

Excess Days in Acute Care (EDAC) After Hospitalization for Diabetes

Measure Methodology Report

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Executive Summary

This methodology report describes the Excess Days in Acute Care (EDAC) After Hospitalization for Diabetes (hereafter “Diabetes EDAC”) measure developed by Yale New Haven Health Services Corporation – Center for Outcomes Research & Evaluation (CORE) under contract with the Centers for Medicare & Medicaid Services (CMS). The outcome of this measure is the number of excess risk-adjusted days a hospital’s patients spend in an emergency department (ED), a hospital observation unit, or a hospital inpatient unit (“days in acute care”) during the 30 days following discharge from an inpatient admission for diabetes. The measure score is calculated as the difference between a hospital’s patients’ predicted days in acute care and its patients’ expected days in acute care (predicted days minus expected days) within 30 days of discharge, per 100 discharges.

The Diabetes EDAC measure captures an important post-discharge quality signal of risk-adjusted, all-cause excess days in acute care within 30 days following a hospitalization for diabetes. The key features of this Diabetes EDAC measure described in this report are:

- **Cohort:** Both Medicare-Fee-For-Service (FFS) and Medicare Advantage (MA) beneficiaries aged 65 and over who were hospitalized for diabetes.
- **Outcome:** All-cause acute care visits within 30 days after discharge (or until death if earlier), including unplanned inpatient stays (counted in days), observation stays (counted in hours and rounded to the nearest integer of days), and ED visits (counted as one day).
- **Risk adjustment:** Risk variables, based primarily on the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes, were empirically identified and include comorbidities and indicators of patient frailty, as well as patient age. The risk adjustment model also accounts for post-discharge death.
- **Measure score:** The difference (“excess”) between a hospital’s patients’ predicted days in acute care, accounting for that hospital’s case mix, and its expected days in acute care (days expected for an average hospital with the same case mix), divided by the number of admissions for the hospital, times 100.

EDAC measures capture a broad picture of post-discharge outcomes that inform hospitals, providers, patients, and the public about care quality, and incentivize global improvement in transitional care. Complementing existing readmission measures, EDAC measures capture post-discharge hospital-based acute care utilization days, including inpatient admission, ED visits, and observation stays. CMS has implemented [EDAC measures in the Inpatient Quality Reporting \(IQR\) Program](#) for several conditions, including acute myocardial infarction (AMI), heart failure (HF), and pneumonia.

Measure testing results for the Diabetes EDAC measure described in this report show good model performance, meaningful measure score variation, good reliability, and evidence to support empiric validity. These results suggest that the Diabetes EDAC measure can provide valuable data for improving the quality of care and is suitable for use in public reporting at the hospital level.

1. INTRODUCTION

1.1 Measure Overview

The Excess Days in Acute Care (EDAC) After Hospitalization for Diabetes (hereafter “Diabetes EDAC”) measure has been developed by Yale New Haven Health Services Corporation – Center for Outcomes Research & Evaluation (CORE) under contract with the Centers for Medicare & Medicaid Services (CMS). The outcome of this measure is the number of excess risk-adjusted days a hospital’s patients spend in an emergency department (ED), a hospital observation unit, or a hospital inpatient unit (“days in acute care”) during the 30 days following an inpatient admission for diabetes. The Diabetes EDAC measure score is calculated as the difference between a hospital’s patients’ predicted days in acute care and its patients’ expected days in acute care (predicted days minus expected days) within 30 days of discharge, per 100 discharges.

EDAC measures capture a broad picture of (hospital-based) post-discharge acute care utilization that informs patients and the public about care quality and incentivizes global improvement in transitional care. EDAC measures provide complementary information to readmission measures; hospitals with higher rates of observation stays in the post-discharge period, for example, may have lower readmission rates that do not fully reflect quality of care outcomes. The features of EDAC measures include¹: 1) the capture of all post-discharge (hospital-based) acute-care outcomes that matter to patients, such as

having to return to the hospital, go to the ED, or spend time in the hospital under observation after an initial inpatient admission; (2) the capture of the full length of hospital and observation unit stays in days, (3) the capture of multiple events per patient, as some patients will have multiple acute care events in 30 days, rather than only the first one of these events; and (4) accounting for time at risk for an event (that is, survival time) which avoids competing risks as sources of bias.

We anticipate that a Diabetes EDAC measure will support hospital efforts to further optimize the quality of care for patients with diabetes, particularly the quality of transitional care and post-discharge support by providing a more comprehensive picture of post-discharge events. The measure will also provide consumers information on hospital-level variation in patients' post-discharge acute care utilization that is captured more completely.

1.2 Diabetes EDAC as a Measure of Quality

Acute care utilization after discharge (that is, an ED visit, an observation stay, or an inpatient readmission) for any reason is disruptive to patients and caregivers, costly to the healthcare system, and puts patients at additional risk of hospital-acquired infections and complications. Although some hospital returns are unavoidable, others may result from poor quality of care or inadequate transitional care. Transitional care includes effective discharge planning, transfer of information to the ambulatory setting or a community setting at the time of discharge, patient assessment and education, and coordination of care and monitoring in the post-discharge period. When appropriate care transition processes are in place (e.g., patients are discharged to a suitable location, communication occurs between clinicians, medications are correctly reconciled, and timely follow-up is arranged),² we expect fewer patients will return to an acute care setting, either for an ED visit, observation stay, or hospital readmission, during the 30 days post-discharge.

1.2.1 Measure Importance

Over 26% of Medicare beneficiaries were being treated for diabetes in 2022.³ Short- and long-term complications from diabetes often result in hospitalizations.^{4–6} In 2020, a Healthcare Cost & Utilization Project (HCUP) statistical brief found that, among Medicare beneficiaries, diabetes mellitus with complications ranked the fifth highest of principal diagnoses at index admission for the total number of 30-day readmissions (58,700) and had the second highest readmission rate per 100 index admissions at 22.2%.⁷

Though data by index admission diagnosis and cost by year are limited, investigators using U.S. population demographics for people with diabetes, national survey data, epidemiological data, health care cost data, and economic data developed a Cost of Diabetes Economic Model to estimate the economic burden of diabetes. They estimated 2022 health care expenditures attributable to diabetes for individuals 65 years of age and older in the United States to include \$67.7 billion for hospital inpatient stays and \$7.2 billion for ED visits.⁸

The goal of the Diabetes EDAC measure is to improve patient care by providing patients, physicians, and hospitals with information about hospital-level, risk-adjusted acute care use following hospitalization for diabetes.

1.2.2 Performance and Preventability

Safely transitioning patients after hospital discharge requires a complex series of tasks, including but not limited to timely and effective communication between providers, prevention of and response to

complications, patient education about post-discharge care and self-management, and timely follow-up.⁹ Suboptimal transitions contribute to a variety of adverse outcomes post-discharge including ED evaluation, need for observation, and readmission.¹⁰ Variation in the care of patients' diabetes while hospitalized is associated with poor outcomes; for example, patients who are discharged with blood glucose near or at hypoglycemic levels have higher levels of 30-day readmission and post-discharge mortality.¹¹ Care transition episodes allow for improvement in the overall care of patients, as with reconciliation of discharge medication regimens with medications taken at baseline for chronic conditions, while also providing an opportunity for reducing the incidence of post-discharge hospital events for diabetic patients.^{12–14}

A 2023 review of interventions aimed at reducing readmissions for patients with type 2 diabetes¹⁵ concluded that interventions that start at the index admission are effective. Study authors identified common strategies associated with effective interventions, including multidisciplinary input, dedicated transition of care teams, certified diabetes educator appointments post-discharge, and hospital-initiated discharge protocol development and implementation, among others. Similarly, a 2021 review¹⁶ found that interventions including inpatient diabetes education, inpatient diabetes management services, inpatient/outpatient care coordination, and medication adjustment were each effective at reducing the risk of readmissions and ED visits for patients discharged after hospitalization for diabetes. While most studies have been retrospective, there have been a few randomized controlled, prospective trials; the largest, published in 2020, found that patients randomized to receive care at a specialized multidisciplinary diabetes program had significantly lower rates of unplanned readmissions 30 days after discharge compared with patients who were randomized to a standard primary care setting (7% vs. 19%, respectively, $p=0.02$).¹⁷

1.2.3 Measurement Gap

There are currently no publicly reported measures of post-discharge care utilization for patients hospitalized for diabetes. It is therefore difficult for providers and the public to gain a complete picture of post-discharge outcomes. By capturing a range of outcomes that are important to patients, this measure can produce a complete picture of post-discharge utilization that informs the public about care quality and incentivizes global improvement in transitional care.

1.3 Measure Use

This measure is intended to assess hospital quality for patients admitted to a hospital for diabetes by measuring their acute care utilization for 30 days following discharge. The Diabetes EDAC measure can be used to assess hospital variation in acute care days following discharge for patients admitted for diabetes and discharged alive, adjusting for hospital case mix, in order to assess the relative performance of hospitals and incentivize improvement in hospital care, including hospital transitional care. The Diabetes EDAC measure aligns with existing CMS EDAC quality measures.

1.4 Approach to Measure Development

We developed this measure in consultation with national guidelines for publicly reported outcome measures, following the technical approach to outcomes measurement set forth in the [CMS Measures Management Blueprint](#), with guidance articulated in the American Heart Association scientific statement, “Standards for Statistical Models Used for Public Reporting of Health Outcomes,” and in alignment with [current standards for Consensus-Based Entity \(CBE\) Endorsement](#).¹⁸ These standards include adequate risk adjustment and transparency. We ensured alignment with CMS's existing EDAC

and readmission measures (in terms of specifications and measure development approach) and sought and obtained expert input during measure development from CMS and through consultation with clinical and statistical experts.

1.4.1 Information Gathering

As part of measure development, an environmental scan and literature review (ES/LR) was completed to identify existing diabetes outcome measures and diabetes-related literature to help inform the cohort definition for this measure (inclusion and exclusion criteria). The findings from the ES/LR were reviewed by the measure development team to inform initial measure specification decisions and then reviewed with clinical experts and TEP members (see Appendix A for a complete list), whose feedback informed final measure specifications.

1.4.2 Expert and Stakeholder Input

CORE obtained expert and stakeholder input on the proposed measure by convening a TEP of clinicians, patients, patient advocates, and other stakeholders (see [Appendix A](#) for a complete list), and with engagement of subject matter experts. Collectively, TEP members brought expertise in clinical content, performance measurement, coding, informatics, quality improvement, hospital administration, and patient and caregiver experience. Throughout 2023 and 2024, CORE held four TEP meetings, where TEP members provided input on the cohort definition and specifications, risk variable selection and risk model assessment, and reviewed model testing results, measure score reliability and validity testing. Following completion of measure development, the TEP participated in a vote on the face validity of the Diabetes EDAC measure specifications, further described in [3.8.1](#).

In addition, the measure development team obtained expert input from two endocrinologists. They provided guidance on measure specifications throughout the timeline of the Diabetes EDAC project and were consulted throughout all steps of measure development.

2. METHODS

2.1 Overview

The Diabetes EDAC measure applies to Medicare FFS and MA beneficiaries at least 65 years old who have been admitted to a non-federal acute care hospital in the United States. The measure reports a collective set of adverse outcomes that can occur post-discharge: ED visits, observation stays, and unplanned readmissions at any time during the 30 days post-discharge; the measure does not count planned readmissions in the measure outcome since they are generally not a signal of the quality of care provided during the index admission.

The outcome of the Diabetes EDAC measure, which is aligned with other CMS EDAC measures, is defined as all-cause days spent in acute care (ED visits without admission, observation stays, and readmissions) within 30 days of hospital discharge. The outcome is adjusted to account for age 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 final measure score is calculated as the difference between a hospital's patients' predicted days in acute care and its patients' expected days in acute care (predicted days minus expected days) within 30 days of discharge, per 100 discharges. Components of the Diabetes EDAC measure are described below.

2.2 Data Sources

For measure development and testing, we used two datasets: a one-year dataset used for initial measure development, including index admissions with discharge dates between January 1, 2022, and December 30, 2022 (CY2022), and for updated measure testing, a two-year dataset including index admissions with discharge dates between January 1, 2022, and December 31, 2023 (CY2022/2023). To create these datasets, we extracted all index and history (12 months prior to the index admission) claims, including: inpatient, outpatient, professional, Durable Medical Equipment (DME), beneficiary enrollment data, and Medicare provider history data, from the CMS Integrated Data Repository (IDR). Data sources for each component of the measure are described below, and align with data used for other CMS EDAC measures that include MA admissions:

- For **cohort** construction, the measure uses enrollment data and hospital inpatient claims.
- For **risk adjustment**, the measure uses inpatient and outpatient facility, professional, and DME claims data up to 12 months prior to the index admission; age is captured from Medicare enrollment data.
- For **outcome** derivation, the measure uses hospital inpatient, outpatient, and professional claims up to 30 days post-index admission.
- To map National Provider Identifiers (NPIs) to CMS Certification Numbers (CCNs) for MA claims where CCNs are not available, the measure uses provider history data that details the association between the CCN and NPI over time.

