

Claims-Only Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure: Measure Methodology for Public Comment

Submitted by

Yale New Haven Health System/ Center for Outcomes Research & Evaluation (YNHHS/CORE)

Prepared for:

Centers for Medicare & Medicaid Services (CMS)

January 2018

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Center for Outcomes Research and Evaluation (CORE) Project Team

Amy Salerno, MD* – Development Lead
Doris Peter, PhD – Reevaluation Lead
Lisa Suter, MD** – New Measure Division
Director
Karen Dorsey, MD, PhD** – Reevaluation
Division Director
Shuling Liu, PhD – Lead Analyst
Zhenqiu Lin, PhD – Director of Data
Management and Analytics
Li Li, PhD – Statistician II
Yongfei Wang, MA – Senior Statistician
Lynette Lines, MS, PMP – New Measure Division
Project Manager
Darinka Djordjevic, PhD – Reevaluation Division
Project Manager

Nicole Cormier, MPH – Project Coordinator
Erica Norton, BS – Research Associate
Fior Rodriguez, BS – Research Assistant
Rebecca Dendy, BA – Research Assistant
Jeph Herrin, PhD** – Statistical Consultant
Jacqueline Grady, MS – Statistical Consultant
and Associate Director of Data Management
and Analytics
Nihar Desai, MD, MPH** – Clinical Consultant
Susannah Bernheim, MD, MHS – Project
Director
Harlan M. Krumholz, MD, SM** – Principal
Investigator
*University of Virginia
**Yale School of Medicine

ACKNOWLEDGEMENTS

This work was a collaborative effort and the authors gratefully acknowledge and thank our many colleagues and collaborators for their thoughtful and instructive input, especially those former team members on this project: Amy Salerno, MD, MHS Development Lead, Lesli Ott, MA, MA Lead Analyst; Maggie Bierlein, MS Supporting Analyst; Maliha Tariq, BA Research Assistant; La'Mont Sutton, MPH Supporting Coordinator; Kerry McCole, M.Phil.Ed., M.S.Ed Research Associate; Kumar Dharmarajan, MD, MBA Clinical Consultant; Carolyn Presley, MD Clinical Consultant; and Theodore Long, MD, MPH Clinical Consultant.

Special thanks to Melissa Miller, MPH; Kanchana Bhat, MPH; and Lori Schroeder, LLM, JD from Yale-New Haven Health Services Corporation/Center for Outcomes Research & Evaluation; and Sharon-Lise Normand, PhD from Harvard School of Public Health.

We would like to give special thanks to Christine Broderick, Courtney Roman, and Olivia May at the National Partnership of Women and Family, along with the ten participants in our Patient and Family Caregiver Work Group. All of your feedback was invaluable to this work.

Additionally, we would like to thank the Technical Expert Panel members, who provided helpful insight and feedback on key measure decisions. We would also like to acknowledge the members of our Technical Work Group who generously gave their time to provide guidance on key clinical and statistical decisions. Please see [Appendix A Acknowledgement Details](#) for a detailed list of acknowledgements.

We would like to especially acknowledge the contribution of data and ongoing support from our colleagues affiliated with Kaiser Permanente Northern California, Gabriel Escobar, M.D., and John D. Greene, MA.

Finally, we would like to thank our Contracting Officer Representative at the Centers for Medicare & Medicaid Services, Lein Han, PhD, for her continued support of our work.

1. EXECUTIVE SUMMARY

Goal of Measure

The goal of developing a Claims-Only Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure, or claims-only HWM measure, was to broadly measure quality of care across hospitals, including the quality of care in smaller volume hospitals. The measure described in this report utilized administrative claims data as the sole data source. This measure will provide information to hospitals that can facilitate targeted quality improvement, provide more transparent information for the public, and allow policymakers to monitor a very important outcome.

This claims-only HWM measure was harmonized with a second HWM measure that used a combination of clinical data pulled from the electronic health record (EHR) and administrative claims data. When referring to either measure, we referred to the measure described in this report as the “claims-only HWM measure” to reflect its data source, and we referred to the measure utilizing both clinical and claims data as the “hybrid HWM measure”.

Background and Rationale

Mortality is an important health outcome that is meaningful to patients and providers, and updated estimates suggest that more than 400,000 patients die each year from preventable harm in hospitals.¹ The vast majority of patients admitted to the hospital have survival as a primary goal. Existing condition-specific mortality measures support targeted quality improvement work, and may have contributed to national declines in hospital mortality rates for measured conditions and/or procedures.² They do not, however, allow for measurement of a hospital’s broader performance, nor do they meaningfully capture performance for smaller volume hospitals. While we do not ever expect mortality rates to be zero, studies have shown that, for selected conditions and diagnoses, mortality within 30 days of hospital admission is related to quality of care, and that high and variable mortality rates across hospitals indicate opportunities for improvement.^{3,4} Therefore, it is reasonable to consider an all-condition, all-procedure, risk-standardized 30-day mortality rate as a quality measure.

Measure Development Process

This measure aims to report the hospital-level, risk-standardized mortality rate within 30 days of hospital admission for most conditions or procedures. The Center for Outcomes Research and Evaluation (CORE) initiated development of the measure by conducting an extensive literature review and environmental scan to inform measure development. We also engaged with several stakeholder groups throughout the development process for both the claims-only HWM measure and the hybrid HWM measure. We elicited feedback on the measure concept, outcome, cohort, risk model variables, and how to develop and report measure results in a meaningful way for patients, family caregivers, and providers. These engagements have included two advisory groups in the form of a Technical Work Group and a Patient and Family Caregiver Work Group. We also convened a national Technical Expert Panel (TEP) consisting of a diverse set of stakeholders, including providers and patients. In 2016, we also sought comment from the general public in the form of an interim public comment period on the cohort, outcome, and approach to grouping patients by condition and procedure for risk adjustment.⁵ The Public Comment Summary Report is posted under the Hospital-Wide Risk-Standardized Mortality Measure zip file, at <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment->

[Instruments/MMS/PC-Updates-on-Previous-Comment-Periods.html](#). We are now seeking input from the general public in this public comment period on the completed measure specifications.

Measure Specifications

Our cohort definition attempted to capture as many admissions as possible for which survival would be a reasonable indicator of quality and for which adequate risk adjustment is possible. We assumed survival would be a reasonable indicator of quality for admissions fulfilling two criteria: 1) survival is most likely the primary goal of the patient when they enter the hospital; and 2) the hospital can reasonably influence the patient's chance of survival through quality of care. We further narrowed the cohort definition in this initial measure version based on concerns with adequate risk adjustment using International Classification of Diseases, Ninth Revision (ICD-9) codes. We will revisit these exclusions in the next measure iteration during updating to International Classification of Diseases, Tenth Revision (ICD-10) codes.

The outcome for this measure is all-cause 30-day mortality. We defined all-cause mortality as death from any cause within 30 days of the index hospital admission date.

To compare mortality performance across hospitals, the measure accounts for differences in patient characteristics (patient case mix) as well as differences in mixes of services and procedures offered by hospitals (hospital service mix). We account for differences in patient case mix using patient clinical comorbidity variables and account for differences in hospital service mix using the patient's principal discharge diagnosis.

Rather than assume that the effects of risk variables are homogeneous across all discharge condition and procedure categories, we separated the cohort into 13 different service-line divisions and estimated separate risk models within each. We then derived a single summary score from the results of the 13 models by combining separate risk-standardized mortality ratios to calculate one hospital-wide mortality rate for each hospital. Using 13 models rather than a single model allows for better risk adjustment for diverse patient groups and improves the usability of the measure. The 13 service-line divisions include Non-Surgical: Cancer, Cardiac, Gastrointestinal, Infectious Disease, Neurology, Orthopedics, Pulmonary, Renal; Surgical: Cancer, Cardiothoracic, General, Neurosurgery, Orthopedics. The 13 divisions also allow hospitals and consumers to have more detailed information on hospital performance.

This report serves as a summary of the measure development, stakeholder input, measure specifications, and measure testing for the claims-only HWM measure.

2. PUBLIC COMMENT

Purpose of the Public Comment Period

We are seeking stakeholder feedback on two measures: 1) the Claims-Only Hospital-Wide Mortality Measure (claims-only HWM measure) and 2) the harmonized Hybrid Hospital-Wide Mortality Measure (hybrid HWM measure). Both measures are in public comment simultaneously. This is the report for the claims-only HWM measure. The report for the hybrid-only HWM measure is also posted on the CMS Public Comment website, within the same zip file as this report.

Both measures have the same cohort, outcome, and service-line divisions. The hybrid HWM measure uses a combination of claims and clinical electronic health record (EHR) data in the risk-adjustment model. Developing two measures of hospital-wide mortality is intended to give CMS options for implementation, as they move toward including more clinical EHR data in outcome measures. This public comment period seeks input from a wide variety of stakeholders regarding several key decisions made during initial measure development of the claims-only HWM measure, including the final measure cohort, measure outcome, risk-adjustment models and overall model performance.

We seek public input on the entire measure methodology, but we ask for specific input on the following aspects of the measure:

- Do you have input on the service-line division structure of the measure?
- Do you have input on the measure testing approach?
 - What additional validity testing would be meaningful for this measure?
- Do you have input on the hospital measure results?
- Do you have input on how the measure results might be presented to the public?
 - How could CMS present supplemental hospital performance information in public reporting, such as service-line division-level results, to create a more meaningful and usable measure?
 - How could CMS report more information about hospitals in a No Different From National Average group (defined using 95% confidence intervals) to help clinicians and patients use the measure results to improve patient care and make informed choices?

These questions are also flagged in call out boxes throughout the document.

Instructions for Providing Feedback

CMS requests that interested parties submit comments on the methodology for the claims-only HWM measure. Instructions are as follows:

- If you are providing comments on behalf of an organization, include the organization's name and contact information.
- If you are commenting as an individual, submit identifying or contact information.
- See the public comment website for deadline to submit comments.
- Please do not include personal health information in your comments.
- Send your comments to cms_hwmmeasure@yale.edu.

3. INTRODUCTION

3.1 Overview of Report

The Centers for Medicare & Medicaid Services (CMS) contracted with Yale New Haven Health System/Center for Outcomes Research and Evaluation (YNHHS/CORE) to develop a Claims-Only Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure based on administrative claims data. Throughout this report, we refer to this measure as the claims-only HWM measure. This hospital-level measure is intended to complement the existing CMS Hospital-Wide All-Cause Unplanned Risk-Standardized Readmission (HWR) Measure (National Quality Forum (NQF) #1789), allowing simultaneous monitoring of readmission and mortality rates across the broadest possible patient populations.

Mortality is an important outcome that is meaningful to patients and providers. The vast majority of patients admitted to the hospital have survival as a primary goal. This important outcome is already the focus of existing CMS condition- and procedure-specific mortality quality measures; hospital-level risk-standardized mortality rates (RSMRs) are reported for patients admitted for heart failure, pneumonia, acute myocardial infarction, chronic obstructive pulmonary disease, stroke, and coronary artery bypass graft surgery.^{6,7} Existing mortality measures support targeted quality improvement work around specific conditions, and may have contributed to national declines in hospital mortality rates for measured conditions and/or procedures.² They do not, however, capture admissions for patients admitted for a majority of the conditions or procedures for which a patient may use the hospital, or allow for measurement of a hospital's broader performance. In addition, the condition and procedure-specific mortality measures fail to measure performance for smaller volume hospitals.

In our measure development dataset from July 2014 - June 2015, there were more than eight million inpatient admissions among Medicare fee-for-service (FFS) beneficiaries ages 65 and over across 4,766 United States (US) acute care hospitals. The observed 30-day mortality rate was more than 9%, ranging from 5.6% among those 65-69 years old (representing approximately 20% of this population) to 21.1% among those 95-99 years old (roughly 2% of the population). As currently specified, the measure captures 57% of all eligible patients and 59% of all deaths and we are working to capture more patients through reevaluation.

