidence in self-management and satisfaction with discharge instructions are collected to inform care improvements • Regular multidisciplinary case review meetings to analyze post-discharge events and refine post-discharge protocols.
Assumptions
• Broad-based strategies to improve post-discharge care can be utilized similarly across different settings and geographic locations. • Hospital connectivity to post-discharge ambulatory settings. • Hospitals have systems in place to track and review CABG-related hospital stays and post-discharge outcomes. • Post-discharge interventions (case management and telemonitoring) are available and feasible. • Provider buy-in for standardized discharge planning and follow-up protocols. • Necessary staff including administrative, physician, nursing, discharge coordinators and ambulatory clinic staff.
External Factors
• Policy and reimbursement models for CABG care transitions (CMS, private payers). • Provider shortages, particularly cardiac surgeons and cardiac rehabilitation programs. • Evolution of advances in CABG procedures and post-op care (cardio-pulmonary bypass, robotic assisted cases, improvements in harvesting of veins, continuous renal replacement therapies). • Variability in patient access to community services and caregiver support. • Variability in patients' ability and willingness to engage in self-management. • Technological challenges in implementing telehealth solutions.

Summary: The CABG EDAC Logic Model focuses on reducing unnecessary acute care use, including unplanned readmissions, ED visits, and observation stays, within 30 days of discharge for Medicare beneficiaries hospitalized for CABG. This logic model outlines an evidence-based strategy reflecting the intended impact of the measure to improve care transitions by emphasizing early follow-up care, standardized discharge protocols, and patient education tailored to CABG management. It also incorporates real-time data tracking and multidisciplinary care coordination to identify gaps and target high-risk individuals. The goal of the measure is to improve communication with patients, support CABG surgery self-management, advance timely outpatient care, and ultimately lower excess days in acute care while enhancing both patient outcomes and hospital quality performance. Over time, this should lead to better post-CABG care, and a stronger, more coordinated system between hospital and outpatient care that ultimately improves both patient outcomes and hospital performance.

References for this section align with the narrative presented in sections 6.2.1 and 2.2.

Conceptual Model

The goal of risk adjustment 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 patient age, comorbid diseases, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome. In pursuing a risk adjustment approach that best leverages the data, we used a framework based largely on individual ICD-10 codes for risk adjustment. The main advantage of leveraging ICD-10 codes in place of alternative methods that employ an ICD-10 grouper (such as CMS's Condition Categories, or 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 (Krumholz et al., 2019). The CABG EDAC measure adjusts for case-mix differences between hospitals based on the clinical status of the patient at the time of the index admission (CABG procedure). Accordingly, only comorbidities that convey information about the patient at that time or in the 12 months prior, and not complications that arise related to the CABG procedure and during the index hospitalization, are included in the risk adjustment. The process for determining patient comorbidities present at the time of the index admission from the index admission claim/encounter data uses a present-on-admission (POA) algorithm (see Section 5.4.2 of the full submission form for details).

The intent is for this measure to adjust for patient demographic and clinical characteristics while illuminating important quality differences. Therefore, this measure does not include an adjustment for social drivers of health because the association between social drivers of health and health outcomes can be due, in part, to differences in the quality of health care that these groups of patients receive. The measure does not adjust for patients' admission source or their discharge disposition (for example, skilled nursing facility) because these factors are associated with the structure of the healthcare system, not solely with patients' clinical comorbidities.

We also considered age, sex, frailty, and an indicator for whether the admission was Medicare Advantage (MA) vs. Fee-for-Service (FFS). Based on evidence from the literature, expert input, guidance from the consensus-based entity for measure endorsement, the Assistant Secretary for Planning and Evaluation, input from other stakeholders, and prior testing results, we included a claims-based indicator of frailty in the final model. This indicator was developed for CMS's Multiple Chronic Conditions (MCC) measure. We adjusted for sex because it is associated with differences in baseline clinical risk, anatomy related to surgical procedure, comorbidity burden, presentation, and post-discharge outcomes after CABG, so adjustment helps ensure that hospitals are compared more fairly based on performance rather than differences in patient case mix. 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).

Clinical risk variables were selected using this conceptual framework together with a data-driven empiric approach as described in Section 5.4.2 of the full measure submission).

Economic Disadvantage

Because our risk variable selection process was based on an empirical approach using individual ICD-10 codes related to a patient's clinical status at admission and in the 12 months prior to admission, we separately considered variables related to economic disadvantage and their overlap with clinical risk factors. Although some recent literature has evaluated the relationship between these variables and the EDAC outcome, few studies directly address

specific causal pathways or examine the role of the hospital in these pathways (see, for example: Hamadi et al., 2019; Kaiser Permanente Washington Health Research Institute, 2022; Rogstad et al., 2022; Joynt Maddox et al., 2019). Our conceptual model described below (and in the Supplemental Attachment) builds on published literature as well as our empirical analyses and identifies several overlapping pathways whereby patients may experience worse outcomes.

Conceptual Model for Clinical Factors and Factors Related to Economic Disadvantage

Our conceptual model described below builds on published literature as well as our empirical analyses and identifies several overlapping pathways whereby patients may experience worse outcomes. These pathways are not mutually exclusive.