The hospital inpatient claims, outpatient claims, professional claims, and DME claims can be identified using the claim types in [Table 1](#). Notably, most MA beneficiary inpatient admissions have two claim submission sources: hospital-submitted claims and Medicare Advantage Organization (MAO)-submitted encounter claims. Both types of claims are information-only (i.e., not billing) that include items and services provided. CMS requires MAOs and hospitals that receive disproportionate-share hospital or medical education payments from Medicare to submit information-only claims for inpatient stays for MA beneficiaries. We use both sources for cohort and outcome derivation.

Table 1. Medicare FFS and Advantage 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

There are benefits to using both inpatient claims sources for MA beneficiaries in order for the broadest capture of MA claims in a timely manner. First, not all hospitals are required to submit claims for MA beneficiaries (i.e., hospitals that do not receive disproportionate-share hospital or medical education payments from Medicare), and using only hospital-submitted data would miss capture of these claims. All hospitals submit inpatient claims for MA beneficiaries to MAO, and so MAO-submitted claims capture these additional admissions not found in the hospital-submitted claims. However, relying solely on MAO-submitted claims poses three challenges: 1) MAO-submitted claims are not as timely as hospital-submitted claims, which is disadvantageous for reporting deadlines for CMS hospital outcome measures; 2) in measure testing, a small proportion of MA admissions were only found in the hospital-submitted claims; and 3) MAO-submitted claims identify hospitals using NPI, whereas hospital-submitted claims are already associated with a CCN used to identify hospitals in the CMS outcome measures.

As a result, if an MA admission was found in both datasets, we used the claim found in the hospital-submitted data. For the small portion of MA admissions with only MAO-submitted claims, we obtained the CCN with IDR provider history data, using the NPI, claim discharge date, provider history begin (effective) date, and provider history end (obsolete) date.

Admissions with only MAO-submitted claims that we could not map to a CCN were not included (<5% of all MA admissions). Because it is expected that this Diabetes EDAC measure would be implemented by CMS for public reporting in the Hospital Inpatient Quality Reporting (IQR) program, which is limited to short-term acute care hospitals and critical access hospitals, we used the CCN taxonomy to further 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').

2.2.1 Dates of Data and Testing

Two datasets were created for use in measure development and testing of various components of the Diabetes EDAC measure. These datasets and their use for measure development and testing were as follows:

- CY2022 (one year): index admissions with a discharge date from January 1, 2022-December 30, 2022, used for:
 - Cohort definition, risk variable selection, model testing, and face validity vote on the measure following testing.
- CY2022/2023 (two years): index admissions with a discharge date from January 1, 2022-December 31, 2023, used for:
 - Model validation, and measure score-related testing including distribution, reliability and validity testing, and testing by patients with and without dual eligibility (DE).

The Diabetes EDAC measure is currently specified to calculate hospital measure scores with two years of data.

2.3 Measure Cohort: Approach to Cohort Development and Cohort Definition

As with other CMS EDAC measures, the measure cohort for the Diabetes EDAC measure is defined by the International Classification of Diseases, Tenth Revision (ICD-10) codes that define the reason for each patients' hospitalization. Through an ES/LR we identified potential inclusion and exclusion criteria for defining a diabetes-specific cohort for an EDAC measure to be attributed to hospitals. In addition to the review of existing literature and measures, CORE enlisted the assistance of the TEP and a diabetes-specific clinical expert.

We considered two approaches to the measure cohort: to either define the measure narrowly based on principal diagnoses only (e.g., patients hospitalized for diabetes); or take the approach of most of the studies and measures we identified and define the measure broadly, based on principal and secondary diagnoses, inpatient and outpatient claims, and perhaps even using medication as a criterion (e.g., patients hospitalized with diabetes). Using a broad approach, a diabetes cohort that includes all patients with diabetes would capture upwards of 25 percent of the hospitalized Medicare population.¹⁹ Given that diabetes co-occurs with many other conditions, such as heart failure, a broad cohort would likely result in a measure for which the cohort overlaps with existing readmission and EDAC measures in CMS programs. A broad approach would also not align with the approach used by existing CMS readmission and EDAC measures that identify patients hospitalized primarily for a single condition (such as heart failure as a principal diagnosis) rather than all patients with heart failure (including all secondary diagnoses). Of particular consideration was an estimation that approximately 10 percent of principal diagnosis codes that may be considered complications of diabetes overlap with the heart failure (HF) EDAC measure cohort.

While a diabetes diagnosis increases the risk of hospitalization in general, and people with diabetes are disproportionately represented among those hospitalized for any cause,¹⁹ diabetes itself is rarely the sole or primary cause of those hospitalizations.²⁰ It is difficult (and there is no gold standard by which) to separate out the many conditions that may be coded as a principal diagnosis of another condition and its causal relationship to a secondary diagnosis of diabetes. In addition, patients hospitalized with a principal diagnosis of diabetes with complications appear to be clinically distinct from patients with a secondary diagnosis of diabetes with complications only; CORE conducted empirical analyses showing that patients hospitalized with a principal diagnosis of diabetes with complications are more homogenous compared with patients hospitalized with only a secondary diagnosis of diabetes, and our analyses and other investigators found that the risk of readmission differs between these two populations.^{21,22}

Reflecting TEP support and CMS preference, the final specifications define the Diabetes EDAC cohort as a narrow cohort of patients hospitalized for diabetes (utilizing principal diagnoses only). The advantages of this narrow approach include:

- A homogenous population which:
 - For quality improvement, focuses the hospital on a specific group of patients; and
 - Likely will allow for better risk adjustment.
- No overlap with other existing EDAC measure cohorts, which:
 - For hospital stakeholders, ensures no double counting of patients, both across measures (e.g., overlap with the [HF EDAC cohort](#)), and when used with other measures (e.g., use in [Overall Hospital Quality Star Ratings](#), that includes the HF EDAC measure).

CORE utilized the Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications Software (CCS) grouper to identify the initial draft list of ICD-10 codes that define hospitalizations for diabetes. (A map of the crosswalk between the AHRQ CCS and ICD-10 codes, as used in other measures and maintained by CORE, is available on the [QualityNet website](#).) The Diabetes EDAC measure identifies patients hospitalized for diabetes using AHRQ CCS50 (“Diabetes mellitus with complications”).

The inclusion criteria and exclusion criteria for the Diabetes EDAC measure cohort ([Table 2](#)) are informed by the general inclusion and exclusion criteria used for all CMS EDAC measures. Details and rationale for each criterion are outlined in the “Inclusion” ([2.3.1](#)) and “Exclusion” ([2.3.2](#)) sections below.

Table 2. Diabetes EDAC Measure Cohort Inclusion and Exclusion Criteria

Inclusion	Exclusion
<ul style="list-style-type: none"> • With a principal discharge diagnosis of diabetes • Enrolled in Medicare (Medicare FFS or MA) for the 12 months prior and during the index hospitalization • Aged 65 and over • Discharged alive from a non-federal short-term acute care hospital • Not transferred to another acute care facility 	<ul style="list-style-type: none"> • Discharged against medical advice (AMA) • Without at least 30 days post-discharge Medicare enrollment • Diabetes admissions within 30 days of a prior discharge from a diabetes index admission

2.3.1 Inclusion Criteria

The Diabetes EDAC measure includes admissions that meet all of the following criteria:

- **Principal discharge diagnosis of diabetes**
 - *Rationale:* Hospitalization for diabetes is the target for measurement.
- **Enrolled in Medicare FFS or MA for the 12 months prior to the date of admission and during the index admission**
 - *Rationale:* The 12-month prior enrollment criterion ensures that the comorbidity data used in risk adjustment can be captured from inpatient, outpatient, and physician claims data for up to 12 months prior to the index admission, to augment the index admission claim itself.
- **Aged 65 or over**
 - *Rationale:* Patients younger than 65 years of age are not included in the measure because they are considered clinically distinct from patients aged 65 and over.
- **Discharged alive from a non-federal short-term acute care hospital**
 - *Rationale:* It is only possible for patients to experience the outcome if they are discharged alive.
- **Not transferred to another acute care facility**
 - *Rationale:* Hospitalizations that result in a transfer to another acute care facility are not included in the measure because the measure’s focus is on admissions that result in discharge to a non-acute care setting (e.g., to home or a skilled nursing facility).

2.3.2 Exclusion Criteria

The Diabetes EDAC measure excludes admissions that meet any of the following criteria:

- **Without at least 30 days of post-discharge enrollment in Medicare FFS or MA**
 - *Rationale:* 30-day outcomes cannot be assessed in this group since claims/encounter data are used to determine whether a patient experienced post-discharge acute care.
- **Discharged against medical advice (AMA)**
 - *Rationale:* Providers did not have the opportunity to deliver full care and prepare the patient for discharge.
- **Diabetes admissions within 30 days of discharge from a prior diabetes index admission**
 - *Rationale:* Additional diabetes admissions within 30 days are excluded as index admissions because they are part of the outcome. CMS does not want to potentially count the additional admission as both an index admission and an unplanned readmission outcome for the first admission.

2.4 Measure Outcome

In alignment with the existing implemented EDAC measures, the outcome for the Diabetes EDAC measure is defined as the number of days a patient spends in acute care (ED visits without an admission, observation stays, and unplanned readmissions) within 30 days after the date of discharge from an index admission (defined separately for each EDAC measure) for any cause.

- **ED visits:** An ED visit is defined as a visit with revenue center codes '0450', '0451', '0452', '0456', '0459', or '0981'. See [Table B.1 in Appendix B for the code definitions](#). Each ED visit is counted as one day (1.0 day).
- **Observation stays:** An observation stay is defined as a visit with revenue center code '0762' and a Healthcare Common Procedure Coding System (HCPCS) code 'G0378' (in the hospital outpatient data files) or when a facility claim is not available, Current Procedural Terminology (CPT) codes '99217' to '99220' or '99234' to '99236' (in the professional data files). This broad definition captures all post-discharge observation stays in the facility and professional data files. See [Table B.1 in Appendix B for the code definitions](#). Observation stays are recorded in terms of hours and rounded up to the nearest integer of days.
- **Readmission:** A readmission is defined as any unplanned admission to an acute care hospital within 30 days of the discharge date for the index hospitalization. "Planned" readmissions, not included in the outcome, are those planned by providers for anticipated medical treatment or procedures that must be provided in the inpatient setting. To exclude planned readmissions, we use [CMS' Planned Readmission Algorithm version 4.0 2024](#). Readmissions are counted in days. Each rehospitalization is counted according to the length of stay, calculated as the discharge date minus the admission date, plus one day. Admissions that extend beyond the 30-day follow-up period are truncated on day 30. If a patient is readmitted to the same hospital on the same day of discharge for the same diagnosis as the index admission, the measure considers the patient to have had one single continuous admission. However, if the diagnosis of the readmission is different from the index admission, this is considered a readmission in the measure.
- **Overlapping outcomes:** When an ED visit, observation stay, or readmission overlaps with another event, we count only the most severe of the overlapping events. For example, in the

case of an overlapping readmission and observation or ED visit, we count the readmission; if an observation stay and ED visit happen on the same day, we count the observation stay.

- **Multiple events:** We count all eligible outcomes occurring in the 30-day period, even if they are repeat occurrences. For example, if a patient returns to the ED three times on three different days, we count each ED visit as one day. Similarly, if a patient has two hospitalizations within 30 days, the days spent in each are counted. We take this approach in order to capture the full post-discharge utilization.

2.4.1 30-Day Time Frame

The measure assesses eligible outcomes within a 30-day period from the date of discharge from an index hospitalization. We considered 30 days as a clinically reasonable timeframe for two reasons:

1. Within a 30-day timeframe, ED visits, observation stays, and readmissions are more likely attributable to the care received during the index admission and during hospital discharge than outcomes occurring later post-discharge.
2. The 30-day timeframe is consistent with CMS' existing, publicly reported, Consensus-Based Entity-endorsed 30-day readmission measures.

Note that if a readmission or observation stay extends beyond 30 days, only that portion of the stay that occurs during the 30 days is included in the outcome. In addition, for patients who did not survive 30 days, their total exposure period is adjusted to reflect the number of days they survived.

2.4.2 All-Cause Days in Acute Care

We measure all-cause acute care utilization for several reasons. First, from the patient's perspective, acute care utilization for any cause is undesirable. Second, limiting the measure to acute care utilization for the exacerbation of a specific condition or to a complication for a specific procedure may make it susceptible to gaming. Moreover, it is often hard to ascertain quality concerns and accountability based on the documented cause of a hospital visit.

2.4.3 Transfers

The measure considers multiple contiguous hospitalizations to be a single acute episode-of-care. Admissions to a hospital within one day of discharge from another hospital are considered transfers whether or not the first institution indicates intent to transfer the patient in the discharge disposition code.