In addition to the obvious harm to individuals and their families and caregivers that results from preventable death, there are also significant financial costs to the healthcare system. Capturing monetary savings for preventable mortality events is challenging, as patients who die may incur fewer expenses than those who survive. Further, distinguishing between truly preventable hospital deaths and those deaths that are truly not preventable is challenging. However, using two recent estimates of the number of deaths due to preventable medical errors, and assuming an average of ten lost years of life per death (valued at \$75,000 per year in lost quality adjusted life years), the annual direct and indirect cost of potentially preventable deaths could be as much as \$73.5 to \$735 billion.⁸⁻¹⁰

In this technical report, we provide detailed information on the development and specifications of the claims-only HWM measure. This includes details on the cohort, outcome, risk adjustment, measure testing, and reporting considerations. The claims-only HWM measure complies with accepted standards for outcome measure development, including appropriate risk adjustment and transparency of specifications. Our goal is to include admissions for patients for whom mortality is likely to present a quality signal and those where the hospital has the ability to influence the outcome for the patient. The

performance metric, risk-standardized mortality rates (RSMR) are derived from the combined results of multiple statistical models built for groups of admissions that are clinically related and share similar risk profiles. This report reflects specifications that have been developed with close input from patients, caregivers, clinicians and methodological experts. In addition, the measure reflects input from a nationally convened Technical Expert Panel (TEP) representing a diverse set of stakeholders as well as input from an interim public comment period.

3.2 Hospital-Wide Mortality as a Quality Indicator

3.2.1 Importance

Mortality is an unwanted outcome for the overwhelming majority of patients admitted to US hospitals. Although mortality within 30 days of hospitalization is uncommon, when assessed among appropriate patients, it provides a concrete signal of care quality across conditions and procedures. It captures the result of care processes, such as peri-operative management protocols, and the impact of both optimal care and adverse events resulting from medical care.

For some conditions and diagnoses, evidence supports that optimal medical care reduces mortality.^{3,4} We know from ongoing improvements in condition- and procedure-specific mortality rates that interventions to improve these outcomes are feasible.² Multiple organizations, including the Institute for Healthcare Improvement (IHI), promote a range of evidence-based strategies to reduce hospital mortality.¹¹ These strategies include:

- Adoption of strategies shown to reduce ventilator-associated pneumonia;¹²⁻¹⁴
- Delivery of reliable, evidence-based care for acute myocardial infarction;^{15,16}
- Prevention of adverse drug events through medication reconciliation;¹⁷
- Prevention of central line infections through evidence-based guideline-concordant care;¹⁸ and
- Prevention of surgical site infections through evidence-based guideline-concordant care.^{19,20}

To reduce mortality, the IHI further encourages hospitals to use multidisciplinary rounds to improve communication, employ Rapid Response Teams to attend to patients at the first sign of clinical decline, identify high-risk patients on admission and increase nursing care and physician contact accordingly, standardize patient handoffs to avoid miscommunication or gaps in care, and establish partnerships with community providers to promote evidenced-based practices to reduce hospitalizations before patients become critically ill.²¹ The IHI's 100,000 Lives Campaign, which was created to enlist hospitals in a coordinated effort to adopt the above interventions, led to an estimated more than 120,000 lives saved over the first 18 months of the campaign.²²

Some of the evidence-based recommendations above apply to specific diagnoses. While condition- and procedure-specific initiatives to reduce mortality may broadly impact mortality rates across other conditions and procedures, there is likely more to be gained by a measure of hospital-wide mortality that can inform and encourage quality improvement efforts for patients not currently captured by existing CMS mortality measures. In addition, there is evidence that a hospital's organizational culture is linked to key measures of hospital quality performance.²³ Since these cultural and leadership qualities affect the entire hospital, the claims-only HWM measure may provide important incentives for hospitals to not only examine their care processes and improve care for individual conditions, but may also provide incentives to encourage care transformation and improve overall organizational culture.

In fact, because of its importance, hospital-wide mortality has been the focus of a number of previous quality reporting initiatives in the US and other countries. Prior efforts have been met with some success and a number of challenges.²⁴ Despite these challenges, countries such as the United Kingdom, Scotland, and Australia, continue to report measures of hospital-wide mortality.²⁵

From 1986 through 1993, the Health Care Financing Administration (now CMS) measured hospital-wide mortality. Hospitals used this information to reduce avoidable deaths and closely examine hospital care processes. However, this effort was stopped partly due to concerns over the adequacy of the case-mix adjustment in the measure that was used, which was based on administrative claims data. The measure described in this report aims to address the limitations^{24,26,27} of the earlier measure specifications, which led to the removal of the measure.²⁸⁻³⁰

Other hospital-wide mortality measures have been reported in the United Kingdom and Canada. These prior efforts to measure hospital-wide mortality similarly faced a number of challenges including concerns about adequate exclusion of patients for whom survival is not the primary goal, such as hospice and palliative care patients; risk adjustment for disease severity, ability to distinguish between conditions present on admission and events occurring after admission, addressing imbalances in both case mix and capability (for example, coronary artery bypass graft surgery performed or not) across hospitals.^{26,31-33} In developing the current measure, we aimed to take advantage of advances in coding and design of the measure to address prior challenges.

While we do not expect optimal mortality rates to be zero, we know, as stated above, that studies have shown that mortality within 30 days is related to quality of care; that interventions have been able to reduce 30-day mortality rates for a variety of specific conditions; and that high and variable mortality rates indicate opportunity for improvement. Therefore, it is reasonable to consider an all-condition, all-procedure risk-standardized 30-day mortality rate as an important quality performance measure for hospitals.

3.2.2 Feasibility

Since the initial CMS hospital-wide mortality effort, much has changed to improve potential feasibility. As of 2015, administrative claims coding has advanced significantly. Advancements include allowing up to 25 diagnostic codes per admission encounter (previously there were only 10 available diagnostic codes) and expanding the use of present on admission codes to signify conditions that were present prior to admission. CMS also has the benefit of years of experience successfully calculating and reporting the claims-only condition- and procedure-specific mortality measures, including performing chart-based validation of a number of these measures. Additionally, CMS has reported results for the claims-only HWR Measure since July 2013, which utilizes novel methods to aggregate readmission rates across diverse patient cohorts, to adjust more accurately for service mix. Finally, CMS has further evolved its measure development approach to expand stakeholder engagement across all phases of measure development and to specifically include patients' perspectives and input to ensure more patient-centered measures. Therefore, it is now feasible to construct a claims-only measure which will be scientifically sound and acceptable to stakeholders.

In addition to these advances, electronic health records are now widely available, offering the ability to incorporate clinical data into measurement. The companion hybrid HWM measure is also under public comment, and is detailed in its own methodology report.³⁴ See Hybrid Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure with Electronic Health Record Extracted Risk Factors:

Measure Methodology for Public Comment, which is also posted on the CMS Public Comment website, within the same zip file as this report.

3.2.3 Usability

A primary motivation for this measure was to provide policymakers with a summary performance assessment of patient survival, particularly for lower volume hospitals that care for insufficient numbers of patients to produce stable, reportable performance estimates using condition- and procedure-specific measures. In addition, the measure is created as a complement to CMS's currently reported HWR, similar to other condition-specific paired mortality and readmission measures. This provides CMS and other stakeholders with an additional tool for simultaneous monitoring of readmission and mortality rates across the broadest possible patient populations.

From the outset, CMS and CORE sought to make this measure broadly usable by both patients and providers. Through input from multiple stakeholders, including patients, families, providers, and the public through our working groups, TEP, and interim public comment, we heard the importance of providing more detailed information than a single summary score for the usability of this measure for both clinicians and patients. Having this more granular information could increase the practical utility of the measure by providing information on differences in performance among service-line areas within hospitals.

Therefore, we approached this measure development from three distinct perspectives – policymakers, providers, and patient and family caregivers – in order to create a measure that provides meaningful, scientifically acceptable hospital performance information for all of these user groups.

3.3 Approach to Measure Development

We developed this measure in consultation with national guidelines for publicly reported outcome measures, following the technical approach to outcome measurement set forth in NQF guidance for outcome measures, CMS Measure Management System guidance, and the guidance articulated in the American Heart Association's scientific statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes."^{35,36} Further, we have engaged with several stakeholder groups continuously during the development process, eliciting feedback on the measure concept, outcome, cohort, risk model variables, measure results, and how to present the measure results in a meaningful way for patients, family caregivers, and providers. These have included two formal advisory groups:

- A Technical Work Group, comprised of clinicians and a statistician; and
- A Patient and Family Caregiver Work Group (formerly two separate groups), comprised of patients, family members, and caregivers for patients who have had multiple encounters with the healthcare system.

We also convened a national Technical Expert Panel (TEP) of diverse stakeholders, including providers and patients. We are now seeking input from the general public in this public comment period on this measure. We previously sought comment on the measure concept, cohort, outcome, approach to risk adjustment, and plans for presenting the results to the public; we are now specifically seeking public comment on the final measure cohort, risk-adjustment models, reliability, and validity of the measure.

We plan on submitting this measure to the National Quality Forum (NQF) for endorsement.

3.4 Interim Measure Development Public Comment Period Summary

We held a public comment period from November to December 2016. Overall, several commenters supported the concept and use of a HWM measure to evaluate hospital quality and drive quality improvement. The majority of the TEP also agreed with the cohort definition. Concerns expressed included the adequacy of claims-based risk adjustment and/or assessment of disease severity, correct attribution of mortality across surgical patients, and handling of hospice patients. A few commenters were concerned about the burden of additional measures on hospitals, or that an all-condition, all-procedure, all-cause mortality measure would not be as actionable or useful by hospitals. We have made updates to the measure specifications based upon this feedback, as summarized in this report, and will continue to try to incorporate stakeholder input as we work to update the measure to use ICD-10 codes.

4. METHODS

4.1 Overview

This document aims to report the development and specifications of the measurement of hospital-level, risk-standardized mortality within 30 days of hospital admission for most conditions or procedures. The measure is reported as a single summary score, derived from the results of risk-adjustment models for 13 mutually exclusive service-line divisions (admissions grouped based on categories of discharge diagnoses or procedures). Hospitalizations were eligible for inclusion in the measure if the patient was hospitalized at a non-Federal short-stay acute care hospital or critical access hospital. To compare mortality performance across hospitals, the measure accounted for differences in patient characteristics (patient case mix) as well as differences in mixes of services and procedures offered by hospitals (hospital service mix). Within a single year, the measure covered approximately 60% of hospitalized Medicare FFS beneficiaries, based upon data from July 1, 2014 – June 30, 2015; the largest group of patients not included in the measure were those without 12 months of enrollment in Medicare, which was needed to provide risk-adjustment data and among these, most have just turned 65 years of age.

This section provides details about the measure development of the hospital-level, risk-standardized mortality measure. Below we detail the data sources used, the measure cohort inclusion and exclusion criteria, the outcome definition and attribution, the approach to risk adjustment, final risk models, reliability testing, and validity testing of measure results. We are currently seeking comment on each of these, as well as comment on all aspects of the measure and how it might be best presented to improve care.

4.2 Data Sources

To develop the HWM measure including the cohort, outcome, service-line divisions, and, for most of testing, we constructed multiple datasets, listed below.

1. Claims-Only Development Dataset. These data were used to define preliminary measure specifications. Because certain inclusion and exclusion criteria were updated in later stages of measure development and testing, this dataset includes more patients than are in the final measure cohort. Results based on this dataset are identified as appropriate in the results section. This dataset consisted of the following data sources:
 - a. An index dataset that contained administrative inpatient hospitalization data, enrollment data, and post-discharge mortality status for FFS Medicare beneficiaries, 65 and older on admission, hospitalized from July 1, 2014 – June 30, 2015. This was used to create the patient cohort, determine the mortality outcome, and identify and select risk-adjustment variables from the index admission.
 - b. A history dataset that includes inpatient hospitalization data on each patient for the 12 months prior to the index admission; this was used to identify and select risk-adjustment variables.
 - c. A history dataset that includes revenue center-level records for emergency department (ED) stays (that do not result in admission to the facility) that are within one day prior to the index admission; these data were used to explore ‘transfer from an outside ED’ as a candidate risk variable but were not included in the final measure results (see [Section 4.5.2 Case Mix Risk Adjustment](#) for more details).

