Sepsis Readmission Measure Conceptual Model

The conceptual approach utilized for risk adjustment for this measure is built upon the robust conceptual model, methodology, and testing of over 15 CMS hospital outcome measures including seven readmission measures that have received prior CBE endorsement and been successfully utilized in national quality improvement, public reporting and payment programs.

The goal of risk-adjustment is to adjust for case-mix differences across the hospitals when evaluating performance. Risk adjustment supports fair and accurate comparison of outcomes across measured entities by including an adjustment for factors such as age, comorbid diseases, and indicators of patient frailty, which are clinically relevant and have relationships with the outcome. The model adjusts for case-mix based on the patient's clinical condition at the time of index hospitalization. However, it excludes conditions that reflect adverse outcomes resulting from the quality of care provided during the index hospitalization, as these are considered aspects of care that are in the causal pathway. While these conditions may increase the likelihood of readmission, including them as risk adjustment variables could reduce the model's ability to accurately reflect the quality of care delivered by hospitals. The model also excludes hospital characteristics, such as teaching status, to ensure consistent quality standards across hospitals. Additionally, hospital characteristics may directly influence patient outcomes rather than serve as confounding variables, making them inappropriate for adjustment.

Risk variables were selected using a clinically and data-driven, empiric approach, followed by minor adjustments for face validity. For candidate risk variable selection, we used a 50% randomly-selected sample of data from the CY2022 and CY2023 dataset, and included all secondary ICD-10 codes documented as present-on-admission (POA) during the index hospitalization (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 included age, a vetted metric of patient frailty (see below), and an indicator for whether the admission was Medicare Advantage (MA) vs. Fee-for-Service (FFS) plan.

The variable selection of individual ICD codes mainly relied on clinically and data-driven methodologies involving two key steps: (1) pre-processing, and (2) evaluating association of all candidate risk variables with outcome.

In pre-processing, we screened and included index and history (pre-index) coded variables if their prevalence among those patients having an index hospitalization for sepsis exceeded 0.5% and 2.5%, respectively. Pairs of identical index and pre-index ICD-10 codes with similar odds ratios that acted in the same direction and where the difference in association with the outcome (measured by odds ratio (OR)) was less than 0.2 were merged. Co-occurring index and pre-index codes with Pearson correlation coefficients greater than 0.8 were combined into one risk variable.

Further, we included a claims-based indicator of frailty that was developed for CMS's Multiple Chronic Conditions (MCC) measure (Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation [YNHHSC/CORE], 2019) based on evidence from the literature, expert input, guidance from the consensus-based entity for measure endorsement, the Assistant Secretary for Planning and Evaluation (ASPE, 2020), and input from other stakeholders, as well as prior testing results.

We examined the association of specific pathogenic organism-associated and non-specific organism-associated sepsis diagnosis with the outcome; sepsis due to pathogenically aggressive organisms may place patients at higher risk of readmission compared to non-specific or less pathogenic organism-associated sepsis. We then grouped sepsis diagnoses based on type of organism, direction of association with the outcome, and frequency of significance.

Further, we included an indicator for transplant recipient status and neutropenia as these are indicators for immunocompromised status, which increases the likelihood of readmission. The transplant indicator included indicators for kidney, heart, lung, liver, bone marrow, pancreas, and stem cell transplant.

We then included the candidate risk variables from the above steps, and age, in a multivariable logistic regression model that underwent variable selection through 1,000 iterations of bootstrapping. We selected variables that were statistically significantly ($p<0.05$) associated with the outcome (all-cause 30-day readmission) in at least 95% of the bootstrapped samples. We determined if additional variables should be added by examining if there was a resulting increase in c-statistic (using a threshold of at least 0.0005 for each additional variable or an increase of at least 0.005 after including additional variables within the next 5% of bootstrapped samples [e.g., moving from 95% to 80%]). We also determined whether additional variables that did not meet the level of statistical significance but were clinically relevant to the outcome should be included. Based on TEP feedback and clinical expert review, we included ICD-10 codes for sepsis pathogens and diagnoses that indicate organ compromise or failure and are markers of severe sepsis including acidosis, fluid or volume overload, hypoxemia, and hypotension.

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 Sepsis Readmission measure does not account for healthcare supply factors such as discharge disposition, for example, discharge to skilled nursing facilities (SNFs) or nursing homes (NHs), access to outpatient services, or workforce availability. While hospitals operate within resource constraints, decisions regarding how resources are allocated often fall within their control and reflect the quality of care provided to patients. The discharge destination plays a critical role in patient outcomes. Patients discharged to SNFs or NHs may experience readmissions due to poor quality of care in these

facilities. However, under the Sepsis Readmission measure, such readmissions are attributed to the hospital rather than the post-acute care facility, reinforcing the importance of hospitals ensuring appropriate discharge planning and transitions of care. One of the key strengths of readmission measures is their ability to drive critical evaluation of care processes across the continuum of care. These measures can help identify gaps in post-discharge management and highlight opportunities for improvement, potentially reducing avoidable readmissions. Hospitals have some level of control over discharge planning, including where patients are transferred for post-acute care and multidisciplinary collaboration between hospitals and SNFs or NHs is essential to ensure seamless transitions and high-quality post-acute care. If a hospital identifies high readmission rates from a specific SNF or NH, then the hospital may consider redirecting patients to facilities with better quality of care or hospitals can bargain with SNF/NH facilities to collaboratively improve care processes and patient outcomes.

CMS also tracks and reports Potentially Preventable 30-Day Post-Discharge Readmission Measure for Skilled Nursing Facility (SNF). This SNF measure is part of a pay-for-performance program, where SNFs receive incentive payments based on their performance in reducing readmissions. This accountability mechanism ensures that post-acute care providers are also held responsible for patient outcomes, aligning incentives across care settings (CMS, 2025). By ensuring effective discharge planning, post-acute care coordination, and monitoring readmission trends, hospitals can optimize patient outcomes while maintaining accountability within the healthcare system.

Hospital-level variables measure attributes of the hospital which may be related to patient risk. Examples of hospital-level variables used in studies include the proportion of dual eligible (both Medicare and Medicaid) patients served in the hospital (Popescu et al., 2019, Basu et al., 2016, Salerno et al., 2017). Among hospital-level variables, factors such as hospital length of stay, use of critical care resources (e.g., non-invasive ventilation and intensive care), and discharge to long-term care or skilled nursing facilities were significant contributors to readmission.

It is incumbent upon health systems to tailor care pathways and post-discharge support services to meet the contextual needs of the patients they serve. It would be unethical for measure developers and CMS to expect lower standards for hospitals that serve patients populations who are poorer than those who are not. Furthermore, hospitals receive extra payment for CMS as part of the disproportionate share hospital adjustment, if they serve a high proportion of low-income patients (CMS, 2023, Philips et al., 2021).

Dual-eligible Status

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. For the dual-eligible (DE) indicator, there is a body of literature demonstrating differential health care and health outcomes among beneficiaries (ASPE, 2020).

To understand the impact of DE on the Sepsis Readmission measure, we assessed the following:

1. The distribution and prevalence of DE patients among hospitals.
2. Patient-level association between DE and the unadjusted readmission rate outcome to identify potential discordant performance.
3. Impact of DE status on model performance and measure score to understand how overall performance is affected.
    a) We examined the correlation between measure scores calculated with and without DE status.
    b) We stratified the measure scores by the hospital-proportion of patients with DE status.
    c) We compared model calibration for patients with DE status to those without DE status.

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