Transfers are attributed to the hospital that ultimately discharges the patient to a non-acute care setting (e.g., to a home or to a skilled nursing facility). Thus, if a patient is admitted to Hospital A, transferred to Hospital B, and ultimately discharged from Hospital B to a non-acute care setting, all ED visits, observation stays, and readmissions within 30 days of discharge are attributed to Hospital B.

2.4.4 Exposure Time

Because some patients do not survive 30 days from the index admission, not all patients are at risk for an acute event for the same amount of time. We calculated 'exposure time' as the number of days each patient survived after discharge, up to 30 days. This exposure time was incorporated as part of the

outcome to reflect the differential risk for EDAC after discharge. This differs from the existing CMS 30-day readmission measures, which consider all patients to be equally at risk for a hospital event regardless of survival time.

2.5 Risk Adjustment

The goal of risk adjustment is to adjust for case-mix differences across 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 an 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. CORE's previous research reevaluating CMS' mortality measures indicates that the model performance can be significantly improved by using individual codes instead of CCs.²³

The Diabetes EDAC measure adjusts for case-mix differences among hospitals based on the clinical status of the patient at the time of the index admission. Accordingly, only comorbidities that convey information about the patient at that time or in the 12 months prior, and not complications that arise during the course of the 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. The POA algorithm applies only in the case of secondary diagnosis codes on the index admission used in the risk adjustment of a measure. In brief, an ICD-10-CM code on the index admission is used in risk adjustment if one of the following is true:

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

The Diabetes EDAC measure does not include adjustment for socioeconomic factors because the outcomes captured by this measure can be due, in part, to differences in the quality of health care that these groups of patients receive. The intent is for the measures to adjust for patient demographic and clinical characteristics while illuminating important quality differences.

The measure does not adjust for patients' admission source or their discharge disposition (e.g., skilled nursing facility) because these factors are associated with the structure of the healthcare system, not solely with patients' clinical comorbidities. Regional differences in the availability of post-acute care providers and practice patterns might exert undue influence on model results. In addition, these data fields are not audited and are not as reliable as diagnosis codes.

2.6 Statistical Approach to Risk Adjustment and Measure Calculation

2.6.1 Selection of Risk Variables

Risk variables were selected using a data-driven, empiric approach, followed by minor adjustments for face validity (noted below). For identifying candidate risk variables, we used the CY2022 dataset and included all secondary ICD-10 codes documented as POA during the index admission (except for the palliative care code of 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. We also considered age, frailty, and an indicator for whether the admission was for an MA vs. Medicare FFS beneficiary. We note that specific Z codes for economic disadvantage factors (see [Table 3](#)) were removed from the candidate list to allow for the selection of clinical risk variables; we later tested the impact of adding DE to the model (see [section 2.7.3](#)).

Note: The development of this measure began while COVID-19 adaptations were still applied to CMS's claims-based measures.²⁴ For EDAC measures, this included: a cohort exclusion, excluding admissions with a secondary diagnosis code POA of COVID-19 (U07.1); an outcome exclusion, excluding outcomes with a principal or secondary diagnosis POA of COVID-19 (U07.1); and an addition to the risk model to adjust for a history of COVID-19. These COVID adaptations applied during measure development and analyses performed with one year of data from January 1, 2022, to December 30, 2022, including risk variable selection.

Table 3. Z Codes Removed from Candidate List of Risk Variables

Z codes	Z code description
Z55	Problems related to education and literacy
Z56	Problems related to employment and unemployment
Z57	Occupational exposure to risk factors
Z58	Problems related to the physical environment
Z59	Problems related to housing and economic circumstances
Z60	Problems related to the social environment
Z62	Problems related to upbringing
Z63	Other problems related to a primary support group, including family circumstances
Z64	Problems related to certain psychosocial circumstances
Z65	Problems related to other psychosocial circumstances

The variable selection of individual ICD-10 codes mainly relied on data-driven methodologies involving three key steps: 1) identifying candidate risk variables for testing in the risk model, 2) evaluating the bivariate association with outcome, and 3) consideration of associations between other non-individual-ICD-10 code variables, including frailty, with the outcome. In the first step, we screened and included ICD 10 codes identified at the index admission (index codes) and those captured in the 12 months prior to admission (pre-index codes) if their prevalence exceeded 0.5% and 2.5%, respectively. Further, co-occurring index and pre-index codes (at the admission level) with Pearson correlation coefficients greater than 0.8 were combined into one risk variable. Finally, pairs of identical index and pre-index ICD-

10 codes with similar odds ratios that acted in the same direction (where the difference in association with the outcome, measured by odds ratio (OR), was less than 0.2) were merged. We note that the first step (identifying candidate risk variables based on prevalence) used a 100% sample of the CY2022 dataset, but that all subsequent steps were based on a random 70% sample.

In the second step, we included the remaining candidate variables including age in a multivariable logistic regression model that underwent variable selection through 1,000 iterations of bootstrapping. We selected variables that were statistically significantly associated with the outcome ($p < 0.05$) in at least 80% of the bootstrapped samples. We determined if additional variables should be added to the multivariate model by examining if there was a resulting increase in the model c-statistic (using a threshold of at least a 0.0005 increase in c-statistic for each additional variable, or an increase of at least 0.005 for including additional variables within the next 5% of bootstrapped samples [variables that were statistically significantly associated with the outcomes in at least 75% of the bootstrapped samples]); however, increases in the c-statistic did not meet these thresholds when additional variables were evaluated.

In addition, 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 did not include sex as a variable since sex can be considered a socio-demographic variable. (History of coronavirus disease 2019 [COVID-19] was added to the model following variable selection, to be consistent with CMS policy at the time of measure development. This variable will not be included in the risk model for future implementation of the measure.)

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).

The process described above for identifying risk variables resulted in the selection of 46 variables. We then reviewed this list and made the following minor adjustments for face validity, resulting in a final list with 42 variables.

- **Laterality:** When an ICD code identified a variable that indicated laterality (e.g., a left or right side of the body), we ensured that the same code for the other side of the body, and codes identified as bilateral and unspecified for laterality, were included. For example, the pre-index (in the prior 12 months) ICD-10 code for "Pain in left foot" (M79.672) was selected during the bootstrapping step, and we added "Pain in right foot" (M79.671) and "Pain in unspecified foot" (M79.673). Related codes were combined into a single variable; for example, all "Pain in foot" codes (M79.671, M79.672, M79.673) were combined into one variable.
- **Deduplication:** During bootstrapping, three ICD-10 codes were selected that overlapped with the MCC frailty variable (history code Z89.421 and index codes E44.0 and E43); we removed the overlapping codes from the list of selected variables.

For the final risk-adjustment model, we used a hierarchical generalized linear model. This consists of a binomial model specified for days in acute care as a proportion of the number of exposure days (alive days up to 30 days post-discharge) and includes random effects for hospitals. This allowed us to account for the within-hospital correlation of the observed outcome and accommodates the assumption that underlying differences in quality across hospitals lead to systematic differences in outcomes.

Explicitly, let Y_{ij} denote the number of days in acute care experienced by the i -th patient discharged from the j -th hospital, and ω_{ij} the patient's exposure time (the number of days alive up to 30). Let π_{ij} denote the probability of receiving acute care per day for the i -th patient discharged from the j -th hospital. The binomial model is as below:

$$Y_{ij} \sim \text{Binomial}(\omega_{ij}, \pi_{ij})$$

$$\text{logit}(\pi_{ij}|X_{ij}) = X_{ij}C + v_j$$

where $v_j \sim N(C_0, \sigma^2)$ denotes the hospital-specific random effect for hospital j . X_{ij} is a vector of patient risk factors, and C is the vector of covariate coefficients.

We estimated the model and used the coefficient vectors C and the random effects v_j to calculate the predicted and expected days in acute care for each index admission. Specifically, the predicted number of days is calculated as:

$$\textbf{Predicted} \quad P_{ij} = \text{logit}^{-1}(X_{ij}C + v_j) * \omega_{ij}$$

And, the expected number of days is calculated as:

$$\textbf{Expected} \quad E_{ij} = \text{logit}^{-1}(X_{ij}C + C_0) * \omega_{ij}$$

where C_0 is the mean of the random effects v_j .

We then calculated the EDAC for the hospital j as:

$$EDAC_j = 100 * \sum(P_{ij} - E_{ij})/m_j$$

where the sum is over all patients at hospital j and m_j is the number of index admissions at hospital j . To be consistent with the reporting of EDAC measures in alignment with CMS' 30-day readmission measures, we multiply the final measure score by 100 to represent EDAC per 100 discharges.

2.6.2 Model Performance

As part of risk variable selection, we randomly split the CY2022 dataset into two samples, with 70% of each hospital's discharges in one sample (the development dataset), and 30% of each hospital's discharges in another sample (the validation dataset). We used the development dataset to select final risk variables (starting with the bootstrapping step), and both the development and validation datasets for model testing.

To assess model performance, we assessed model discrimination and calibration, as well as overfitting.

To assess discrimination, we computed two discrimination statistics, the c-statistic and predictive ability. The c-statistic is the probability that predicting the outcome is better than chance, which is a measure of how accurately a statistical model can distinguish between a patient with and without the outcome. Predictive ability measures the ability to distinguish high-risk subjects from low-risk subjects; therefore, for a model with good predictive ability, we would expect to see a wide range in observed outcomes between the lowest and highest deciles of predicted outcomes. To assess predictive ability, we calculated the mean observed proportion of days in acute care of the lowest and the highest predicted deciles of proportion of days in acute care within 30-days post discharge.

For model calibration, we assessed calibration plots for both CY2022 development and validation datasets, as well as for CY2022/2023 data, with mean predicted and mean observed days in acute care plotted against deciles of predicted days in acute care. The closer the predicted days are to the observed days, the better calibrated the model is.

In addition, we provide an analysis of overfitting. Overfitting refers to the phenomenon in which a model accurately describes the relationship between predictive variables and outcomes in the development dataset but fails to provide valid predictions in new patients. Estimated calibration values of γ_0 close to 0 and estimated values of γ_1 close to 1 provide evidence of good calibration of the model.

2.6.3 Model Performance for Special Populations

In addition to examining the calibration of the model across all index admissions for diabetes, as described above, we also examined calibration for specific subpopulations of patients identified by our clinical experts and TEP, including patients with and without amputation at the index admission, type 1 and type 2 diabetes, and patients with and without dialysis at the index admission,. These analyses were performed to ensure that the risk model was well calibrated across patients with a higher risk of the outcome (e.g., patients with amputation are at higher risk for the outcome compared with patients that did not undergo amputation).

2.7 Measure Testing

2.7.1 Measure Score and Entity-Level Reliability

We calculated reliability at both the measure score level and at the entity level.

To calculate measure score level reliability, we used the permutation split-sample reliability (SSR) approach.²⁵ Using two years of data (CY2022/2023), we randomly split each hospital's index admissions for diabetes into two groups, and calculated the measure score for each half-sample of each hospital. Then, to assess the agreement between the two half-samples, the intra-class correlation coefficient (ICC) was calculated (2,1),²⁶ and a correlation using the Spearman-Brown prophecy formula was performed.²⁷ We repeated this process, randomly sampling the data 100 times without replacement, and as a metric of agreement, we calculated the average ICC across all 100 samples.^{25,26,28} We calculated permutation SSR for all hospitals with at least one admission and for hospitals with at least 25 admissions.

For entity-level reliability, signal-to-noise reliability was calculated to quantify how much of the observed variation in the measure score was due to true differences between hospitals rather than random variation. We used two years of data (CY2022/2023) to calculate the signal-to-noise reliability for a hospital with observed case size n , using the following method presented by Adams and colleagues (2010),²⁹

$$\frac{\sigma_{\text{facility-to-facility}}^2}{\sigma_{\text{facility-to-facility}}^2 + \frac{\sigma_{\text{facility-error}}^2}{n}}.$$

Facility-to-facility variance is between-hospital variance (signal), which is estimated from the hierarchical binomial model; and the facility error variance is the residual variance (noise), which is estimated using the variance of the logistic distribution ($\pi^2/3$).

2.7.2 Validity Testing

Face Validity

We systematically assessed the face validity of the measure score as an indicator of quality by soliciting TEP members' agreement, via a survey, with the following question: "Do you think that the Diabetes EDAC measure as specified, can distinguish between better and/or worse performance across hospitals?" We measured agreement using a six-point scale (strongly agree, agree, somewhat agree, somewhat disagree, disagree, strongly disagree).