- d. A separate dataset was constructed to define the surgical procedure algorithm that included admissions from July 1, 2012 – June 30, 2014. This dataset included the major surgical procedures. The algorithm is described in detail in [Section 4.3.7 Defining Service-Line Divisions](#).
 - e. We obtained index admission and inpatient comorbidity data from the Medicare Inpatient Standard Analytic File (SAF). Enrollment and mortality status were obtained from the Medicare Enrollment Database, which contains beneficiary demographic, benefit, coverage, and vital status information. ED stays were obtained from the Medicare Outpatient SAF.
2. Split Sample Datasets. We created two split sample datasets by combining 24 months (July 1, 2013 – June 30, 2015) of administrative claims data as described above and then randomly split a hospital's patients into two distinct datasets. Datasets are presented in tables as Sample 1 and Sample 2. As with the development dataset, we used data from the Inpatient and Outpatient SAFs and Medicare Enrollment Database for risk variable, demographic, and vital status information. We used the split sample dataset to produce the final measure and perform reliability testing, which included final model performance ([Section 5.4 Service-Line Division-Level Risk Models](#)), final measure results ([Section 5.5 Final Measure Results](#)), and final measure testing ([Section 5.6 Measure Testing Results](#)). Results from this dataset incorporate all cohort inclusions and exclusions.
3. Clinical Hybrid Dataset. For overall measure result validity testing, we constructed a dataset using Kaiser Permanente Northern California claims and electronic health record (EHR) data, as outlined in detail in the hybrid HWM measure public comment report, in section titled Data Sources.³⁴ See Hybrid Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure with Electronic Health Record Extracted Risk Factors: Measure Methodology for Public Comment, which is also posted on the CMS Public Comment website, within the same zip file as this report.

4.3 Cohort

Our guiding principle for defining eligible admissions was that the measure should appropriately reflect a meaningful quality signal across a large number of acute care hospitals. Therefore, our cohort should capture as many admissions as possible for which survival would be a reasonable indicator of quality. We excluded admissions for which adequate risk adjustment was not possible. We defined an admission as having a reasonable indicator of quality if it fulfilled two criteria: 1) survival was most likely the primary goal of the patient when they entered the hospital (for example, a patient admitted at the end of their life under hospice care for comfort measures may not have survival as their primary goal); and 2) the hospital could be reasonably expected to impact the chance of the patient's survival with improved quality of care (for example, the hospital does not have the ability to meaningfully impact the chance of survival for a patient admitted with brain death). Therefore, in the measure we included all admissions except those for which full data were not available, or for which 30-day mortality cannot reasonably be considered a signal of quality care. We excluded admissions for which risk adjustment presented specific challenges using claims data. For each inclusion and exclusion criteria below, using these principles we completed multiple rounds of clinical review internally, and then reviewed and validated each decision with our Technical Work Group, Patient and Family Caregiver Work Group, and

TEP. For any admissions excluded due to challenges of adequate risk adjustment, we will continue to reevaluate the possibility of including those admissions in future iterations of the measure as we explore other options for risk adjustment.

4.3.1 Grouping Patients into Clinically Coherent Categories

For our previous claims-based condition- and procedure-specific outcome measures, we used individual ICD-9 codes for the index admission to define the cohort. Because of the large and diverse number of admissions considered and thousands of included ICD-9 codes in CMS's existing HWR measure, the HWR measure used the Agency for Healthcare Research and Quality (AHRQ) Clinical Classification Software (CCS) to group the numerous ICD-9 codes into clinically meaningful categories. The HWR measure then used those CCS categories for further cohort specification and risk-adjustment modeling. Similar to the HWR measure, the HWM measures use the AHRQ CCS to group the principal discharge diagnoses and major procedures, with slight modifications specific to mortality risk (See [Section 4.3.7 Defining Service-Line Divisions](#)). We plan on reevaluating this measure using ICD-10 code data prior to implementation.

CCS is a software tool developed as part of the [Healthcare Cost and Utilization Project \(HCUP\)](#), a Federal-State-Industry partnership sponsored by the AHRQ. It collapses ICD-9 condition and procedure codes into a smaller number of clinically meaningful condition and procedure categories.³⁷ There are about 14,000 ICD-9 condition codes, grouped into 285 mutually exclusive AHRQ condition categories, most of which are single, homogenous diseases such as pneumonia or acute myocardial infarction. However, some are aggregates of conditions, such as "other bacterial infections." There are also about 3,900 ICD-9 procedure codes, grouped into 231 mutually exclusive CCS procedure categories.

Rationale for using CCS:

- Using ICD-9 codes would have been impractical because there are potentially thousands of ICD-9 codes, some of which occur so infrequently that using this level of detail in statistical modeling would produce unreliable results.
- AHRQ CCS categories are grouped specifically for the purpose of clinical coherence. They have been deployed in many other policy and research projects to analyze outcomes and utilization of services in hospitals.
- By using a categorization taxonomy that is widely known, publicly available, and clinically coherent, the methods are more transparent and the results are more easily interpreted.
- The AHRQ CCS categorization is consistent with the methods used in the existing CMS HWR measure, which the claims-only HWM measure was designed to complement.

We have tested for and made modifications for highly heterogeneous CCS, as outlined in [Section 4.5.3 Service Mix Risk Adjustment: CCS Risk Variables Based on Principal Discharge Diagnosis Code CCS](#), ensuring that each CCS will be a robust and accurate risk adjuster.

We classified all admissions during the calendar year using the CCS categories prior to defining the inclusion and exclusion criteria.

4.3.2 Inclusion Criteria

The final cohort flowchart that includes the percent of admissions that did not meet the inclusion criteria described below can be found in [Section 5.1 Cohort](#). Since some of the inclusions were added or

modified after the Claims-Only Development Dataset was created, the Split Sample Datasets (sample 1 and sample 2) represent the final version of the measure cohort. Where relevant, tables and figures reference which dataset was used. An index admission is the hospitalization to which the mortality outcome is attributed and includes admissions for patients:

1. Enrolled in Medicare FFS Part A for the 12 months prior to the date of admission and during the index admission [**Note:** The vast majority of patients without 12 months of prior enrollment are individuals 65 years old who were not eligible for Medicare in the prior year];
 - a. **Rationale:** This is to ensure that patients are Medicare FFS beneficiaries and their comorbidities are captured from prior claims data for adequate risk adjustment.
2. Have not been transferred from another inpatient facility.
 - a. **Rationale:** This measure considers multiple contiguous hospitalizations as a single acute episode of care. Transfer patients are identified by tracking claims for inpatient short-term acute care hospitalizations over time. Admissions to an acute care hospital within one day of discharge from another acute care hospital are considered transfers regardless of whether or not the first institution indicates intent to transfer the patient in the discharge disposition code, and regardless of the principal discharge diagnosis. Transferred patients are included in the measure cohort, but it is the initial hospitalization, rather than any “transfer-in” hospitalization(s), that is included as the index admission.
3. Admitted for acute care:
 - a. Do not have a principal discharge diagnosis of a psychiatric disease (CCSs 650, 651, 652, 654, 655, 656, 657, 658, 659, 662 & 670);
 - i. **Rationale:** Patients admitted primarily for psychiatric treatment are typically cared for in separate psychiatric hospitals which are not comparable to acute care hospitals. [Note: This measure does include patients who are admitted for acute medical conditions and also have comorbid psychiatric disease.]
 - b. Do not have a principal discharge diagnosis of “rehabilitation care; fitting of prostheses and adjustment devices” (CCS 254);
 - i. **Rationale:** Patients admitted for rehabilitation services are not typically admitted to an acute care hospital and are not admitted for acute care.
4. Aged between 65 and 94 years;
 - a. **Rationale:** Medicare patients younger than 65 usually qualify for the program due to disability, end-stage renal disease, or Amyotrophic Lateral Sclerosis (ALS). They are not included in the measure because they are considered to be too clinically distinct from Medicare patients between 65 and 94 years. The characteristics and outcomes of these patients may not be representative of the larger Medicare patient population. To avoid holding hospitals responsible for the survival of the oldest elderly patients, and with the guidance of our work groups and TEP, we decided to only include patients between 65 and 94 years of age. While we acknowledge that many elderly patients do have survival beyond 30 days as a primary goal for their hospitalization, we also understand that, on average, very old patients may be less likely to have survival as a primary goal and that

the hospital may not always be able to impact the chance of survival in the oldest elderly patients.

5. Not enrolled in hospice at the time of or in the 12 months prior to their index admission;
 - a. **Rationale:** Patients enrolled in hospice in the prior 12 months or at the time of admission are unlikely to have 30-day survival as a primary goal of care.
6. Not enrolled in hospice within two days of admission. [**Note:** For development purposes, we did not have the date of hospice enrollment. Thus, to operationalize this criterion we made the following modification: Have not died within two days of admission or had a length of stay of two days or fewer and also been enrolled in hospice during admission or at discharge];
 - a. **Rationale:** This exclusion reflects input from our TEP and working groups and analyses performed in response to their feedback. There is not a single, correct approach regarding patients enrolled in hospice during admission or upon discharge – mortality may or may not represent a quality signal for this group of patients and hospice enrollment is inadequate to differentiate this issue. However, based on feedback from stakeholders and experts we consulted during measure development, it is likely that for most patients and/or families who had the discussion and agreed to enroll in hospice within two days of admission, survival is not likely the primary goal due to a condition that was present on admission and therefore, mortality should not be used as a marker of quality care. [**Note** that this inclusion was added after the finalization of the development dataset.]
7. Without a principal diagnosis of cancer and enrolled in hospice during their index admission (See [Appendix B AHRQ CCSs for Cancer and Metastatic Cancer](#) for the full list of CCSs capturing cancer principal discharge diagnosis codes);
 - a. **Rationale:** Patients admitted primarily for cancer who are enrolled in hospice during admission are unlikely to have 30-day survival as a primary goal of care.
8. Without any diagnosis of metastatic cancer (See [Appendix B AHRQ CCSs for Cancer and Metastatic Cancer](#) for full list of CCSs capturing metastatic cancer principal discharge diagnosis codes); and
 - a. **Rationale:** Although some patients admitted with a diagnosis of metastatic cancer will have 30-day survival as a primary goal of care, for many such patients admitted to the hospital, death may be a clinically reasonable and patient-centered outcome. Therefore, this is a group of patients that may not have 30-day survival as a primary goal of care.
9. Without a principal discharge diagnosis of a condition which hospitals have limited ability to influence survival, including: anoxic brain damage (ICD-9 3481); persistent vegetative state (ICD-9 78003); prion diseases such as Creutzfeldt-Jakob disease (ICD-9 04619); Cheyne-Stokes respiration (ICD-9 78604); brain death (ICD-9 34882); respiratory arrest (ICD-9 7991); or cardiac arrest (ICD-9 4275) without a secondary diagnosis of acute myocardial infarction.
 - a. **Rationale:** Hospitals have little ability to impact mortality for these conditions. This list of conditions was determined by three independent clinicians who reviewed high mortality conditions, and then reviewed with our TEP and Technical Working Group.