- **Comorbidities and economic disadvantage:** Economically disadvantaged patients may have worse health at the time of hospital admission and patient comorbidities are known risk factors for post discharge acute care use in patients hospitalized for a CABG procedure (Shawon et al., 2021). Patients who have lower income/education/literacy or unstable housing may have a worse general health status and may present for their hospitalization/procedure with a greater severity of underlying illness (Owens et al., 2022). These factors, which are characterized by patient-level or neighborhood-/community-level (as proxy for patient-level) variables, may contribute to worse health status at admission due to competing priorities (restrictions based on job, lack of childcare, etc.), lack of access to care (geographic, cultural, or financial), or lack of health insurance. Given that these risk factors all lead to worse general health status, this causal pathway should be largely accounted for by current clinical risk adjustment. We note that patient comorbidities and economic disadvantage variables overlap in their contribution to a higher risk of the outcome, as shown by our empirical evidence (see Section 5.3).
- **Differential care:** A second pathway by which economic disadvantage may contribute to post discharge acute care risk is that patients may not receive equivalent care within a facility (Lloren at el., 2019). It has been shown that for other conditions (acute myocardial infarction, pneumonia, and heart failures), that across almost all hospitals (>98% of hospitals with sufficient data for assessment), dually eligible patients have higher rates of post discharge hospital based care (readmission) when compared with patients who are not dually eligible patients in the same hospital (within hospital disparities), after accounting for comorbidities, and area level variables (Silvestri et al., 2022). For CABG specifically, a 2024 study of Medicare beneficiaries found that patients with dual eligibility were less likely to receive post-procedural home health care compared with patients who were not dual eligible, and home health care use was associated with lower risk of readmission and ED visits (Thompson et al., 2024). The authors also found that home health care use was primarily driven by the discharging hospital.
- **Low-quality hospitals:** Economically disadvantaged patients may receive care at lower quality hospitals. Patients of lower income, lower education, or unstable housing may not have the same access to high quality facilities, in part, because such facilities may be less likely to be found in geographic areas with large populations of patients with these factors (Fahrenbach et. al., 2020). Thus, patients with low income may be more likely to be treated in lower quality hospitals, which can contribute to an increased risk of readmission. In addition, or alternatively, low quality hospitals may not implement evidence-based interventions to reduce the risk of readmission, such as post-discharge follow-up; economically disadvantaged patients are known to have lower rates of follow-

up after discharge and higher rates of post-discharge acute care (Anderson et al., 2022).

- **Residual risk:** Economically disadvantaged patients may experience worse health outcomes only partially under the control of the healthcare system. Some economic factors, such as income or wealth, may affect the likelihood of readmission without directly affecting health status at admission or the quality of care received during the hospital stay. For instance, while a hospital may make appropriate care decisions and provide tailored care and education, a lower-income patient may still have a worse outcome post-discharge due to competing economic priorities or a lack of access to care outside of the hospital (Chatterjee et al., 2022).

These proposed pathways overlap and are complex to distinguish analytically. They also have different implications on the decision to risk adjust, or not, depending on the degree to which hospitals can mitigate the increased risk. Furthermore, the ongoing consolidation of the healthcare market puts more control, resources, and accountability on hospitals (that are now increasingly part of large multi-hospital systems) to invest in mitigating these risks (Levinson et al., 2024). However, in some markets, hospital systems choose to close facilities or limit access to care, based on financial decisions, rather than assessments of resource needs (Levins, 2023), including assessment of, and investment in, programs that mitigate such needs.

Economic Variables Used in Testing

Based on the available literature and given the limited availability of valid and reliable variables that can be tested in claims data, we selected dual eligibility as a variable for testing.

Dual eligibility for Medicare and Medicaid is available at the patient level in the Medicare Master Beneficiary Summary File. The eligibility threshold for aged 65 or older Medicare patients considers both income and assets. There is also a body of literature demonstrating differential health care and health outcomes among dually eligible beneficiaries (ASPE, 2020).

Please see Section 5.4.2 for the details of the testing approach, results, and interpretation.

References

Anderson, A., Mills, C. W., Willits, J., Lisk, C., Maksut, J. L., Khau, M. T., & Scholle, S. H. (2022). Follow-up post-discharge and readmission disparities among Medicare fee-for-service beneficiaries, 2018. *Journal of General Internal Medicine, 37*(12), 3020–3028. https://doi.org/10.1007/s11606-022-07488-3

Centers for Medicare & Medicaid Services. *2024 All-Cause Unplanned Admissions for Multiple Chronic Conditions Measure.* Published December 20, 2023. Updated December 21, 2023. https://qpp.cms.gov/resources/document/750f3c88-e16c-46a5-a7f6-e8235aefd574. Accessed March 25, 2026.