Empiric (Construct) Validity

We also explored validation through meaningful comparisons of the Diabetes EDAC measure scores with those from existing quality metrics where we would expect to see a relationship. We examined correlations between Diabetes EDAC measure scores and components of the [Overall Hospital Star Ratings](#), including the Readmission Group Score (with and without the related hospital-wide readmission measure), the Summary Score (with and without the entire Readmission Group), and the Patient Experience Group score. Because the Diabetes EDAC measure score is on a lower-is-better scale, and the Star Ratings scores are on a higher-is-better scale, we hypothesized that the Diabetes EDAC measure would be negatively correlated (weakly to moderately) with Star Ratings-related measure scores. We also examined the correlation between the Diabetes EDAC measure score and [Medicare Spending Per Beneficiary](#) (MSPB). For MSPB, higher scores are associated with higher costs, so we hypothesized that the Diabetes EDAC measure would be positively correlated (weakly to moderately) with MSPB. For these analyses, we used CY2022/2023 data for the Diabetes EDAC measure scores and MSPB, and Star Ratings preview data from the April 2025 release on Care Compare with measure dates of data ranging from 07/2020 to 06/2023.

2.7.3 Economic Disadvantage Testing

It is known that patients with economic disadvantages can have both higher rates of diabetes, as well as higher rates of readmission³⁰ and worse overall health outcomes. To understand the impact of economic disadvantage on the Diabetes EDAC measure, we examined DE as follows:

- Patient and hospital-level prevalence of DE.
- Unadjusted outcomes for patients with DE.
- Impact of adjusting for DE on measure scores.
- Relationship between the hospital proportion of patients with DE and measure scores.

For these analyses, we used one year of data (CY2022) and examined DE as a surrogate marker for economic disadvantage. Dually enrolled beneficiaries are individuals who qualify for both Medicare and, because of poverty, Medicaid benefits. DE data for Medicare and Medicaid are 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.

3. RESULTS

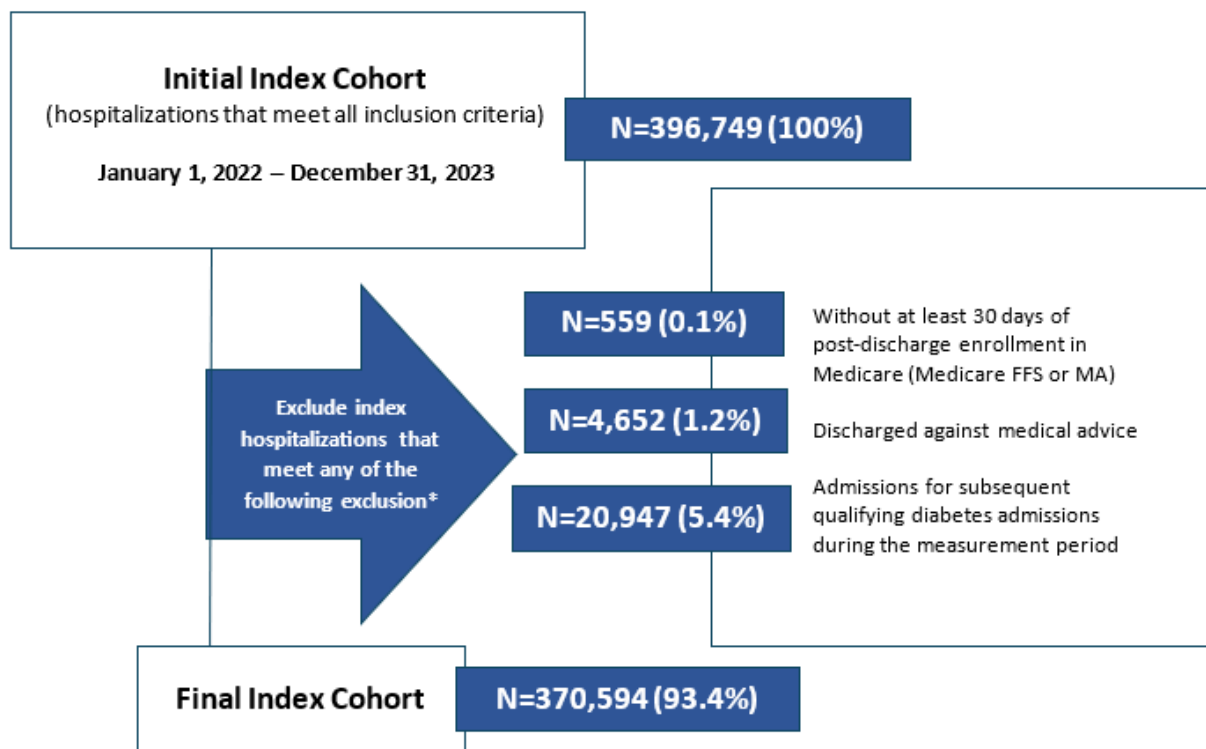
In this section, we provide testing results for the Diabetes EDAC measure.

3.1 Measure Cohort

The inclusion and exclusion criteria for this measure are presented in [Table 2](#); [Figure 1](#) shows the percentage of admissions that met each exclusion criterion in the CY2022/2023 dataset (January 1, 2022-December 31, 2023). The final cohort size is 370,594 with two years of data.

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

Figure 1. Diabetes 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.

3.2 Unadjusted Diabetes EDAC Measure Outcomes for All Index Admissions

[Table 4](#) shows the distribution of unadjusted (observed) Diabetes EDAC measure outcomes for all index admissions for diabetes using data from the CY2022/2023 (January 1, 2022-December 31, 2023) dataset. The mean number of observed days per 100 discharges in acute care among 370,594 index admissions for diabetes was 172 (standard deviation [SD], 398), with a mean of 147 (SD, 387) readmission days, 20 (SD, 55) observation days, and 12 (SD, 64) ED days.

Table 4. Unadjusted Outcomes for All Index Admissions: Observed Days in Acute Care and Readmission, Observation, and ED Days per 100 Discharges (January 1, 2022 – December 31, 2023) (N=370,594)

Acute Care Days	Mean (SD) per 100 Discharges
Observed Days in Acute Care	172 (398)
Readmission Days	147 (387)
Observation Days	20 (55)
ED Days	12 (64)

3.3 Final Risk Model Variables

[Table 5](#) shows the frequencies and the risk-adjusted ORs with 95% confidence intervals (CIs) of all risk variables in the Diabetes EDAC risk model for index admissions in the two-year dataset (CY2022/2023, January 1, 2022-December 31, 2023).

Table 5. Diabetes EDAC Measure Risk Model Variables: Frequency and Adjusted OR with 95% Confidence Intervals (January 1, 2022 – December 31, 2023)

Variable	Description	Percentage (%) (N=370,594)	OR (95% CI)
AGE	Age, mean (SD)	75.1 (7.17)	1.00 (1.00, 1.00)
ICD-10 codes during the index admission			
IND_B9561	Methicillin susceptible Staphylococcus aureus infection as the cause of diseases classified elsewhere	2.87	0.81 (0.80, 0.82)
IND_C7951	Secondary malignant neoplasm of bone	0.57	1.29 (1.25, 1.33)
IND_D631	Anemia in chronic kidney disease	13.44	1.32 (1.31, 1.33)
IND_D638	Anemia in other chronic diseases classified elsewhere	4.27	1.22 (1.21, 1.24)
IND_D649	Anemia, unspecified	10.21	1.13 (1.12, 1.14)
IND_E860	Dehydration	12.40	0.97 (0.96, 0.98)
IND_E871	Hypo-osmolality and hyponatremia	13.44	1.12 (1.11, 1.13)
IND_I10	Essential (primary) hypertension	35.81	0.82 (0.81, 0.82)
IND_I447	Left bundle-branch block, unspecified	0.92	1.07 (1.04, 1.09)
IND_I96	Gangrene, not elsewhere classified	5.20	1.18 (1.17, 1.20)
IND_N400	Benign prostatic hyperplasia without lower urinary tract symptoms	8.76	0.94 (0.93, 0.95)
IND_R188	Other ascites	0.60	1.64 (1.59, 1.68)
IND_T380X5A	Adverse effect of glucocorticoids and synthetic analogues, initial encounter	0.95	1.26 (1.23, 1.29)
IND_T383X6A	Underdosing of insulin and oral hypoglycemic [antidiabetic] drugs, initial encounter	1.70	0.91 (0.89, 0.93)

Variable	Description	Percentage (%) (N=370,594)	OR (95% CI)
IND_Z515	Encounter for palliative care	2.75	0.97 (0.95, 0.98)
IND_Z66	Do not resuscitate (DNR)	8.61	0.93 (0.92, 0.94)
IND_Z7984	Long term (current) use of oral hypoglycemic drugs	29.55	0.85 (0.85, 0.86)
IND_Z79899	Other long term (current) drug therapy	27.99	0.91 (0.90, 0.91)
ICD-10 codes in the 12 months prior to admission			
PRE_E1010	Type 1 diabetes mellitus with ketoacidosis without coma	3.93	1.26 (1.24, 1.27)
PRE_E1151	Type 2 diabetes mellitus with diabetic peripheral angiopathy without gangrene	38.03	1.02 (1.02, 1.03)
PRE_E860	Dehydration	17.75	1.12 (1.12, 1.13)
PRE_E875	Hyperkalemia	19.36	1.17 (1.17, 1.18)
PRE_E876	Hypokalemia	16.72	1.17 (1.17, 1.18)
PRE_F17210	Nicotine dependence, cigarettes, uncomplicated	11.57	1.09 (1.08, 1.10)
PRE_I739	Peripheral vascular disease, unspecified	38.42	1.07 (1.06, 1.08)
PRE_I96	Gangrene, not elsewhere classified	14.02	1.05 (1.04, 1.06)
PRE_J90	Pleural effusion, not elsewhere classified	14.18	1.29 (1.28, 1.30)
PRE_R000	Tachycardia, unspecified	10.99	1.13 (1.12, 1.14)
PRE_R1110	Vomiting, unspecified	4.59	1.15 (1.14, 1.17)
PRE_R296	Repeated falls	8.89	1.14 (1.13, 1.15)
PRE_Z1231	Encounter for screening mammogram for malignant neoplasm of breast	9.39	0.91 (0.90, 0.92)
PRE_Z7952	Long term (current) use of systemic steroids	3.45	1.21 (1.19, 1.22)
PRE_Z9114	Patient's other noncompliance with medication regimen	5.17	1.19 (1.18, 1.20)
PRE_Z9119	Patient's noncompliance with other medical treatment and regimen	3.42	1.15 (1.14, 1.17)
ICD-10 codes either during the index admission or 12 months prior to admission			
E11649	Type 2 diabetes mellitus with hypoglycemia without coma	21.90	1.14 (1.13, 1.15)
J449	Chronic obstructive pulmonary disease, unspecified	24.67	1.11 (1.11, 1.12)
COMB1: IND_I70261 IND_I70262 IND_I70263 PRE_I70261 PRE_I70262 PRE_I70263	Atherosclerosis of native arteries of extremities with gangrene, right leg Atherosclerosis of native arteries of extremities with gangrene, left leg Atherosclerosis of native arteries of extremities with gangrene, bilateral legs	12.99	1.28 (1.27, 1.29)

Variable	Description	Percentage (%) (N=370,594)	OR (95% CI)
COMB2: IND_M86171 IND_M86172 IND_M86179	Other acute osteomyelitis, right ankle and foot Other acute osteomyelitis, left ankle and foot Other acute osteomyelitis, unspecified ankle and foot	9.41	0.82 (0.81, 0.83)
COMB3: IND_I70221 IND_I70222 IND_I70223 PRE_I70221 PRE_I70222 PRE_I70223	Atherosclerosis of native arteries of extremities with rest pain, right leg Atherosclerosis of native arteries of extremities with rest pain, left leg Atherosclerosis of native arteries of extremities with rest pain, bilateral legs	10.61	1.12 (1.11, 1.13)
COMB4: PRE_M79672 PRE_M79671 PRE_M79673	Pain in left foot Pain in right foot Pain in unspecified foot	23.25	1.03 (1.03, 1.04)
COMB5: PRE_I70201 PRE_I70202 PRE_I70203	Unspecified atherosclerosis of native arteries of extremities, right leg Unspecified atherosclerosis of native arteries of extremities, left leg Unspecified atherosclerosis of native arteries of extremities, bilateral legs	14.70	1.02 (1.02, 1.03)
Other risk variables			
MA	MA (versus FFS)	54.76	1.09 (1.08, 1.10)
MCCFI	Multiple Chronic Conditions Frailty Index	68.12	1.29 (1.28, 1.30)

3.4 Model Testing Results

3.4.1 Model Testing Results, All Patients

Risk model development and initial testing were conducted using the CY2022 (one-year) dataset. After applying all measure inclusion and exclusion criteria, this dataset included 172,139 discharges for index admissions for diabetes. The development sample from this dataset consisted of 120,712 discharges from 3,760 hospitals. In the development sample, more than half of the hospitalizations for diabetes were male patients (n=67,526, 55.94%) and had a mean age of 75.1 years. The validation sample from the dataset consisted of 51,427 discharges from 3,358 hospitals. More than half of the index admissions for diabetes in the validation sample were male patients (n=28,599, 55.61%) and had a mean age of 75.1 years.