4.3.3 Exclusion Criteria

The final cohort flowchart that includes the percent of admissions that were excluded using the below criteria can be found in [Section 5.1 Cohort](#). As noted above, some of the exclusions were added or modified after the Claims-Only Development Dataset was created, and therefore the Split Sample Datasets (sample 1 and 2) represent the final version of the measure cohort. Where relevant, tables and figures reference which dataset was used. We then applied several exclusion criteria to the measure population. This measure excludes index admission for patients:

1. With inconsistent or unknown vital status;
 - a. **Rationale:** We do not include stays for patients where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.
2. Discharged against medical advice (AMA);
 - a. **Rationale:** Hospitals had limited opportunity to implement high-quality care and is not responsible for events that follow a discharge AMA.
3. With an admission for crush injury (CCS 234), burn (CCS 240), intracranial injury (CCS 233), or spinal cord injury (CCS 227);
 - a. **Rationale:** Even though a hospital likely can influence the outcome of some of these conditions, we felt that there were specific challenges to risk adjustment using claims data. These conditions are less frequent events that are unlikely to be uniformly distributed across hospitals and may entail distinct risk profiles. Therefore, we chose to exclude these admissions in this iteration of the measure and plan to revisit them in future iterations.
4. With certain principal discharge diagnosis codes for which mortality may not be a quality signal. This exclusion was added after the Claims-Only Development Dataset was created, and is therefore only found in the Split Sample Datasets.
 - a. **Rationale:** As part of the adjustments to address heterogeneous CCSs, we removed a few admissions with principal discharge diagnosis ICD-9 codes that were clinically distinct from others in the CCS, for which quality of care was less likely to impact survival, and where there were a small number of patients. See details in [Section 4.5.3 Service Mix Risk Adjustment: CCS Risk Variables Based on Principal Discharge Diagnosis Code CCS](#) and [Appendix G Heterogeneous CCS Modifications](#).
5. With an admission in a CCS condition or procedure categorized as in the service-line divisions: Other Surgical Procedures or Other Non-Surgical Conditions. See [Appendix C Procedure Categories Defining the Surgery Service-Line Division](#) for list of procedure categories and [Appendix D Condition Categories Assigned to the Non-Surgical Divisions](#) for a list of condition categories. [Section 4.3.7 Defining Service-Line Divisions](#) below has more details on how admissions were categorized into service-line divisions. This exclusion was added after the Claims-Only Development Dataset was completed, and was incorporated into the Split Sample Dataset.
 - a. **Rationale:** Even though a hospital likely can influence the outcome of many of these conditions, we found specific challenges to risk adjustment using ICD-9 data. These

divisions are populated by more hospitalizations for conditions based on CCSs that have low volume, variable mortality, and high heterogeneity in risk. The small numbers of admissions and events in each CCS and the large numbers of CCSs included in these service-line divisions create challenges for statistical model convergence. We chose to exclude these admissions in this iteration of the measure and will revisit these admissions, attempting to include them as we re-specify the measure using ICD-10 data.

6. With an admission in a low volume CCS, defined as less than or equal to 100 patients with that principal discharge diagnosis per service-line division across all hospitals. This exclusion was added after the Claims-Only Development Dataset was completed, and was incorporated into the Split Sample Dataset.
 - a. **Rationale:** To calculate a stable and precise risk model, there are a minimum number of admissions that are needed. In addition, a minimum number of admissions and/or outcome events are required to inform grouping admissions into larger categories. These admissions present challenges to both accurate risk prediction and coherent risk grouping and are therefore excluded.

4.3.4 Other Cohort Considerations

With the approval of our TEP, the measure does not currently utilize billing codes for do-not-resuscitate (DNR) for cohort decisions, as this is not a reliable method for determining a patient's wishes at the time of or during the admission. [Note: We will explore clinically relevant data variables related to patient care preferences for end-of-life care during measure validation.]

4.3.5 Addressing Patients with Multiple Admissions

The risk of mortality is not independent of the number of admissions a patient has had in a given time period, as a patient with multiple admissions can have at most one negative outcome (death). In addition, we know that the overall mortality rate for patients admitted more than once is higher than that of patients with only one admission. We also know that the percent of patients with multiple admissions that a hospital cares for varies. While patients do not always go back to the same hospital for repeat admissions, empirical analyses of Medicare data demonstrate that the majority of patients return to the same hospital. Other condition-specific hospital mortality measures reported by CMS address this issue by randomly selecting only one admission per patient per year.

As this measure includes all conditions and procedures, we systemically investigated different approaches to handling the issue of patients with multiple admissions within the measurement period. There was no practical statistical modeling approach that could account or adjust for the complex relationship between the number of admissions and risk of mortality in the context of a hospital-wide mortality measure. Therefore, in order to provide a scientifically rigorous, statistically appropriate, and technically feasible measure that provides transparency, and where appropriate, emphasizes simplicity, we used the approach currently employed in existing CMS mortality measures of including only one randomly selected admission per patient in the one-year measurement period. This reduces the number of admissions, but does not exclude any patients from the measure.

Rationale: Random selection better reflects that the results of their hospitalizations can only be death or survival when patients enter the hospital and therefore more fairly reflects the relationship between the quality of care and the outcome. Selecting the last admission would not be as accurate a reflection of the risk of death as random selection, as the last admission is inherently associated with a higher mortality risk.

The selection of the proposed cohort is presented in Results, [Section 5.1 Cohort \(Figure 2\)](#).

4.3.6 Service-Line Division Approach

It is unlikely that the effect of risk variables (such as diabetes) is homogeneous across all discharge condition categories. Therefore, we chose to group our cohort into clinically-related service-line divisions where the prevalence and effect of risk factors would likely be less heterogeneous, and then estimate separate risk adjustment regression models within each service-line division. For this multiple model approach, we have currently created, tested, and included 13 different risk models for 13 different service-line divisions (detailed below in [Section 4.3.7 Defining Service-Line Divisions](#) and supported by our work groups and TEP) and have derived a single summary score from the results of the 13 models, representing a single hospital-wide mortality rate for each hospital. This approach allows risk variables to have different effects for different conditions. For example, the effect of the comorbid risk factor of having diabetes may be different for a patient who is admitted for pneumonia than for a patient who had a knee replacement surgery.

In particular, this allows the measure to account for differences in mortality risk between surgical and non-surgical patients. Our analyses found that even within the same discharge condition, patient risk of death was strongly affected by whether a major surgical procedure was performed during hospitalization. Patients undergoing major surgical procedures are typically clinically different than those that are admitted with the same discharge condition but do not undergo a major surgical procedure. For example, a patient admitted for a hip fracture (CCS 226) that undergoes a major surgical procedure such as hip replacement to treat their fracture is likely considered healthy enough to have the surgery, compared to patients who are so ill that they either would not survive or choose not to risk surgery. In this example, surgery is associated with a lower observed mortality rate. In other examples, surgery is likely an indicator of more severe disease. For example, patients with a principal discharge diagnosis gastrointestinal ulcer (except hemorrhage) (CCS 139) that undergo a major surgery are generally those that have ulcers causing perforation or obstruction, which are markers of more severe disease compared to patients without perforation and obstruction requiring only medical therapy or minor surgical interventions.

In theory, estimating more models, such as a separate model for each of the diagnostic condition categories, could provide greater discrimination of mortality risk at the patient level. However, such an approach is not feasible; many hospitals would not have an index admission in many of the condition categories rendering the measure less useful. We are proposing 13 distinct service-line divisions to balance the desire for more models to maximize discrimination of mortality risk with the need to minimize the number of models to ensure reliable results would be obtainable for most hospitals.

Finally, and most importantly, through input from the TEP and all of the work groups, we heard the importance of providing more detailed information than a single summary score for the usability of this measure for both clinicians and patients. The multiple model approach, which uses results for each of the service-line division models to create the overall hospital-wide mortality measure score, could

increase the practical utility of the measure by providing information on differences in performance among divisions (service-line areas) within hospitals. This aspect of the measure will allow hospitals to better target quality improvement efforts and was strongly supported by patients, family caregivers, and our TEP. However, the final decision to share divisional or other granular performance information that is supplemental to the overall HWM measure result will need to balance the input of patients and providers, who seek greater transparency and granularity, with the fact that such granular information may be less reliable or accurate than the aggregated HWM measure result.

In summary, using 13 models rather than a single model may allow for better risk adjustment for diverse patient groups, and will likely improve the usability of the measure. Using many more risk models (service-line divisions) may not be feasible given the number of cases per hospital in each condition.

4.3.7 Defining Service-Line Divisions

We expect the hospital component of mortality risk to be in part related to the care provided by a team of doctors, nurses, care coordinators, pharmacists, etc. Conditions typically cared for by the same team of clinicians would therefore be expected to experience similar added (or reduced) levels of mortality risk. Therefore, we grouped discharge condition categories typically cared for by the same group of clinicians into 13 service-line divisions (See [Table 1](#)). Organizing results by care team in this way will allow hospitals to identify areas of strength and weakness if their hospital performance varies across service-line divisions. This approach also addressed the strong preference of patients and caregivers to have a better understanding of hospital performance for certain conditions or procedures.

These 13 service-line divisions were created through a detailed process, led by clinicians and vetted by all of our work groups and TEP. The process consisted of the following steps:

1. Identified surgical versus non-surgical admissions;
2. Grouped admissions into 10 surgical sub-divisions and 23 non-surgical subdivisions based on clinical coherence and care teams;
3. Combined subdivisions into five surgical divisions and nine non-surgical divisions based on clinical coherence and risk variable performance;
4. Presented results to work groups and TEP and, in response to feedback, add additional surgical division of surgical cancer, created the initial 15 service-line divisions; and
5. Tested the risk model performance for each of the initial 15 divisions, and due to complexity of models and inability to adequately risk adjust the heterogeneous divisions, removed Other Surgical Procedures and Other Non-Surgical Conditions service-line divisions, as reviewed by our TEP and working groups.