Chatterjee, P., Liao, J. M., Wang, E., & Navathe, A. S. (2022). Characteristics, utilization, and concentration of outpatient care for dual-eligible Medicare beneficiaries. The American Journal of Managed Care, 28(10), e370–e377. https://doi.org/10.37765/ajmc.2022.89189

Fahrenbach, J., Chin, M. H., Huang, E. S., Springman, M. K., Weber, S. G., & Tung, E. L. (2020). Neighborhood disadvantage and hospital quality ratings in the Medicare Hospital Compare Program. *Medical Care, 58*(4), 376–383. https://doi.org/10.1097/MLR.0000000000001283

Hamadi, H., Moody, L., Apatu, E., Vossos, H., Tafili, A., & Spaulding, A. (2019). Impact of hospitals' referral region racial and ethnic diversity on 30-day readmission rates of older adults. Journal of Community Hospital Internal Medicine Perspectives, 9(3), 181–188. https://doi.org/10.1080/20009666.2019.1613882

Joynt Maddox, K. E., Reidhead, M., Hu, J., Kind, A. J. H., Zaslavsky, A. M., Nagasako, E. M., & Nerenz, D. R. (2019). Adjusting for social risk factors impacts performance and penalties in the hospital readmissions reduction program. *Health Services Research, 54*(2), 327–336. https://doi.org/10.1111/1475-6773.13133

Kaiser Permanente Washington Health Research Institute. (2022). *Association of social risk factors with emergency department and inpatient hospital utilization.* Social Needs Network for Evaluation and Translation (SONNET). https://kpwashingtonresearch.org/application/files/4016/7639/1403/SONNET_Report_Social-Risk-Health-Care-Utilization_FINAL.pdf

Krumholz, H. M., Coppi, A. C., Warner, F., Triche, E. W., Li, S.-X., Mahajan, S., Li, Y., Bernheim, S. M., Grady, J., Dorsey, K., Lin, Z., & Normand, S.-L. T. (2019). Comparative Effectiveness of New Approaches to Improve Mortality Risk Models From Medicare Claims Data. *JAMA Network Open*, *2*(7), e197314–e197314. https://doi.org/10.1001/jamanetworkopen.2019.7314

Levins, H. (2023, January 19). Hospital consolidation continues to boost costs, narrow access, and impact care quality. *Leonard Davis Institute of Health Economics, University of Pennsylvania*. https://ldi.upenn.edu/our-work/research-updates/hospital-consolidation-continues-to-boost-costs-narrow-access-and-impact-care-quality/

Levinson, Z., Godwin, J., Hulver, S., & Neuman, T. (2024, April 19). Ten things to know about consolidation in health care provider markets. *KFF*. https://www.kff.org/health-costs/issue-brief/ten-things-to-know-about-consolidation-in-health-care-provider-markets/

Lloren, A., Liu, S., Herrin, J., Lin, Z., Zhou, G., Wang, Y., Kuang, M., Zhou, S., Farietta, T., McCole, K., Charania, S., Dorsey Sheares, K., & Bernheim, S. (2019). Measuring hospital-specific disparities by dual eligibility and race to reduce health inequities. Health services research, 54 Suppl 1(Suppl 1), 243–254. https://doi.org/10.1111/1475-6773.13108

Office of the Assistant Secretary for Planning and Evaluation. (2020). Second report to Congress on social risk factors and performance in Medicare's value-based purchasing programs. U.S. Department of Health and Human Services. https://aspe.hhs.gov/reports/second-report-congress-social-risk-medicares-value-based-purchasing-programs

Owens, P. L., Liang, L., Barrett, M. L., & Fingar, K. R. (2022). Comorbidities associated with adult inpatient stays, 2019. *Agency for Healthcare Research and Quality, Healthcare Utilization Project Statistical Brief #303.* https://hcupus.ahrq.gov/reports/statbriefs/sb303-Comorbidities-Adult-Hospitalizations-2019.jsp

Rogstad, T. L., Gupta, S., Connolly, J., Shrank, W. H., & Roberts, E. T. (2022). Social risk adjustment in the Hospital Readmissions Reduction Program: A systematic review and implications for policy. *Health Affairs, 41*(9), 1266–1274. https://doi.org/10.1377/hlthaff.2022.00614

Shawon, M. S. R., Odutola, M., Falster, M. O., & Jorm, L. R. (2021). Patient and hospital factors associated with 30-day readmissions after coronary artery bypass graft (CABG) surgery: A systematic review and meta-analysis. *Journal of Cardiothoracic Surgery, 16*(1), 172. https://doi.org/10.1186/s13019-021-01556-1

Silvestri, D., Goutos, D., Lloren, A., Zhou, S., Zhou, G., Farietta, T., Charania, S., Herrin, J., Peltz, A., Lin, Z., & Bernheim, S. (2022). Factors associated with disparities in hospital readmission rates among US adults dually eligible for Medicare and Medicaid. *JAMA Health Forum, 3*(1), e214611. https://doi.org/10.1001/jamahealthforum.2021.4611

Thompson, M. P., Hou, H., Likosky, D. S., Pagani, F. D., Falvey, J. R., Bowles, K. H., Wadhera, R. K., & Sterling, M. R. (2024). Home health care use and outcomes after coronary artery bypass grafting among Medicare beneficiaries. *Circulation: Cardiovascular Quality and Outcomes, 17*(7), e010459. https://doi.org/10.1161/CIRCOUTCOMES.123.010459