Model performance statistics in [Table 6](#) show that the risk model has acceptable c-statistics for this type of measure, good predictive ability, and good evidence for lack of overfitting. The calibration plots using CY2022 data in [Figure 2a](#) and [Figure 2b](#), and using CY2022/2023 data in [Figure 3](#), demonstrate good

alignment between predicted and observed outcomes, indicating that the model provides accurate probability estimates across the full range of predictions in both the one-year and two-year datasets.

Table 6. Diabetes EDAC Measure Model Testing Statistics (January 1, 2022 – December 30, 2022)

Sample	C-Statistic	Predictive Ability (%)	Overfitting (γ_0, γ_1)
Development (120,716)	0.68	1.66 – 13.23	0.00, 1.00
Validation (51,427)	0.70	1.22 – 14.43	-0.06, 0.96

Figure 2a. Diabetes EDAC Measure Development Sample Calibration Plot (January 1, 2022 – December 30, 2022)

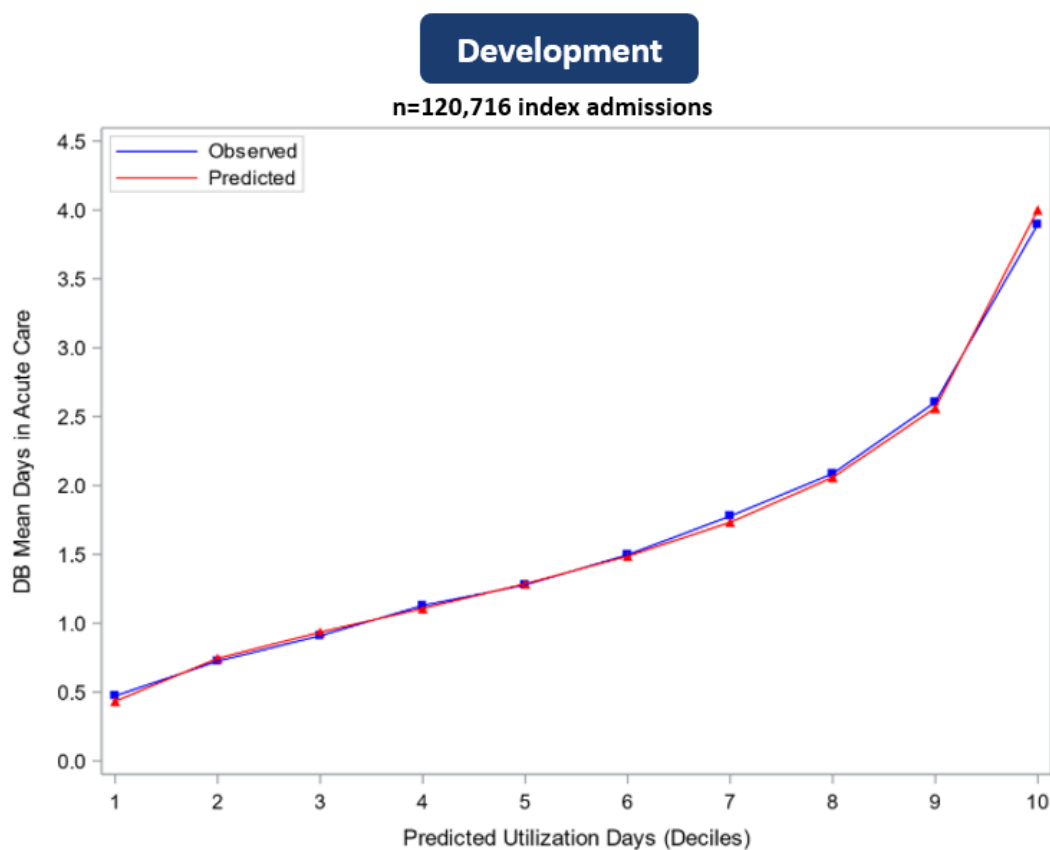


Figure 2b. Diabetes EDAC Measure Validation Sample Calibration Plot (January 1, 2022 – December 30, 2022)

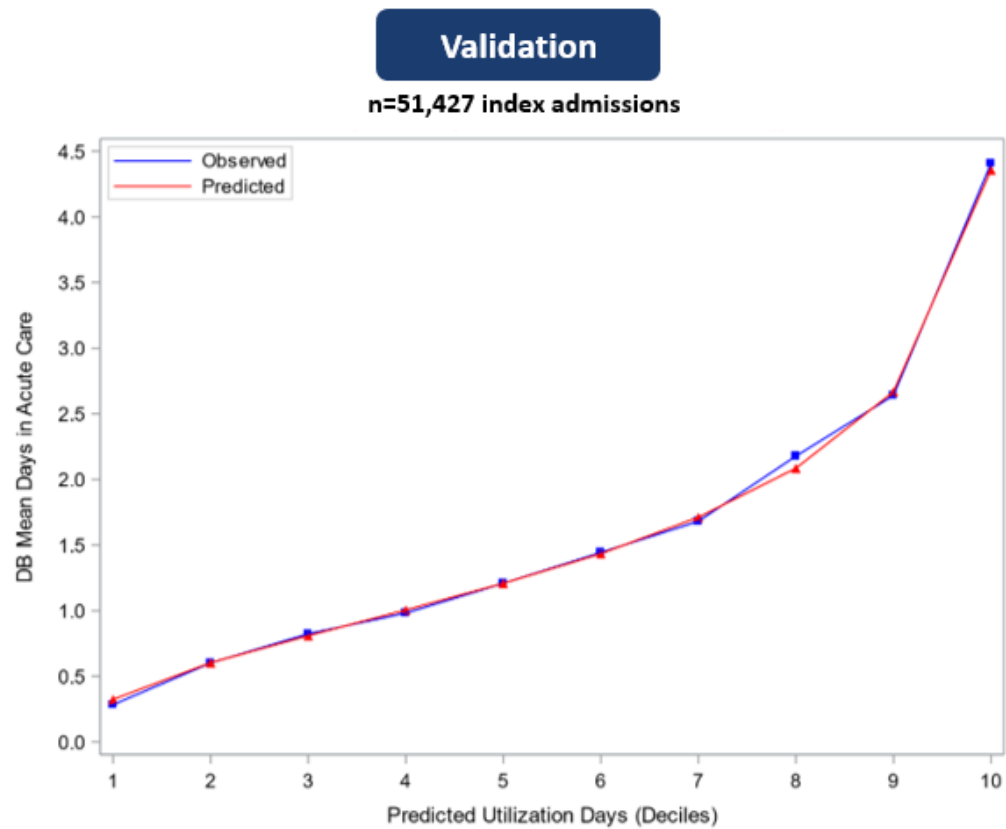
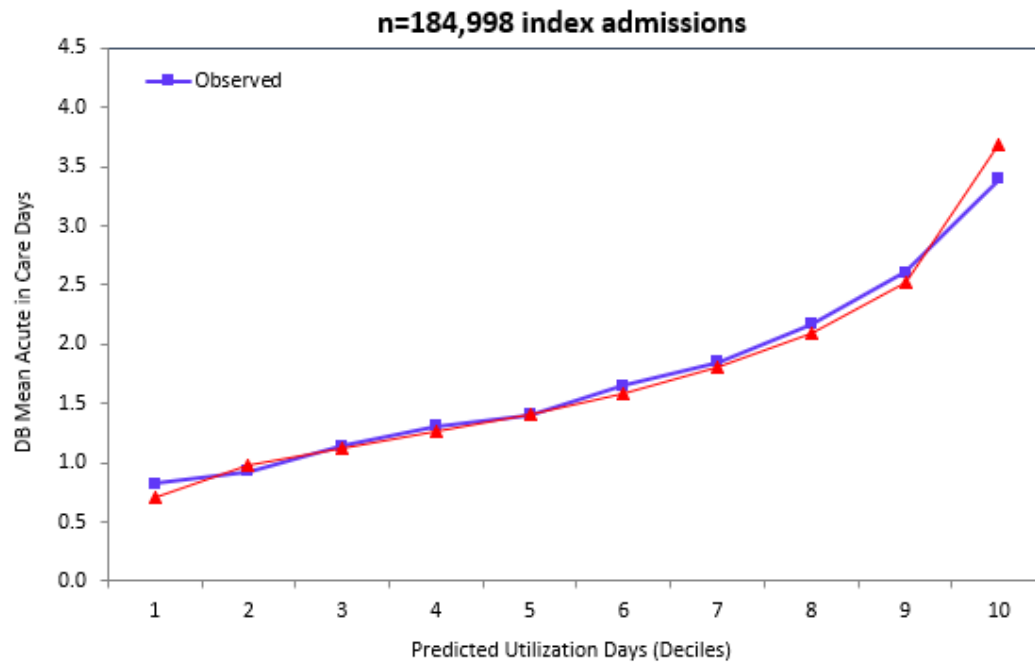


Figure 3. Diabetes EDAC Measure Calibration Plot (January 1, 2022 – December 31, 2023)



3.4.2 Calibration in Special Populations

During initial risk model development with the CY2022 dataset, CORE tested model performance within subpopulations of the Diabetes EDAC cohort, examining calibration through risk-decile plots for patients with and without an amputation procedure in the index admission, for patients with type 1 versus type 2 diabetes, and for patients on dialysis versus not on dialysis at time of index admission ([Figure 4a](#), [Figure 4b](#), [Figure 5a](#), [Figure 5b](#), [Figure 6a](#) and [Figure 6b](#)). The calibration plots all demonstrate good alignment between predicted and observed outcomes for all sub-populations, indicating that the model provides accurate probability estimates across the full range of predictions even for patients at greater risk for the outcome vs. those with lower risk (e.g. patients with type 1 diabetes vs. type 2 diabetes).

Figure 4a. Calibration Plot for Index Admissions with Amputations in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)

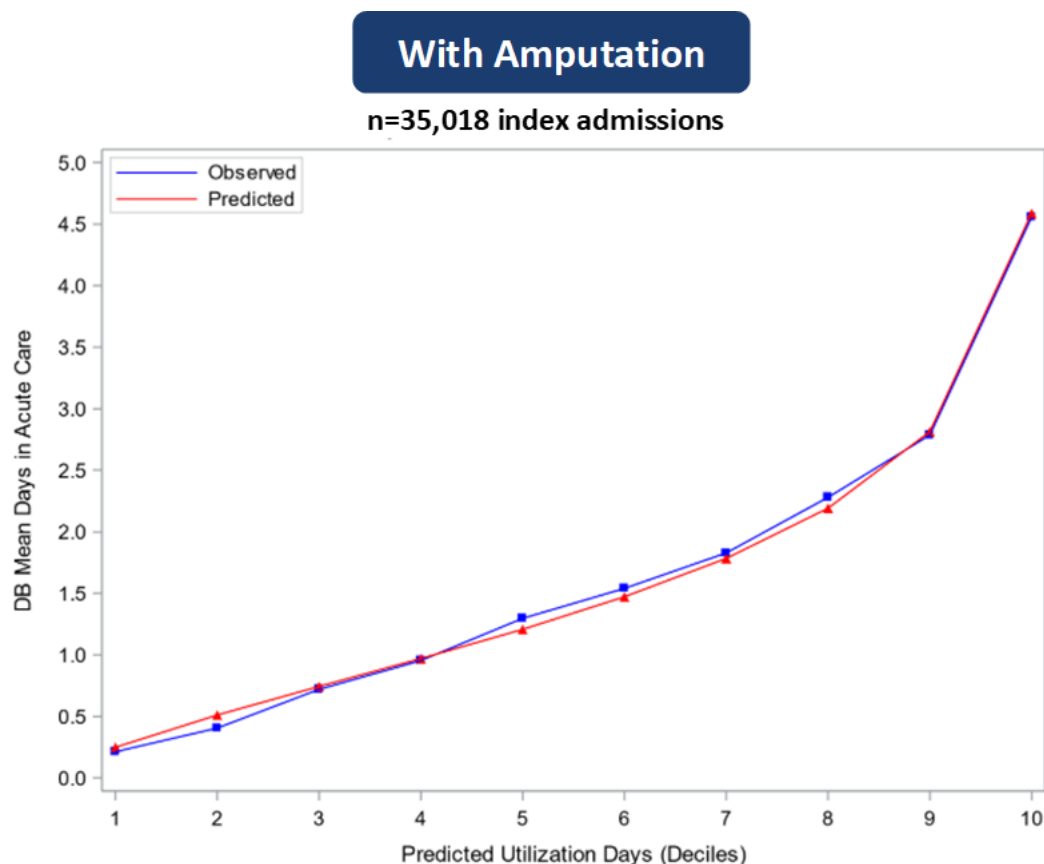


Figure 4b. Calibration Plot for Index Admissions without Amputations in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)