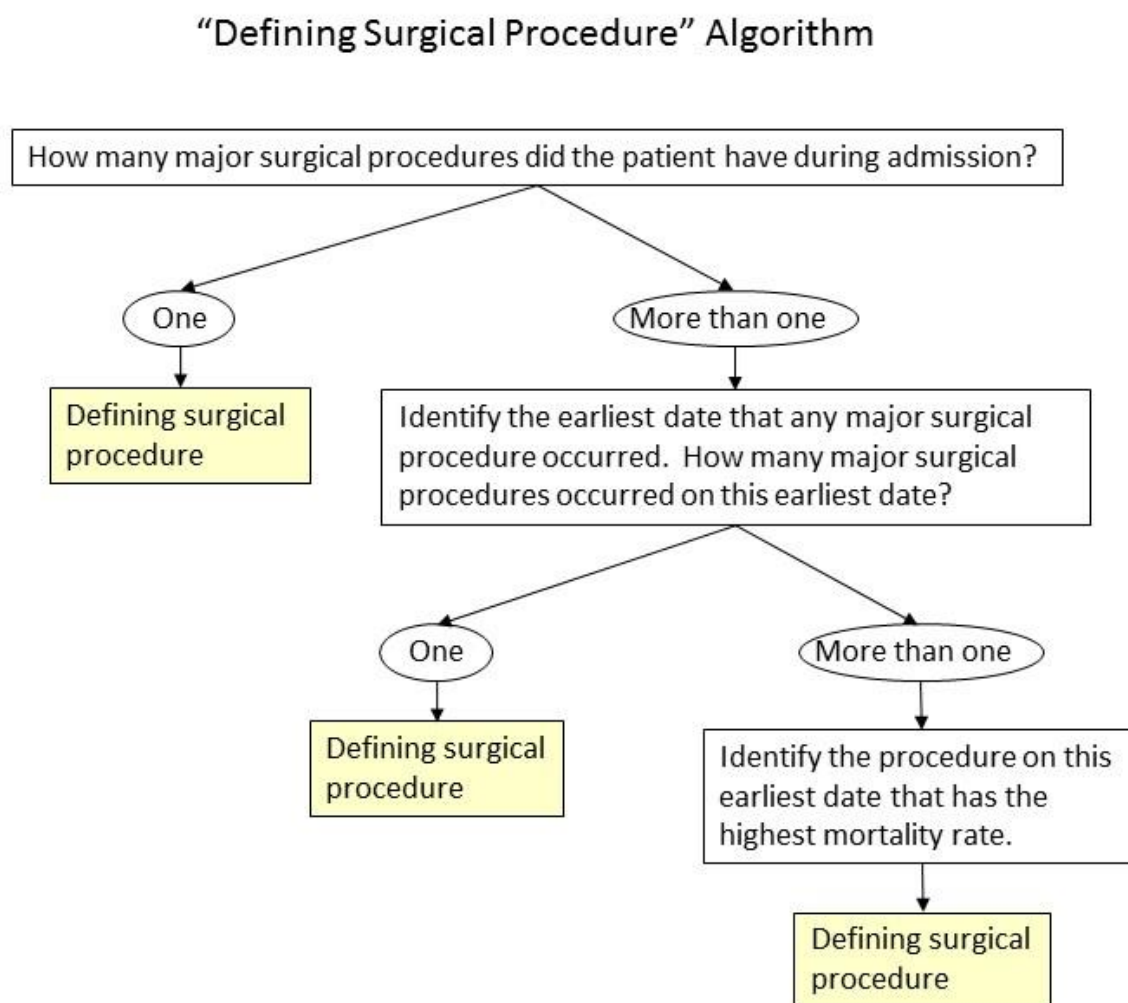
Surgical vs. Non-Surgical Assignment

Admissions were first screened for the presence of an eligible surgical procedure category. These were defined as “major surgical procedures,” representing procedures for which a patient is likely to be cared for primarily by a surgical service and identified using the approach used by the HWR measure to identify surgical admissions. Admissions with any such major surgical procedures were assigned to a surgical division, regardless of the principal discharge diagnosis code for the admission. All remaining admissions were assigned to service-line divisions based on the principal discharge condition category.

Identifying the Defining Surgical Procedure

Unlike principal discharge diagnoses, of which there can only be one per admission, patients can undergo multiple surgical procedures during a hospital stay, and it is not possible in claims data to determine which, if any, procedure was related to the reason for admission. In order to report on service-line divisions that are more granular than a single division containing all surgical patients, we created an algorithm to assign a “defining surgical procedure” ([Figure 1](#)). If a patient only has one major surgical procedure, that procedure is the “defining surgical procedure.” However, if a patient has more than one major surgical procedure within a single hospitalization, the first dated major surgical procedure will be assigned as the “defining surgical procedure.” If there is more than one major surgical procedure that occurs on that earliest date, the procedure with the highest mortality rate (defined by unadjusted mortality rates for all admissions with major surgical procedures from the two years prior to our dataset, including admissions from July 1, 2012 – June 30, 2014) will be the “defining surgical procedure.”

Figure 1. Defining Surgical Procedures Algorithm



Grouping of Sub-Divisions

For surgical admissions, we used work done previously for the HWR measure, which identified and then classified each major surgical procedure CCS into one of 10 surgical sub-divisions based on surgical service-line with clinician input; these groupings were re-reviewed by five physicians on our team as well as our TEP.

For the non-surgical admissions, two practicing physicians at CORE reviewed the CCS categories for principal discharge diagnoses and grouped them into 23 clinically coherent non-surgical sub-divisions based upon service-line. These sub-divisions were reviewed by three additional physicians and any discrepancies were resolved by consensus among all physicians. The final sub-divisions were then reviewed and endorsed by our TEP.

Combining Sub-Divisions into Service-Line Divisions

For each of the 23 non-surgical and 10 surgical sub-divisions, we then calculated the odds ratios (OR) for risk of 30-day mortality with 95% confidence intervals (CI) for all of the candidate comorbidity variables (see [Section 4.5 Approach to Risk Adjustment](#)) and, for each of the surgical sub-divisions, we also calculated the OR for risk of 30-day mortality with 95% CI for all of the principal discharge diagnosis CCSs. This ensured that the reason for admission for the surgical patients (the principal discharge diagnosis) was also considered for combining sub-divisions. This was not necessary for non-surgical divisions, as the non-surgical divisions were defined using the principal discharge diagnosis CCS. We also calculated the number of patients within each sub-division to understand possible case volume limitations across the sub-divisions. We used this information to further combine sub-divisions into divisions based on clinical coherence as well as similar directionality across the majority of the comorbid conditions, while still trying to ensure adequate case volume.

Using this approach, we combined the 23 non-surgical sub-divisions into nine service-line divisions (eight more homogeneous divisions, and one “Other Condition” division that included admissions across multiple specialties, and the 10 surgical sub-divisions into five surgical divisions (4 more homogeneous divisions, and one “Other Procedures” division that included admissions across multiple types of procedures. This created a total of 14 divisions.

Creating the Final 13 Service-Line Divisions

We presented the original 14 service-line divisions to our work groups and TEP and, based upon their feedback, we added a 15th division (surgical cancer). The surgical cancer division is defined as an admission for a patient that undergoes any of the “major surgical procedures” and also has a principal discharge diagnosis of cancer. The AHRQ CCS procedure categories for the major surgical procedures by service-line division are shown in [Appendix C Procedure Categories Defining the Surgery Service-Line Cohort](#). The list of the AHRQ discharge condition categories for each non-surgical division are shown in [Appendix D Condition Categories Assigned to the Non-Surgical Divisions](#).

After testing the models, we removed the heterogeneous divisions: “Other Non-Surgical Conditions” and “Other Surgical Procedures” (See [Section 4.3.3 Exclusion Criteria](#)). We plan to reevaluate the exclusion of these two divisions during reevaluation of the measure in ICD-10 data. We will work towards including as many patients as possible. [Table 1](#) shows the number of admission in each of the final 13 divisions.

Table 1. Service-Line Divisions Admissions Claims-Only Development Dataset (July 1, 2014 – June 30, 2015)

Service-Line Division	Admissions
Non-Surgical Divisions	
Cancer	38,635
Cardiac	682,716
Gastrointestinal	351,117
Infectious Disease	555,864
Neurology	267,384
Orthopedics	131,747
Pulmonary	548,770
Renal	240,404
Surgical Divisions	
Cancer	89,276
Cardiothoracic	111,546
General	183,637
Neurosurgery	27,144
Orthopedics	665,995
Total Development Cohort	3,894,235

Question for public comment:

Do you have input on the service-line division structure of the measure?

4.4 Outcome

The outcome for this measure is all-cause 30-day mortality. We define mortality as death from any cause within 30 days of the index hospital admission date. We identify deaths for Medicare FFS patients using the Medicare Enrollment Database.

4.4.1 Thirty-Day Timeframe

We combined input from clinical experts with empirical analyses, published literature, and consistency with existing CMS mortality measures to define the 30-day timeframe for capturing mortality.

It is imperative to have a standard period of assessment so that the outcome for each patient is measured consistently from the date of admission. Without a standard period, variation in length of stay would have an undue influence on mortality rates, and hospitals would have an incentive to adopt strategies to shift deaths out of the hospital without improving quality. Most prior all-condition mortality measures that assess a standard time frame and all existing CMS condition- and procedure-specific hospital mortality measures utilize a 30-day timeframe, starting the day of admission, for assessing mortality.

To evaluate the appropriateness of the 30-day time frame across the HWM cohort, we reviewed survival curves for Medicare beneficiaries 65 years and older across all diagnostic CCS groupings up to 90 days

following admission. We found that diagnostic CCS groups with the highest mortality rates had their steepest declines in the first few days and the curves continued to decline but at a slower rate after that time. In general, few diagnostic CCS groups showed complete leveling off of mortality, even at 90 days. However, the 30-day period does capture the largest declines in mortality. At the request of our TEP, we also reproduced these survival curves for the final 13 divisions.

Additional support for the 30-day time frame stemmed from evidence that mortality can be influenced by hospital care and the early transition to the outpatient setting during this time. Finally, we reviewed the 30-day timeframe with our Technical, Patient, and Family Caregiver Work Groups and TEP, and they supported the 30-day timeframe. In summary, we chose a post-admission observation period of 30-days balancing considerations of empirical data findings, actionability, cross-measure consistency, and fairness of attribution.

4.4.2 All-Cause Mortality

We defined the outcome as “all-cause” mortality rather than related to the index hospitalization for multiple reasons. First, from the patient perspective, mortality for any reason is an undesirable outcome of care. In defining the measure cohort, we worked with clinical experts and patients to only include patients for whom it is reasonable to assume that 30-day survival is a primary goal of care. Second, there is no reliable way to determine whether mortality is related to the index hospitalization based on the documented cause of mortality. As with readmissions, many deaths that might not be deemed related are in fact influenced by the care received during hospitalization. For example, a heart failure patient who is discharged with inappropriately dosed medications may develop renal failure from over diuresis and die. It would be inappropriate to treat this death as unrelated to the care the patient received for heart failure. Third, all existing CMS mortality measures report all-cause mortality, making this approach consistent with existing measures. Finally, defining the outcome as all-cause mortality may encourage hospitals to implement broader initiatives aimed at improving the overall care within the hospital and transitions from the hospital setting instead of limiting the focus to a narrow set of condition- or procedure-specific approaches.

4.4.3 Outcome Attribution

Outcomes for surgical and non-surgical patients are attributed to the admitting hospital. In cases of transfers, the sequence of hospitalizations is treated as one episode of care and the admission and associated outcome are attributed to the first admitting hospital. For example, if a patient is admitted to acute care Hospital A, and then transferred to acute care Hospital B, the admission and associated outcome (survival or death within 30-days) is attributed only to Hospital A.

A surgical transfer patient is defined as a patient who is originally admitted to one hospital where no major surgical procedure is performed and is then transferred to a different hospital where they receive a major surgical procedure. Given that surgical transfer patients are more likely to have risks that are similar to other surgical patients (rather than non-surgical patients), we assigned surgical transfer patients to a surgical division for risk adjustment and reporting (rather than a non-surgical division). However, the mortality outcome remains attributed to the original admitting hospital that made the decision to both admit and transfer the patient.

4.5 Approach to Risk Adjustment

Below we describe our approach to developing the measure risk models for each of the divisions and the final overall risk-standardized mortality rate (RSMR). First, we outline how we selected case-mix risk variables, which has not changed since our draft public comment period. Next, we describe how we have adjusted the service mix adjustment with the principal discharge diagnosis, which has updates from the interim public comment report. Finally, we describe how the 13 divisions are combined to produce the single overall RSMR.

4.5.1 Risk Adjustment Overview

The goal of risk adjustment is to account for differences across hospitals in patient demographic and clinical characteristics that might be related to the outcome but are unrelated to quality of care. Risk adjustment for this measure was complicated by the fact that it includes many different discharge condition categories, as well as patients undergoing surgical procedures. Therefore, we adjusted for both case mix differences (clinical status of the patient on admission, accounted for by adjusting for comorbidities and diagnoses present on admission) and service mix differences (the types of conditions/procedures cared for by the hospital, accounted for by adjusting for the discharge condition category).

Comorbidities for inclusion in risk adjustment were identified in inpatient hospital administrative claims during the 12 months prior to and including the index admission. To assemble the more than 14,000 ICD-9 codes into clinically coherent variables for risk adjustment, the measure employs the publicly available CMS condition categories (CMS-CCs) to group codes into CMS-CCs, and selects comorbidities based on clinical relevance and statistical significance.³⁸

We do not plan to adjust for patients' admission source or discharge disposition (for example, skilled nursing facilities) because these factors are associated with the structure of the health care system, and may reflect the quality of care delivered by the system. We are currently not planning on adjusting for socioeconomic status, gender, race, or ethnicity because hospitals should not be held to different standards of care based on the demographics of their patients; however, we will examine these factors during validation and testing and consider the most recent guidance from the NQF in our final decision.

Below we explain our general approach to capturing patient-level case mix in the risk model, followed by an explanation of service-line risk adjustment. These sections are followed by a description of the division-level and overall hospitals-level statistical models in detail.

4.5.2 Case Mix Risk Adjustment

Candidate Comorbid Risk Variables

Our goal is to develop parsimonious models that include clinically relevant variables strongly associated with the risk of mortality in the 30 days following an index admission. For candidate variable selection, using the development sample we started with the CMS-CCs grouper, used in previous CMS risk-standardized outcome measures, to group ICD-9 codes into comorbid risk adjustment variables.

To select candidate variables, a team of clinicians reviewed all CMS-CCs and combined some of these CMS-CCs into clinically coherent groups to ensure adequate case volume. Any combined CMS-CCs were combined using both clinical coherence and consistent direction of mortality risk prediction across the CMS-CC groups in the majority of the 15 divisions.

In response to input from our TEP, we explored “transfer from the emergency department (ED)” as an additional candidate risk variable. This variable represented a patient transferred directly from another hospital’s ED without first being admitted to that hospital. We examined the association of “transfer from ED” status and mortality risk across the service-line divisions, but found it did not meet our inclusion criteria (see [Final Comorbid Risk Variable Selection](#) below) and therefore did not include this variable in the final risk model. All candidate risk variables are listed in [Appendix E Candidate Comorbid Risk Variables](#).

Potential Complications of Care During Hospitalization

Complications occurring during hospitalization are not comorbid illnesses and do not reflect the health status of patients upon presentation. In addition, they likely reflect hospital quality of care, and, for these reasons, should **not** be used for risk adjustment. Although adverse events occurring during hospitalization may increase the risk of mortality, including them as risk factors in a risk-adjusted model could lessen the measure’s ability to characterize the quality of care delivered by hospitals. We have previously reviewed every CMS-CC and identified those which, if they were to occur only during the index hospitalization, are more likely than not to represent potential complications rather than pre-existing comorbidities. For example: fluid, electrolyte, or base disorders; sepsis; and acute liver failure are all examples of CMS-CCs that could potentially be complications of care (see [Appendix F Potential Complications of Care](#) for this list).

For the claims-only HWM measure, we took a two-step approach to identifying complications of care. First, we searched the secondary diagnosis codes in the index admission claim for all patients in the measure and identified the presence of any ICD-9 code associated with a CMS-CC in [Appendix F Potential Complications of Care](#). If these codes appeared only in the index admission claim, we flagged them because they are potential complications of care. Next, we determined if these potential complications of care were associated with a “present on admission” code. Any potential complication of care with an associated “present on admission” code was kept in the risk model; any potential complication of care without an associated “present on admission” code was removed under the assumption that it represented a complication of care. In this way, we supplemented the existing approach to identifying potential complications of care used in CMS’s publicly reported mortality measures by incorporating “present on admission” codes. Our analyses demonstrate that a majority of hospitals currently use “present on admission” codes across a majority of conditions. Therefore, we felt that a combined approach to excluding complications of care from the risk model that used both the existing methodology and “present of admission” codes allow the measure to capture as many clinically appropriate risk variables as possible while simultaneously removing complications of care from the risk model.

Final Comorbid Risk Variable Selection

To inform variable selection, we used the development sample to create 500 bootstrap samples for each of the service-line divisions (this analysis was performed prior to removing the divisions Other Non-Surgical Conditions and Other Surgical Procedures; therefore, this analysis was completed on 15 divisions). For each sample, we ran a standard logistic regression model that included all candidate variables. The results were summarized to show the percentage of times that each of the candidate variables was significantly associated with 30-day mortality (at the $p \leq 0.05$ level) in the 500 bootstrap

samples (for example, 70% would mean that the candidate variable was significant at $p \leq 0.05$ in 70% of the bootstrap samples). We also assessed the direction and magnitude of the regression coefficients.

We found that models containing all risk factors performed similarly to models containing a more limited set of “significant” risk factors, described below. We therefore used a fixed, common set of comorbidity variables in all of our models for simplicity and ease of implementation and analysis. We describe below the steps for variable selection.

- a. The CORE Project Team reviewed the bootstrapping results and decided to provisionally examine risk adjustment variables at or above a 90% cutoff in one of the 15 service-line division models (in other words, retain variables that were significant at the $p \leq 0.05$ level in at least 90% of the bootstrap samples for each division). We chose the 90% cutoff because this threshold has been used across other measures and produced a model with adequate discrimination.
- b. In order to develop a statistically robust and parsimonious set of comorbid risk variables, we then chose to limit the variables to those that met a 90% threshold in at least 13/15 divisions. This step resulted in the retention of 20 risk factors, including age and 19 comorbid risk variables. This resulted in C-statistics that did not change by more than 0.02 in any of the 15 divisions compared to models that contained all possible risk variables. See [Table 18](#) in [Appendix E Candidate Comorbid Risk Variables](#).

Below is [Table 2](#) that identifies the list of final comorbid risk variables.

Table 2. Final Risk Variables with the Number of Divisions Where Significant (Total of 15 Divisions) (July 1, 2014 – June 30, 2015, early version)

Risk variable	# Divisions where Significant
Age, years	15
Pneumonia (CC 114-116)	14
Dialysis or Severe Chronic Kidney Disease (CC 134, 136, 137)	13
Acute or Unspecified Renal Failure (CC 135, 140)	13
Poisonings and Allergic and Inflammatory Reactions (CC 175)	13
Minor Symptoms, Signs, Findings (CC 179)	15
Protein-Calorie Malnutrition (CC 21)	14
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	13
Disorders of Lipoid Metabolism (CC 25)	13
Liver Failure (CC 27, 30)	14
Other GI Disorders (CC 34, 35, 37, 38)	15
Other Musculoskeletal and Connective Tissue Disorders (CC 44, 45)	13
Hematologic or Immunity Disorders (CC 46-48)	13
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	14

Risk variable	# Divisions where Significant
Other Infectious Diseases (CC 7)	13
Metastatic & Severe Cancers (CC 8, 9)	13
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	13
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	14
Congestive Heart Failure (CC 85)	14
Hypertension and hypertensive heart disease (CC 94, 95)	14

4.5.3 Service Mix Risk Adjustment: Risk Variables Based on Principal Discharge Diagnosis Code CCSs

As described in [Section 4.3.7 Defining Service-Line Divisions](#), we use the AHRQ CCS grouper to group all ICD-9 principal discharge diagnoses into clinically coherent categories. For all AHRQ principal discharge diagnosis code CCSs with sufficient volume, we also included a discharge diagnosis-specific indicator in the model. This will ensure that the principal discharge diagnosis for each patient is also included in the risk model, in addition to the 20 variables described above.

Rationale: Discharge diagnosis categories differ in their baseline mortality risks and hospitals will differ in their relative distribution of these discharge diagnosis categories (service mix) within each division. Therefore, adjusting for principal discharge diagnosis categories levels the playing field across hospitals with different service mixes. However, direct comparisons between hospitals can be imprecise due to limitations of such adjustments.

Low Risk CCSs

There were some CCSs with zero mortality events. These ‘no event’ CCSs predicted survival perfectly and thus prevented the models from converging, so we combined CCSs with 0 mortality events into the next lowest mortality CCS, re-labeling this as Low Risk CCSs. This decision was reviewed and approved by our Technical Working Group and TEP.

Highly Heterogeneous CCSs

For some of the AHRQ CCS groups, risk of mortality varied significantly across the different ICD-9 diagnoses within the CCS. There was concern voiced by our Technical Work Group and TEP that we may not be adequately risk-adjusting using these heterogeneous CCSs. Therefore, using our original dataset, we calculated the correlation between mortality rate and inpatient admissions grouped by principal discharge diagnosis ICD-9 code within each CCS. We identified any CCS with an intraclass correlation (ICC) score >0.05 as having high heterogeneity. The ICC is used in this context to identify heterogeneity of mortality risk across ICD-9 codes within the ICC. The value 0.05, or 5%, is a conventional threshold for accounting for between group heterogeneity.

- We identified 37 CCSs with $ICC > 0.05$ as having high heterogeneity.

To address the heterogeneity, three clinicians independently, and through consensus, modified the highly heterogeneous CCSs using clinically informed recategorizations, as described in detail in [Appendix](#)

[G Heterogeneous CCS Modifications](#). This was reviewed with our Technical Work Group and TEP as well. We modified these highly heterogeneous CCSs using the following mechanisms:

- Splitting the CCSs into more than 1 CCS. Two examples:
 - Example 1: We split gastrointestinal ulcer into gastrointestinal ulcer without perforation versus intestinal perforation (allowing us to better capture the disparate mortality risk of perforation versus none).
 - Example 2: We split acute cerebrovascular disease into intracranial hemorrhage versus non-intracranial hemorrhagic acute cerebrovascular events.
- Moving ICD-9 codes to more clinically coherent CCS. Two examples:
 - Example 1: We moved the ICD-9 code for 'Neoplasm related pain' from CCS named 'Other nervous system disorders' to the CCS named 'Malignant neoplasm without specification of site'.
 - Example 2: We moved the ICD-9 code for 'Adult failure to thrive' from CCS named 'Other nutritional, endocrine, and metabolic disorders' to the CCS named 'Nutritional deficiencies'.
- Excluding admissions with primary ICD-9 codes that are clinically different from others in the CCS, for which quality of care less likely impacts survival, and where there were a small number of patients. Two examples:
 - Example 1: We excluded ICD-9 code for 'Defibrination syndrome' or disseminated intravascular coagulation (DIC), from the coagulation and hemorrhagic disorder CCS.
 - Example 2: We excluded ICD-9 code for 'Amyotrophic lateral sclerosis (ALS)', from the other hereditary and degenerative nervous system disorders CCS.

Therefore, CCSs for risk adjustment and cohort have been slightly modified from the AHRQ definitions as outlined in [Appendix G Heterogeneous CCS Modifications](#). For consistency, these changes were also applied to the service-line division definitions and are reflected in the final division definitions in [Appendix D Condition Categories Assigned to the Non-Surgical Divisions](#). We will plan to reexamine heterogeneous CCSs in reevaluation using ICD-10 codes.

Rationale: Based upon the Technical Work Group's concerns, we identified the most heterogeneous CCSs and used a robust approach vetted by three independent clinicians to create more clinically meaningful divisions for use in mortality risk models. We plan to revisit this work when we re-specify the measure for ICD-10 codes.

Therefore, we are using this method of clinically modifying heterogeneous CCSs using the list in the word document in this initial version of the measure, with a plan to update the work using ICD-10 codes during reevaluation of this measure.

Consequences of CCS modification: The changes to the CCSs resulted in more homogenous CCS risk variable groups, and increased the face validity of risk model. However, due to the infrequency of outcome (mortality) events and an increased number of risk variables, the statistical model became too unstable in 2 of 15 divisions and would not converge to give results for the claims-only measure. Those

divisions were the “Other Surgical Procedures” and “Other Non-Surgical Conditions” divisions, which had the highest number of CCS principal discharge diagnosis variables.

In order to preserve the statistical and face validity of the measure, we removed the divisions Other Surgical Procedures and Other Non-Surgical Conditions for this iteration of the measure (See [Section 4.3.3 Exclusion Criteria](#)) We will revisit this issue in greater depth when we reevaluate the measure to include ICD-10 codes. We reviewed this decision with the TEP, and our working groups.