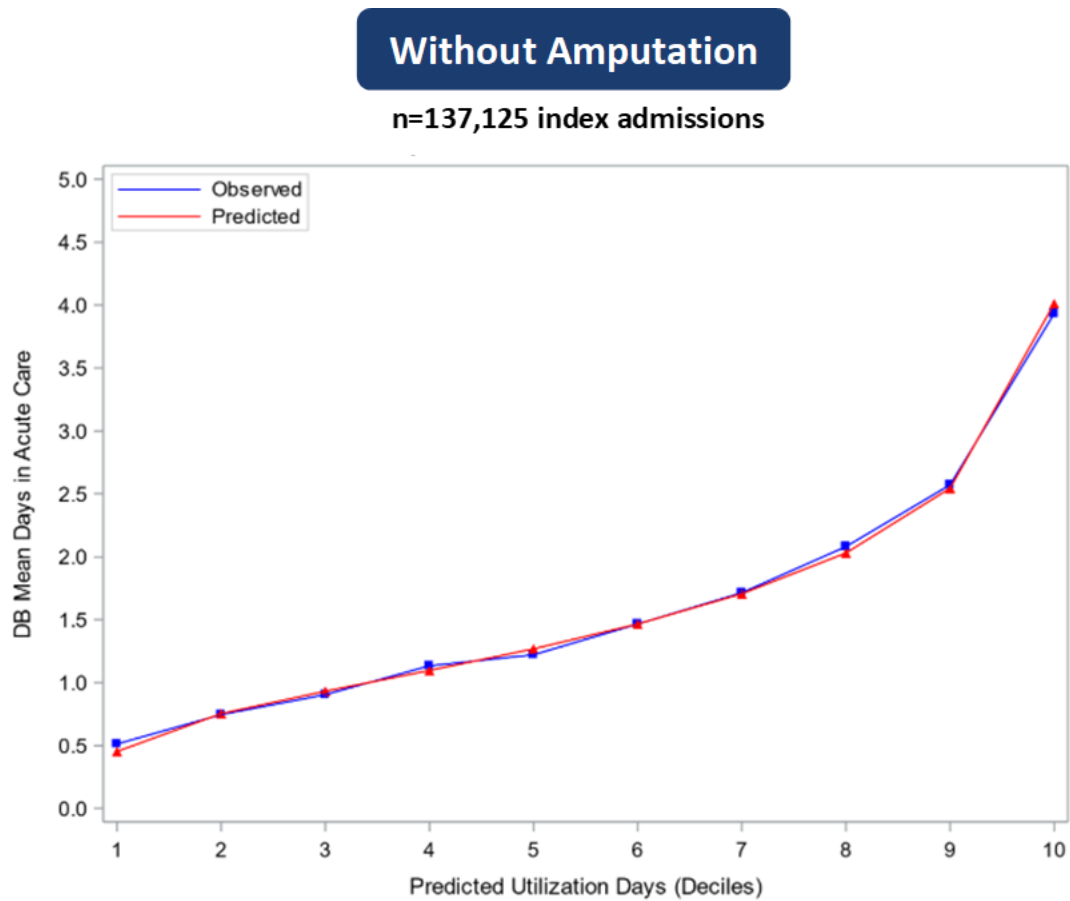


Figure 5a. Calibration Plot for Index Admissions with Type 1 Diabetes in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)

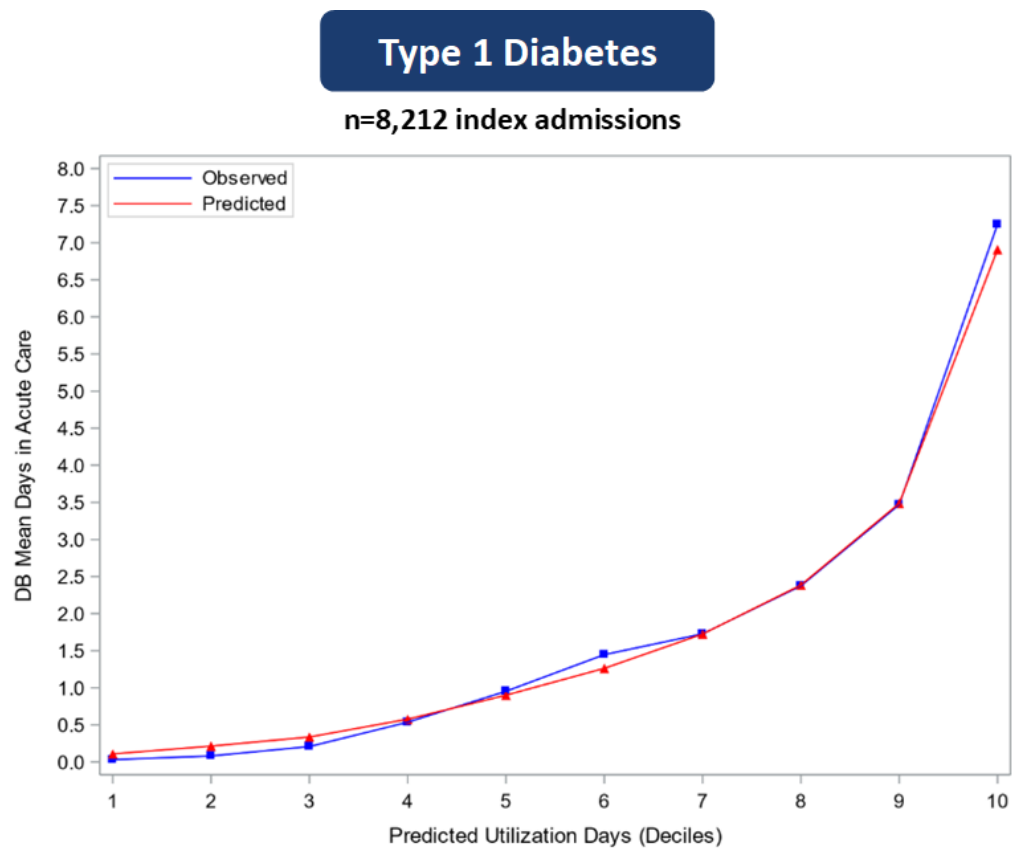


Figure 5b. Calibration Plot for Index Admissions with Type 2 Diabetes in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)

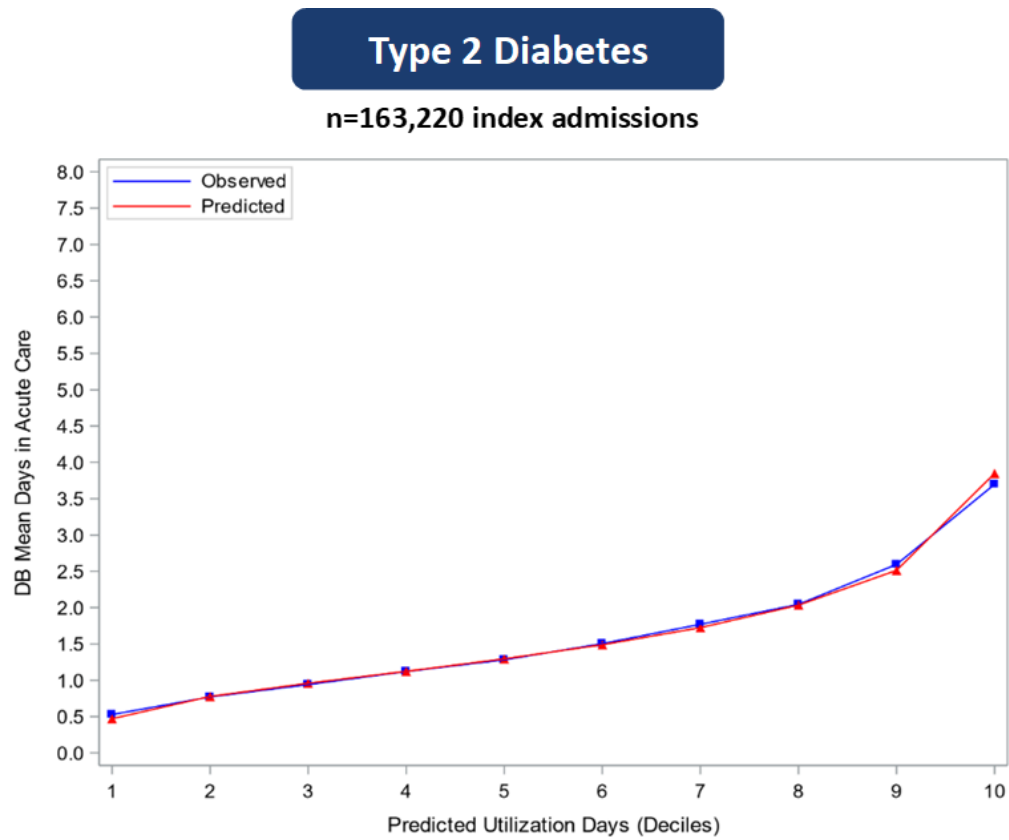


Figure 6a. Calibration Plot for Index Admissions with Dialysis at the Index Admission in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)

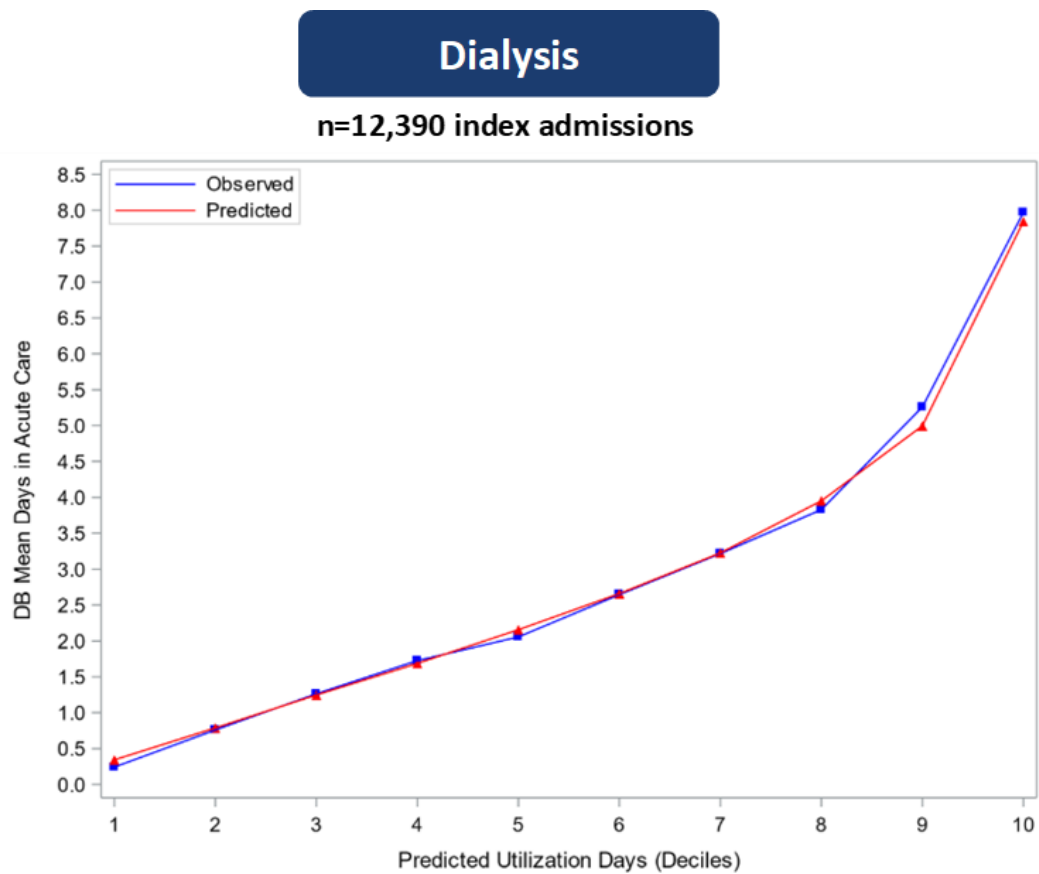
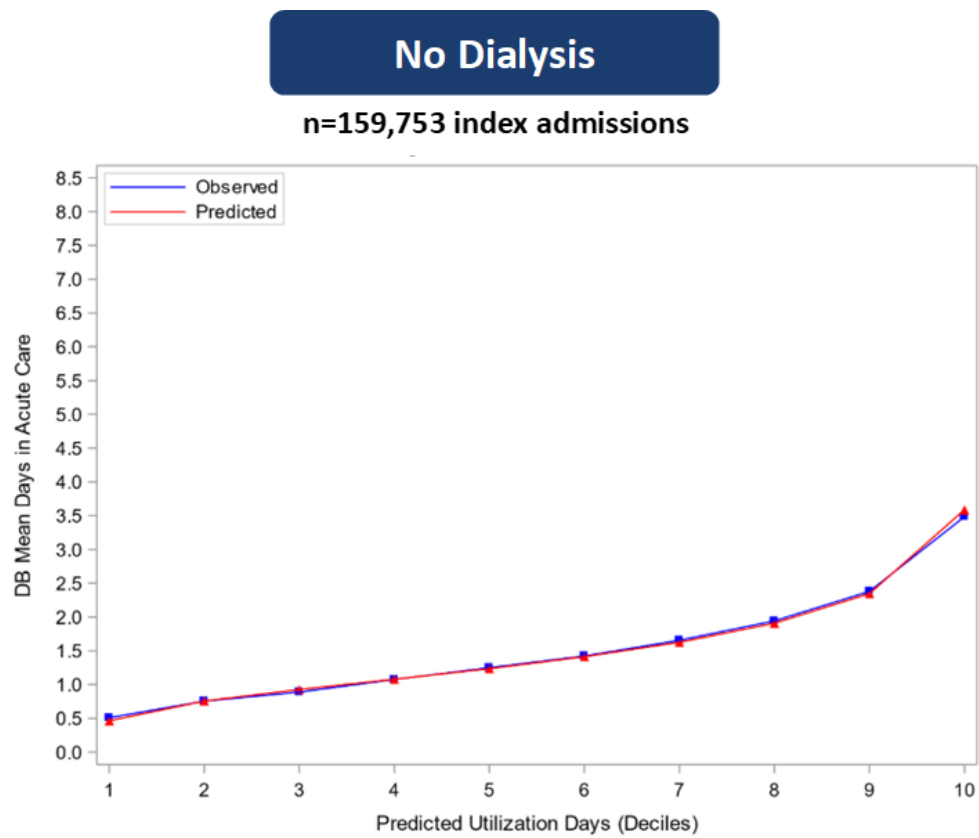