4.5.4 Final Division-Level Risk Models

After risk factor selection using standard logistic regression models, we used the Markov Chain Monte Carlo technique (MCMC) to estimate the final risk-adjustment models within each division. This is a statistical method for fitting models, including hierarchical generalized linear models (HGLMs), under the Bayesian framework. This method produces confidence intervals (strictly, ‘credible intervals’) for any combination of predictions based on the model, in contrast to maximum likelihood methods which require bootstrapping. Each risk model adjusts for age and the same 19 comorbid risk variables. In addition, all 13 division-level models adjust for principal discharge diagnosis grouped by CCS by including an indicator variable for the CCS within the model (see [Section 4.5.3 Service Mix Risk Adjustment: Risk Variables Based on Principal Discharge Diagnosis Code CCSs](#) for details). Each model also includes a random effect for the hospital. As noted in [Section 4.7.1 Data Element Testing](#) below, with results in [Section 5.6.1 Data Element Reliability and Validity Testing Results](#), we report the coefficients with standard errors and the ORs with 95% confidence intervals for mortality risk for each risk variable in each of the 13 models.

4.5.5 Model Performance

We then examined the performance of each of the final 13 risk models (see results in [Section 5.4.2 Service-Line Division-Level Risk Model Performance](#)). For each of the 13 risk models, we computed summary statistics to assess model performance: calibration (a measure of over-fitting), discrimination in terms of predictive ability, discrimination in terms of c-statistic (see below).

Over-fitting refers to the phenomenon in which a model describes the relationship between predictive variables and outcome well in the development dataset, but fails to provide valid predictions in new patients. When the y_0 in the validation sample is close to zero and the y_1 is close to one in each of the models, there is little evidence of over-fitting.

Discrimination in predictive ability measures the ability to distinguish high-risk subjects from low-risk subjects. Therefore, we would hope to see a wide range between the lowest decile and highest decile.

The c-statistic is a measure of how accurately a statistical model is able to distinguish between a patient with and without an outcome. For binary outcomes, the c-statistic is identical to the area under the Receiver Operator Curve. A c statistic of 0.50 indicates random prediction, implying all patient risk factors are useless. A c statistic of 1.0 indicates perfect prediction, implying patients’ outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in patients’ outcomes. While higher c statistic is desirable, we do not want to maximize it by adjusting for factors that should not be adjusted for. For example, we do not want to include in-hospital complications as a risk factor, even though this might increase the model c-statistic.

4.5.6 Calculating the RSMR Point Estimate and Confidence Intervals

To calculate an overall hospital-wide mortality rate, we needed to combine the results of the 13 risk models (divisions) into one overall score. We envisioned a HWM measure that will provide a broad indication of a hospital's performance and capture cross-cutting hospital-wide characteristics that contribute to quality of care. As with CMS's other claims-based performance measures, the measure result will be a point estimate (the RSMR) and will be reported with an estimate of the uncertainty surrounding the RSMR. While there are multiple approaches to calculate this overall RSMR through combining the results of the 13 models, after consultation with multiple statisticians and review with our Technical Working Group, our patient and family caregiver working groups, and our TEP, we are using a weighted mean with empirical correlation approach, as this approach (described below) provides a statistically precise and conservative estimate of better and worse outliers.

Weighted Mean with Empirical Correlation

This approach requires first calculating a Standardized Mortality Ratio (SMR) for each hospital for each service-line division and then combines the SMRs for each hospital's 13 divisions by taking the average of the performance in each of the divisions, taking into account how precisely we were able to predict the outcome for that division. In technical terms, to calculate the point estimate, we used the point estimates of all 13 SMRs (one from each division) and take the weighted mean, similar to the HWR measure methodology. However, unlike the HWR measure, which only has a point estimate for each service-line division SMR, with this MCMC technique (see [Section 4.6 Statistical Approach to Calculating Division-Level and Overall Standardized Mortality Ratios](#)), we also have a variance for each division-level SMR. Therefore, we weighted the SMRs by the inverse variance, rather than by volume. This is a more statistically precise weighting, but is similar to weighting by volume. The statistical approach is described in greater detail in the next section.

For calculating confidence intervals, we considered all possible variances and covariances (a matrix of 13 by 13 was considered), creating a conservative estimate. This differs from the existing hospital-wide readmission measure, which uses bootstrapping to estimate 95% interval estimates. Due to the complexity of the HWM measure and its 13 component division-level models, bootstrapping is not feasible. Therefore, this approach was computationally feasible and it minimizes the risk that a hospital would be incorrectly labeled an outlier.

Using this weighted mean with empirical correlation technique, we calculated the RSMR for each hospital. Consistent with existing CMS claims-based mortality measures, we also calculated 95% confidence intervals to identify hospitals that performed better or worse than the national average. See [Section 5.5.1 Hospital-Level Overall RSMR Results](#) for results. Alternative approaches to reporting outliers based upon 95% confidence intervals is discussed in [Section 5.7 Presenting Results](#).

4.6 Statistical Approach to Calculating Division-Level and Overall Standardized Mortality Ratios

This section provides further detail on the specific technical information for the statistical modeling for creating the final measure results. This includes information on the statistical models for each of the 13 divisions, how the results are calculated for each of the 13 divisions, and then how those results are combined to form the overall mortality rate.

4.6.1 Models for Each Service-Line Division

For model development, we used the Claims-Only Development Dataset, which was a full year of admission data from July 1, 2014 – June 30, 2015, with 12 months of history data. We used logistic regression models with a logit link function, with outcome Y_{ij} for the i -th patient at the j -th hospital equal to 1 if the patient died within 30 days of admission and 0 otherwise. By using logistic regression models, we could assess risk factors and model performance without reference to the variation in performance across hospitals.

For our final models, we used the Split Sample Dataset (two years of combined data, randomly split). We extended the logistic regression models to include an additional random intercept term. That is, due to the natural clustering of observations within hospitals, we used hierarchical logistic regression to model the log-odds of mortality for each of the 13 service-line divisions. Death within 30 days was modeled as a function of patient-level demographic and clinical characteristics and a random hospital-level intercept. This model specification accounts for within-hospital correlation of the observed outcomes and models the assumption that underlying differences in quality among the health care facilities being evaluated lead to systematic differences in outcomes. We estimated a separate hierarchical logistic regression model for each service-line division. In order to obtain the variance and interval estimates, we fit the hierarchical model under the Bayesian framework along with the Markov Chain Monte Carlo (MCMC) technique.

Specifically, for a given service-line division, we estimated a hierarchical logistic regression model as follows. Let Y_{ij} denote the outcome (equal to 1 if patient i at hospital j dies within 30 days, 0 otherwise) for a patient in a specified division $d \subseteq \{1, \dots, 13\}$ at hospital j ; $\mathbf{Z}_{ij}$ denotes a set of risk factors. Let M denote the total number of hospitals and m_j the number of index patient stays in hospital j . We assume the outcome is related linearly to the covariates via a logit function:

$$\text{logit}(\Pr(Y_i = 1)) = \alpha_j + \beta^* \mathbf{Z}_{ij} \quad (1)$$

$$\alpha_j = \mu + \omega_j$$

$$\omega_j \sim N(0, \tau^2)$$

where $\mathbf{Z}_{ij} = (Z_{ij1}, Z_{ij2}, \dots, Z_{ijk})$ is a set of k patient-level covariates. α_j represents the hospital-specific intercept; μ is the adjusted average outcome over all hospitals; and τ^2 is the between hospital variance component. The hierarchical logistic regression model for each cohort was estimated using the SAS software system (MCMC procedure).

4.6.2 Standardized Mortality Ratio for Each Service-Line Division

We used the results of each hierarchical logistic regression model to calculate standardized mortality ratio as the predicted number of deaths over the expected number of deaths for each service-line division at each hospital. The predicted mortality rate in each division was calculated, using the corresponding hierarchical logistic regression model, as the sum of the predicted probability of death for each patient, including the hospital-specific (random) effect. The expected number of deaths in each division for each hospital were similarly calculated as the sum of the predicted probability of death for each patient, setting the hospital-specific (random) effect to be zero. Using the notation of the previous

section, the model specific risk-standardized mortality ratio was calculated as follows. To calculate the predicted mortality rate pred_{dj} for index admissions in each division $d=1,\dots,13$ at hospital j , we use

$$\text{pred}_{dj} = \sum \text{logit}^{-1}(\alpha_j + \beta^* \mathbf{Z}_{ij}) \quad (2)$$

where the sum is over all m_{dj} index admissions in division d with index admissions at hospital j . To calculate the expected number exp_{dj} we use

$$\text{exp}_{dj} = \sum \text{logit}^{-1}(\mu + \beta^* \mathbf{Z}_{ij}) \quad (3)$$

Then, as a measure of excess or reduced mortality rate among index admissions in cohort D at hospital j , we calculate the standardized mortality ratio SMR_{dj} as

$$\text{SMR}_{dj} = \text{pred}_{dj} / \text{exp}_{dj} \quad (4)$$

4.6.3 Hospital-Wide Risk-Standardized Mortality Rate

To report a single mortality score, the separate service-line division SMRs are combined into a single value.

For a given hospital, j , which has patients in some subset of divisions $d \subseteq \{1,\dots,13\}$, we calculate the SMR as described above for each division for which the hospital discharged patients. If the hospital does not have index admissions in a given division d , then the weight $w_{dj} = 0$. Then, calculate the variance-weighted logarithmic mean:

$$\text{SMR}_j = \exp((\sum w_{dj} \log(\text{SMR}_{dj})) / \sum w_{dj}) \quad (5)$$

where the sums are over all service-line divisions and w_{dj} is the inverse of the variance of SMR_{dj} ; note that if a hospital does not have index admissions in a given division ($w_{dj} = 0$) then that cohort contributes nothing to the overall score SMR_j . This value, SMR_j , is the hospital-wide standardized mortality ratio for hospital j . To aid interpretation, this ratio is then multiplied by the overall national observed mortality rate for all index admissions in all cohorts, $\bar{Y}$, to produce the risk-standardized hospital-wide mortality rate (RSMR_j).

$$\text{RSMR}_j = \text{SMR}_j * \bar{Y} \quad (6)$$

Creating Interval Estimates

We first estimated the mean and variance for each $\log(\text{SMR})_{dj}$ based on the MCMC posterior distribution of the $\log(\text{SMR}_{dj})$. We let $\log(\text{SMR}_d)$ denote the vector of $\log(\text{SMR}_{dj})$, where $j=1,2,\dots,J$. We then utilized all posterior means of $\log(\text{SMR}_{dj})$ from each division and each hospital, if it exists, to construct the covariance matrix of $\log(\text{SMR}_d)$, where $d=1,2,\dots,13$. This 13 by 13 covariance matrix estimates the dependency of SMRs between divisions and will be same for all the hospitals. We constructed our confidence interval for SMR_j by considering all possible variances and covariances. Let $f(\cdot)$ denotes the equation (5). According to the delta method, we have.³⁹

$$\begin{aligned}
Var(SMR_j) &= \exp \left(2 \sum_{d=1}^D \frac{w_{dj} \times \log(SMR_{dj})}{\sum w_{dj}} \right) \\
&\times \left(\sum_{d=1}^D \left(\frac{w_{dj}}{\sum w_{dj}} \right)^2 Var(\log(SMR_{dj})) \right. \\
&\left. + \sum_{d=1}^D \sum_{d'=1}^D \frac{w_{dj}}{\sum w_{dj}} \times \frac{w_{d'j}}{\sum w_{dj}} Cov(\log(SMR_d), \log(SMR_{d'})) \right)
\end{aligned}$$

Because the $\log(SMR_{dj})$ are estimates rather than observations we accounted for the measure errors using $\sum_{d=1}^D (Var(\log(SMR_{dj})))$, which were estimated from the posterior distribution. Because we did not assume the $\log(SMR_{dj})$ from different divisions are independent we could not set the covariances to zero; instead as an approximation we summed over all the empirical variances and covariances of $\log(SMR_{dj})$ using $\sum_{d=1}^D \sum_{d'=1}^D Cov(\log(SMR_d), \log(SMR_{d'}))$, which were from the covariance matrix. Assuming a normal distribution for each SMR_j , the confidence interval estimates are calculated as $SMR_j \pm Z_{0.975} \times SD(SMR_j)$ where $Z_{0.975}$ is the 97.5% quantile for a standard normal distribution.