Figure 6b. Calibration Plot for Index Admissions without Dialysis at the Index Admission in Diabetes EDAC Measure Cohort (January 1, 2022 – December 30, 2022)



3.5 Hospital-Level Results

3.5.1 Distribution of Hospital Volume of Index Admissions for Diabetes

[Table 7](#) shows the distribution of hospital volume of index admissions for the Diabetes EDAC measure for a two-year period using data from the CY2022/2023 dataset (January 1, 2022-December 31, 2023). Among 4,193 hospitals with at least one index admission for diabetes discharged during the two-year period, the range of volume of index admissions per hospital (minimum to maximum) was 1-2,088, the mean was 88 (with SD, 127), and the median was 37 (interquartile range, 6-132).

Table 7. Distribution of Hospital Volume of Index Admissions for Diabetes EDAC Measure Cohort, January 1, 2022 – December 31, 2023 (Hospitals with at least One Index Admission, N=4,193)

Characteristic	January 1, 2022 – December 31, 2023
Mean Number of Admissions (SD)	88 (127)
Minimum-Maximum	1-2,088
25 th Percentile	6
50 th Percentile	37
75 th Percentile	132

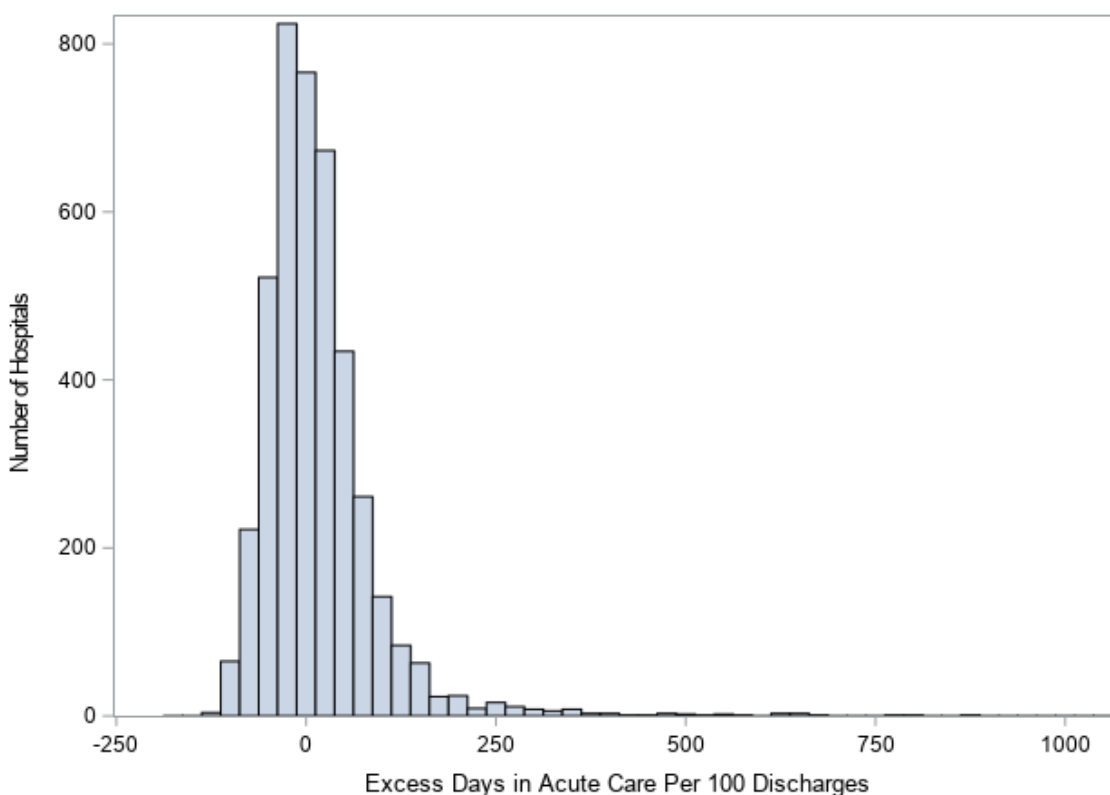
3.5.2 Distribution of Measure Scores

[Table 8](#) and [Figure 7](#) show the risk-adjusted Diabetes EDAC measure scores across hospitals. The hospital measure scores ranged from -124.5 to 1612.9 excess days in acute care per 100 discharges. The mean hospital score was 15.3 excess days per 100 discharges (SD, 80.6 excess days), and the median was 1.6 days. Variation in measure scores suggests there are meaningful differences in the quality of care received across hospitals.

Table 8. Distribution of Hospital Diabetes EDAC Measure Scores, January 1, 2022 – December 31, 2023 (Hospitals with at least One Index Admission)

Category	Value
Number of Hospitals	4,193
Mean (SD)	15.3 (80.6)
Range (min. to max.)	-124.5 to 1612.9
25 th Percentile	-29.5
50 th Percentile	1.6
75 th Percentile	40.3

Figure 7. Distribution of Hospital Diabetes EDAC Measure Scores, January 1, 2022 – December 31, 2023 (Hospitals with at least One Index Admission)



3.6 Between-Hospital Variance

[Table 9](#) shows the between-hospital variance for hospital Diabetes EDAC measure scores, which represents the ‘signal’ that hospitals perform differently on this measure.

Table 9. Diabetes EDAC Measure Between-Hospital Variance (January 1, 2022 – December 31, 2023)

Characteristic	Value
Between-hospital variance (SE)	0.266 (0.009)

SE=standard error

3.7 Reliability Testing Results

[Table 10](#) shows results of measure score reliability testing using split-half reliability, using 100 permutation split samples (see [section 2.0](#) for details) for all hospitals and for hospitals with at least 25 index admissions for diabetes, using the CY2022/2023 dataset (January 1, 2022-December 31, 2023). The average ICC split-half reliability of 0.79 (95% CI) for hospitals with at least 25 admissions exceeds the [consensus-based entity \(CBE\) endorsement threshold](#) (minimum ≥ 0.6). [Table 11](#) shows the distribution of entity level signal-to-noise reliability for all hospitals and for hospitals with at least 25 admissions, using the CY2022/2023 dataset (January 1, 2022-December 31, 2023). The minimum signal-to-noise

reliability of 0.668 for hospitals with at least 25 admissions also exceeds the CBE threshold minimum (minimum ≥ 0.6).

Table 10. Diabetes EDAC Measure Split-Half Measure Score Reliability with Bootstrapping (January 1, 2022 – December 31, 2023)

Minimum Case Volume	Average ICC across 100 bootstrapped samples
≥ 1 admission	0.43
≥ 25 admissions	0.79

Table 11. Diabetes EDAC Measure Signal-To-Noise Entity-Level Reliability (January 1, 2022 – December 31, 2023)

Minimum Case Volume	Number of Hospitals (%)	Mean (SD)	Min-Max	25 th Percentile	50 th Percentile	75 th Percentile
≥ 1	4,193 (100)	0.629 (0.311)	0.075-0.994	0.326	0.749	0.914
≥ 25	2,342 (56)	0.878 (0.082)	0.668-0.994	0.831	0.904	0.942

3.8 Validity Testing Results

3.8.1 Face Validity

[Table 12](#) shows the results of the TEP face validity vote, where [TEP members](#) indicated their agreement with the following questions: “Do you think that the Diabetes EDAC measure as specified, can distinguish between better and/or worse performance across hospitals?” 10 TEP members responded to the TEP survey; nine out of 10 (90%) agreed (strongly agreed, agreed, or somewhat agreed) in response to the face validity question, indicating support for the validity of the Diabetes EDAC measure.

Table 12. Diabetes EDAC Measure TEP Face Validity Voting Results

Response Category	Number	Frequency
Strongly Agree	4	40.0%
Agree	2	20.0%
Somewhat Agree	3	30.0%
Somewhat Disagree	0	0.0%
Disagree	1	10.0%
Strongly Disagree	0	0.0%

3.8.2 Empiric Validity

[Table 13](#) provides Pearson correlation coefficients that show the relationship between the Diabetes EDAC measure score for hospitals with at least 25 eligible admissions, and related measures (see section [2.7.2](#) for details of the methodology). These results show a statistically significant association with the expected strength and in the expected direction with measures in the same causal pathway, supporting the validity of the Diabetes EDAC measure score.

Table 13. Association (Pearson Correlation Coefficients) between Diabetes EDAC Measure Scores for Hospitals with at Least 25 Eligible Admissions (January 1, 2022 – December 31, 2023) and Comparator Measures

Comparison Measure	Number of Hospitals	Pearson Correlation Coefficient	p-value
Star Ratings Adjusted Readmission Group Scores	2,252	-0.254	<.0001
Star Ratings Adjusted Readmission Group Scores Excluding Hospital-Wide Readmission	2,231	-0.232	<.0001
Star Ratings Adjusted Summary Scores	2,252	-0.233	<.0001
Star Ratings Adjusted Summary Scores Excluding Readmission Group Score	2,252	-0.146	<.0001
Star Ratings Adjusted Patient Experience Group Score	2,238	-0.175	<.0001
Medicare Spending Per Beneficiary	2,225	0.080	.0002

Star Rating Preview Data from the April 2025 release on Hospital Care Compare with measure dates of data ranging from 07/2020 - 06/2023

3.9 Economic Disadvantage Testing

3.9.1 Hospital-Level Prevalence of Dual Eligibility (DE)

[Table 14](#) provides data on hospital proportion of index admissions for diabetes that were patients with DE, showing a median of 21.3% among 4,193 hospitals with at least one diabetes admission.

Table 14. Hospital-Level Proportion of Index Admissions for Diabetes that were Patients with Dual Eligibility (January 1, 2022 – December 31, 2023)

Variable	Median Hospital Proportion (%) (25th Percentile – 75th Percentile)
DE	21.3 (11.9 – 33.3)

3.9.2 Unadjusted Outcomes for Index Admissions for Diabetes for Patients with and without Dual Eligibility

[Table 15](#) shows that the unadjusted Diabetes EDAC measure outcome was higher for index admissions for diabetes among patients with DE compared to index admissions for diabetes among patients without DE.

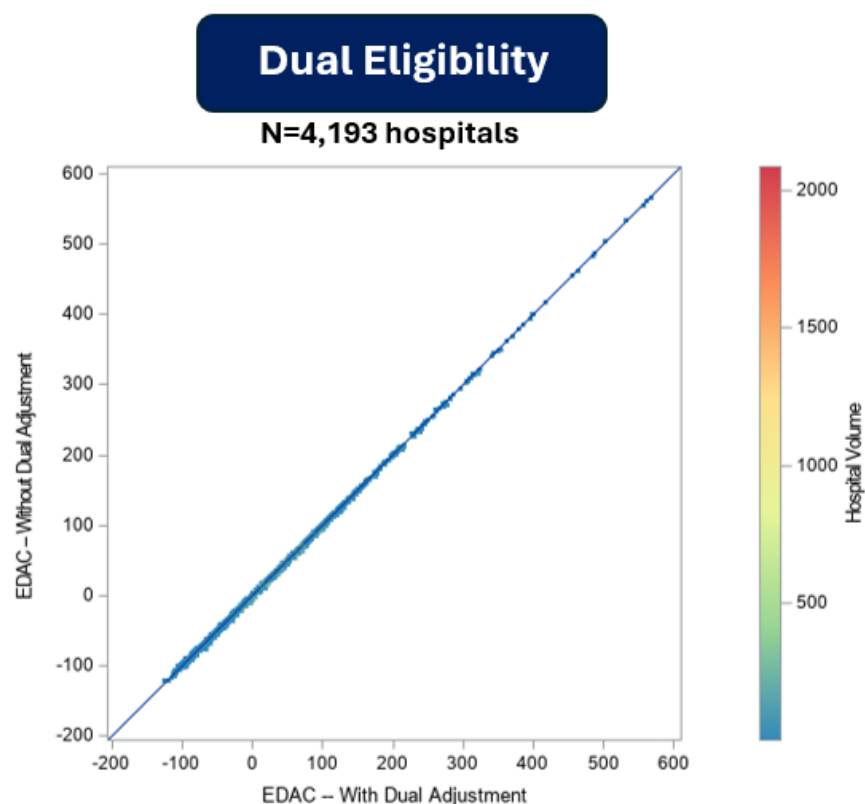
Table 15. Diabetes EDAC Measure Unadjusted Outcomes for Index Admissions for Diabetes for Patients that are Dual Eligible and Non-Dual Eligible per 100 Discharges (January 1, 2022 – December 31, 2023)

Status	Number of Index Admissions	Mean Unadjusted Days in Acute Care (SD) per 100 Discharges
DE	96,190	202 (430)
Non-DE	274,404	162 (385)

3.9.3 Impact of Dual Eligibility Adjustment on Measure Scores

[Figure 8](#) shows the impact of adjusting for DE on Diabetes EDAC measure scores. Measure scores calculated with and without the addition of DE as a risk variable, adjusted for the other variables in the risk model, were highly correlated (0.999), suggesting minimal impact of the addition of DE on measure scores in a multivariable model.

Figure 8. Diabetes EDAC Measure Scores Calculated with and without Dual Eligibility (January 1, 2022 – December 31, 2023)

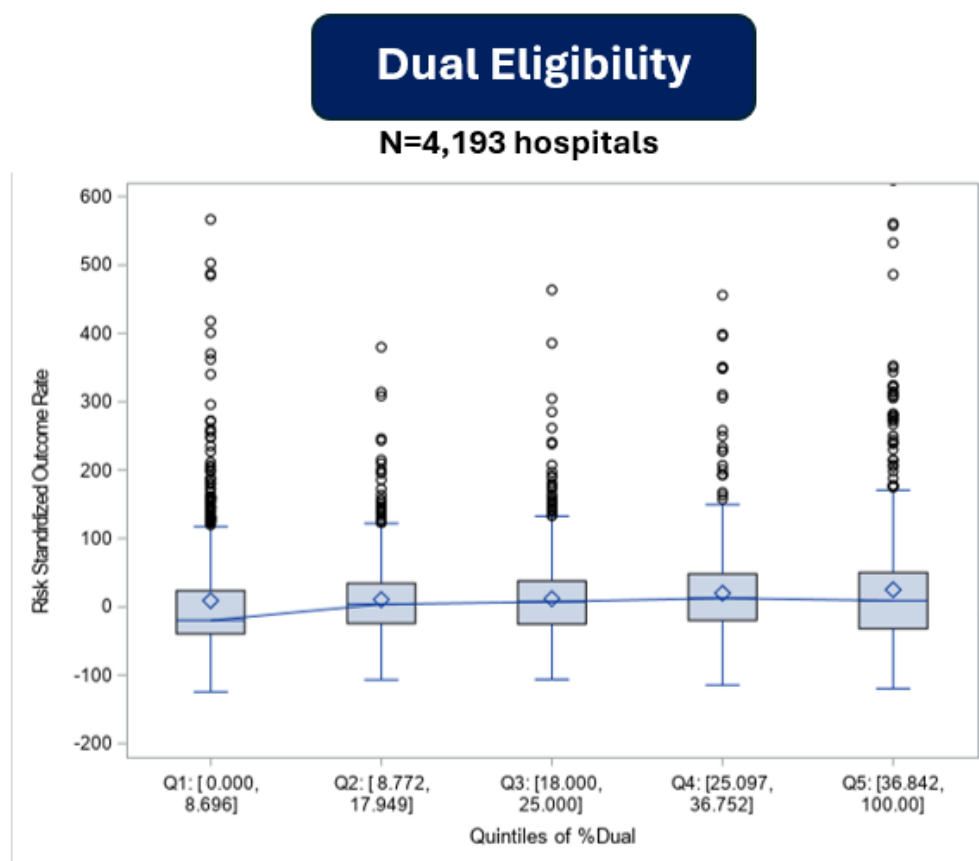


3.9.4 Relationship Between the Hospital Proportion of Index Admissions for Diabetes for Patients with Dual Eligibility and Measure Scores

In [Figure 9](#), hospitals are grouped into four quartiles by the proportion of hospital index admissions for diabetes that were for patients with DE. The figure shows that the distributions of Diabetes EDAC

measure scores within quartiles overlap across quartiles, indicating that measure performance is not distinct across quartiles. Hospitals in the fourth quartile can perform as well as hospitals in the 1st-3rd quartiles.

Figure 9. Diabetes EDAC Measure Scores by Hospital-Proportion of Index Admissions for Diabetes for Patients with Dual Eligibility (January 1, 2022 – December 31, 2023)



While testing results show that index admissions for diabetes for patients with DE have higher unadjusted rates of the outcome, including DE in the risk model resulted in a minimal impact on measure scores: measure calculated with and without DE are highly correlated, and the distribution of measure scores within quartiles of hospitals by the proportion of their index admissions for diabetes that were for patients with DE largely overlap. These empiric results did not support adjusting the measure for DE.

4. SUMMARY

The Diabetes EDAC measure, which assesses risk-adjusted days in acute care following hospitalization for diabetes, will inform healthcare providers and can help to facilitate their engagement in efforts to improve the quality of care during the hospital stay and at discharge for patients hospitalized for diabetes. Reducing ED visits, observation stays, and unplanned readmissions for patients with this common and costly condition is likely to improve outcomes for patients and impact Medicare spending. The cohort was defined by a principal diagnosis (ICD-10 codes) and risk-adjustment model (based primarily on individual ICD-10 codes), as is consistent with other existing CMS 30-day risk-adjusted EDAC measures and can be implemented using available data. Consistent with measure development guidelines, this measure was developed with input from clinical and methodological experts and multiple stakeholders, including patients.

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6. APPENDICES

Appendix A: Diabetes EDAC Clinical Consultants and Technical Expert Panel (TEP) Members

These individuals gave generously of their time, providing guidance on key clinical and methodological decisions. Without their expertise, this project would not have been possible. The names of the individuals are listed below.

Dr. Rozalina McCoy, MD, MS — Endocrinologist

Associate Professor, University of Maryland School of Medicine
Associate Division Chief for Clinical Research, Division of Endocrinology, Diabetes, and Nutrition, Department of Medicine, University of Maryland School of Medicine
Director of Precision Medicine and Population Health, University of Maryland Institute for Health Computing
Adjunct Faculty, Division of Gerontology, Department of Medicine, University of Maryland School of Medicine
Adjunct Faculty, Department of Health Policy and Management, University of Maryland School of Public Health

Dr. Kasia Lipska, MD, MHS, BS – Endocrinologist

Associate Professor, Yale School of Medicine
Affiliated Faculty, Yale Institute for Global Health
Clinical Investigator, Yale-New Haven Hospital Center for Outcomes Research and Evaluation (CORE)

Technical Expert Panel (TEP)

Name and Credentials	Organization (if applicable) and Role	Location
Rosie Bartel, MA	PFANetwork, PFCCPartners; Person Family Engagement Partner	Chilton, WI
Ann Borzecki, MD, MPH	VA Bedford Healthcare; Physician-Investigator	Bedford, MA
Jean Boyer	Person Family Engagement Partner	Picayune, MS
Sophia Brasil, MPH	Stratis Health; Senior Data Analyst	Boise, ID

Name and Credentials	Organization (if applicable) and Role	Location
Steven Coffee, MA, EM CQSL	Headquarters U.S. Cyber Command, Patients for Patient Safety, U.S., Head2HeartConnections, LLC; Colonel, USAF Director, Military Personnel, Patient Advocate/Caregiver	Dumfries, VA
Craig Davies	Person Family Engagement Partner	New Orleans, LA
Michael Duan, MS	Premier, Inc.; Principal Data Scientist	Charlotte, NC
Sachin Shah, MD, MPH	Massachusetts General Hospital, Harvard University; Physician; Clinical Researcher	Boston, MA
Donté Smith	Legacy Community Health; Person Family Engagement Partner, Caregiver/Patient Navigator	Houston, TX
Brian Stein, MD, MS	Rush University Medical Center; Physician and Chief Quality Officer	Chicago, IL
Mary Vaughan-Sarrazin, PhD	University of Iowa Department of Internal Medicine, VA Medical Center; Associate Professor, Department of Internal Medicine	Iowa City, IA
Bonnie Weiner, MD, MSEC, MBA, MSCAI, FACC, FAHA, DNBPAS	Saint Vincent Hospital, Worcester Medical Center, Accreditation for Cardiovascular Excellence; Physician and Director – Interventional Cardiology; Associate Program Director of Cardiovascular Medicine Fellowship; Chief Medical Officer at Accreditation for Cardiovascular Excellence Inc.	Harvard, MA
Prior TEP Members		
Matt Cheung, PhD, RPh <i>Dates of TEP service: 2023-2024</i>	University of the Pacific, Thomas J Long School of Pharmacy (part-time); Adjunct Professor of Pharmacy Practice, Independent Consultant (Medical Reviewer, Patient/Stakeholder Research Partner)	Gatos, CA
Ryan Merkow, MD, MS <i>Dates of TEP service: 2023-2024</i>	University of Chicago Medicine Comprehensive Cancer Center and Cancer Service Line, Department of Surgery; Director for Surgical Cancer Quality, Associate Director of Health Services Research, Director Hepatic Artery Infusion Pump Program	Chicago, IL

Appendix B: Definition of Emergency Department Visits and Observation Stays

Table B.1 — Codes Used to Define ED Visits and Observation Stays

Code (Code Type)	Description
ED Definition	
0450 (Revenue Center Code)	Emergency room-general classification
0451 (Revenue Center Code)	Emergency room- Emergency Medical Treatment and Active Labor Act (EMTALA) emergency medical screening services
0452 (Revenue Center Code)	Emergency room-ER beyond EMTALA screening
0456 (Revenue Center Code)	Emergency room-urgent care
0459 (Revenue Center Code)	Emergency room-other
0981 (Revenue Center Code)	Professional fees-emergency room
Observation Stay Definition	
0762 (Revenue Center Code)	Treatment or observation room-observation room
G0378 (Healthcare Common Procedure Coding System [HCPCS] Code)	Hospital observation service, per hour
99217 (Current Procedural Terminology [CPT] Code)	Observation care discharge day management
99218 (CPT Code)	Initial observation care, per day, for the evaluation and management of a patient which requires these 3 key components: A detailed or comprehensive history; A detailed or comprehensive examination; and Medical decision-making that is straightforward or of low complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually, the problem(s) requiring admission to outpatient hospital "observation status" are of low severity. Typically, 30 minutes are spent at the bedside and on the patient's hospital floor or unit.
99219 (CPT Code)	Initial observation care, per day, for the evaluation and management of a patient, which requires these 3 key components: A comprehensive history; A comprehensive examination; and Medical decision making of moderate complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually, the problem(s) requiring admission to outpatient hospital "observation status" are of moderate severity. Typically, 50 minutes are spent at the bedside and on the patient's hospital floor or unit.
99220 (CPT Code)	Initial observation care, per day, for the evaluation and management of a patient, which requires these 3 key components: A comprehensive history; A comprehensive examination; and Medical decision making of high complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually, the problem(s) requiring admission to outpatient hospital "observation status" are of high severity. Typically, 70 minutes are spent at the bedside and on the patient's hospital floor or unit.

Code (Code Type)	Description
99234 (CPT Code)	Observation or inpatient hospital care, for the evaluation and management of a patient including admission and discharge on the same date, which requires these 3 key components: A detailed or comprehensive history; A detailed or comprehensive examination; and Medical decision making that is straightforward or of low complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually the presenting problem(s) requiring admission are of low severity. Typically, 40 minutes are spent at the bedside and on the patient's hospital floor or unit.
99235 (CPT Code)	Observation or inpatient hospital care, for the evaluation and management of a patient including admission and discharge on the same date, which requires these 3 key components: A comprehensive history; A comprehensive examination; and Medical decision making of moderate complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually the presenting problem(s) requiring admission are of moderate severity. Typically, 50 minutes are spent at the bedside and on the patient's hospital floor or unit.
99236 (CPT Code)	Observation or inpatient hospital care, for the evaluation and management of a patient including admission and discharge on the same date, which requires these 3 key components: A comprehensive history; A comprehensive examination; and Medical decision making of high complexity. Counseling and/or coordination of care with other physicians, other qualified health care professionals, or agencies are provided consistent with the nature of the problem(s) and the patient's and/or family's needs. Usually the presenting problem(s) requiring admission are of high severity. Typically, 55 minutes are spent at the bedside and on the patient's hospital floor or unit.

Appendix C: Planned Readmission Algorithm

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