Given $RSMR_j = SMR_j \times \bar{Y}$, we calculated the lower and upper bound of the confidence interval for $RSMR_j$ by multiply $\bar{Y}$ to the corresponding estimates of the lower and upper bound of the SMR_j .

4.7 Measure Testing

We tested the measure's data elements, internal consistency, and measure score. We performed both reliability and validity testing as described below.

4.7.1 Data Element Testing

In constructing the claims-only HWM measure, we aimed to utilize only those data elements from the claims that have both face validity and reliability. We assessed the reliability of the data elements by comparing risk factor frequencies and ORs in the Split Sample Dataset, with results in [Section 5.6.1 Data Element Reliability and Validity Testing Results](#). For validity of the data elements, the CORE Project Team has already demonstrated for a number of prior measures the validity of claims-only measures for profiling hospitals by comparing either the measure results or individual data elements against medical records, as discussed further in [Section 5.6.1 Data Element Reliability and Validity Testing Results](#).

4.7.2 Internal Consistency Testing

To test internal consistency, we calculated Cronbach's alpha. Cronbach's alpha is used to assess the internal consistency (i.e., reliability) of a set of items as a group, i.e., how closely those items are related.

4.7.3 Measure Score Testing

Measure Score Reliability Testing

We assessed reliability of each risk model (service-line division) using the Split Sample Dataset to compare performance for each division. We calculated c-statistics, parameter estimates for each risk variable, and distributions of both division-level SMR and hospital-level RSMR.

We also assessed the reliability of the overall RSMR for each hospital in the split sample of data, using GLIMMIX and volume-weighted means to calculate the RSMRs. We compared hospitals' measure scores between the split samples by examining the scatter plots of RSMRs calculated in each split sample and calculating the ICC between the RSMRs in the two split samples.

Measure Score Validity Testing

We are developing this measure in consultation with national guidelines for publicly reported outcome measures, outside experts, and the public. This measure is consistent with the technical approach to outcome measurement set forth in NQF guidance for outcome measures, CMS Measure Management System guidance, and the guidance articulated in the American Heart Association's scientific statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes."^{35,36,40}

To further validate the results of our measure, we recreated the claims-only HWM measure (referred to as the "Claims-Only Risk Model" below) in the Clinical Hybrid Dataset, which is a different data source that includes both claims data as well as clinical data elements from the EHR from 22 hospitals. There were slight modifications made due to the limited data source, along with more details on each risk model, which are outlined in the Hybrid HWM Measure Report. We also created three other risk models using clinical EHR risk variables to calculate results of the overall RSMR and each of the division-level SMRs to validate the Claims-Only Risk Model against clinical data.

1. "Claims-Only Risk Model": Uses only claims-based variables in risk model:
 - a. Service mix: AHRQ CCS categories for patients' principal discharge diagnoses captured from claims data
 - b. Case mix: CMS Condition Categories (CCs) for patients' comorbidities captured from claims data during hospitalizations in the 12 months prior to and including the index admission (age plus 19 CC risk variables for each division risk model from HWM measure)
2. "Clinical-Only Risk Model": Uses only EHR-based clinical variables in risk model (no claims comorbidity OR principal discharge diagnoses):
 - a. Service mix: None
 - b. Case mix: age plus 10 clinical variables captured from EHR data
3. "Clinical + Principal Discharge Diagnoses Risk Model": Uses EHR-based clinical variables with claims-based principal discharge diagnoses in risk model (no claims comorbidity):
 - a. Service mix: AHRQ CCS categories for patients' principal discharge diagnoses captured from claims data
 - b. Case mix: age plus 10 clinical variables captured from EHR data
4. "Clinical + Claims Risk Model": Uses EHR-based clinical variables + claims-based comorbidity and principal discharge diagnosis variables in risk model; this is the final risk model for the hybrid HWM measure:
 - a. Service mix: AHRQ CCS categories for patients' principal discharge diagnoses captured from claims data

- b. Case mix: Both the age plus 10 clinical variables captured from EHR data and the CCs for patients' comorbidities captured from claims data during hospitalizations in the 12 months prior to and including the index admission (19 CC risk variables and age plus 10 clinical variables for each division risk model)

To assess validity of the claims-only measure, we compared the hospital-level measure results in the Clinical Dataset achieved using the Claims-Only Risk Model to the hospital-level measure results obtained with the Claims + Clinical-Only Risk Model (the final risk model for the companion hybrid HWM measure). We calculated the correlation (using Pearson's Correlation) of the final hospital-level RSMRs in the Clinical Hybrid dataset between the Claims-Only Model and the Claims + Clinical Risk Model (see [Section 5.6.2: Internal Consistency Testing Results](#)). While a gold standard benchmark for validity testing of a HWM measure does not exist, clinical data is widely considered a better risk-adjustment data source than administrative claims. Therefore, comparison of hospital measure results obtained using these two risk models provides an objective assessment of the ability of the Claims-Only Risk Model to produce similar risk prediction and hospital performance assessment to clinical data.

In addition, to further assess face validity, we plan to survey the TEP and ask each member to rate the validity of the claims-only HWM measure after updating the measure for use in ICD-10 data.

Question for public comment:

Do you have input on the measure testing approach?

What additional validity testing would be meaningful for this measure?

5. RESULTS

5.1 Cohort

As shown in [Figure 2](#) below, our original dataset with Medicare FFS admissions from July 1, 2014 – June 30, 2015 contained 10,134,008 admissions. After applying inclusion criteria, our initial index cohort contained 6,837,098 admissions. We then applied exclusion criteria (including criteria applied after the Claims-Only Development Dataset), and randomly selected one index admission per patient per year. This resulted in a preliminary index cohort of 3,894,235 admissions (patients), which was 57% of the admissions in the initial index cohort.

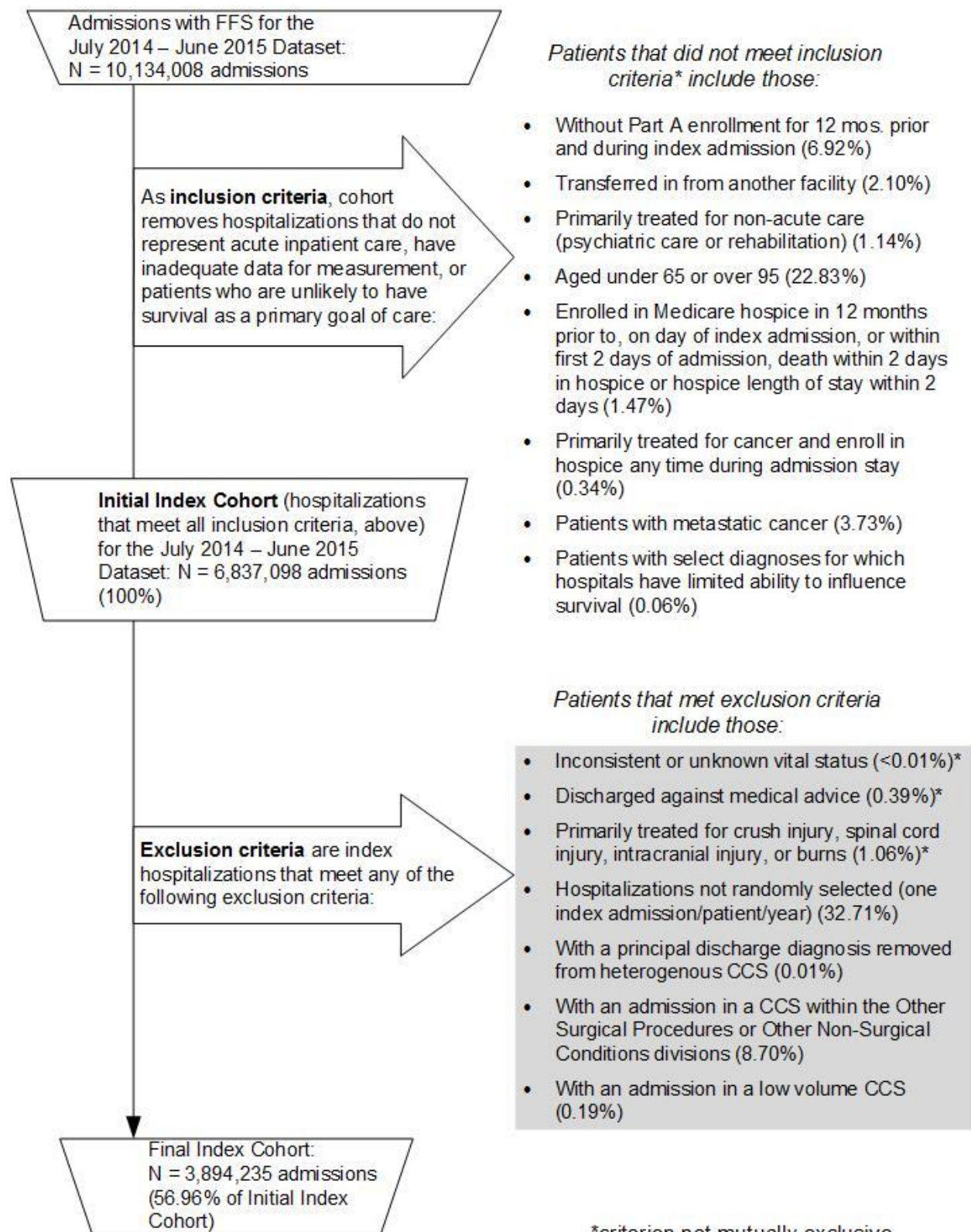
5.2 Service-Line Division Definitions

Results for each division for the patient-level logistic regression models, including the number of admissions, unadjusted 30-day mortality rate, and the c-statistic are shown below in [Table 3](#).

Table 3. Number of Admissions, Unadjusted 30-Day Mortality Rate, and C-Statistic from Logistic Regression Model Within Divisions, Claims-Only Development Dataset (July 1, 2014 – June 30, 2015, final version)

Division	Admissions	Unadjusted 30-Day Mortality (%)	C-Statistic
Non-Surgical Divisions			
Cancer	38,635	19.1%	0.78
Cardiac	682,716	7.5%	0.84
Gastrointestinal	351,117	5.3%	0.84
Infectious Disease	555,864	14.8%	0.85
Neurology	267,384	11.2%	0.86
Orthopedics	131,747	5.5%	0.82
Pulmonary	548,770	11.2%	0.82
Renal	240,404	8.9%	0.79
Surgical Divisions			
Cancer Surgery	89,276	2.6%	0.85
Cardiothoracic Surgery	111,546	6.7%	0.82
General Surgery	183,637	5.5%	0.88
Neurosurgery	27,144	8.5%	0.92
Orthopedic Surgery	665,995	1.8%	0.90
Total Cohort	3,894,235	--	--

Figure 2. Preliminary Index Cohort Flowchart with Results



5.3 Volume Distribution by Hospital and Division

[Table 4](#) below shows the total number of hospitals that have admitted any patients in each division. It also shows the distribution of the number of admissions per hospital in each division. For example, in the non-surgical cancer division, 3,231 hospitals have admitted at least one patient from the non-surgical cancer division and the median number of admissions for all hospitals in the non-surgical cancer division with at least one admission was 6.

Table 4. Hospital Volume Distributions by Division, Claims-Only Development Dataset (July 1, 2014 – June 30, 2015, final version)

Division	# Hospitals	Mean # Hospitals	Std Dev # Admissions	Median # Admissions	Min # Admissions	Q25% # Admissions	Q75% # Admissions	Max # Admissions
Cancer	3,231	12.0	18.8	6	1	2	15	396
Cardiac	4,501	151.7	201.0	62	1	17	220	2100
Gastrointestinal	4,457	78.8	97.0	40	1	13	112	1334
Infectious Disease	4,552	122.1	146.6	64	1	20	178	1616
Neurology	4,302	62.2	85.6	24	1	7	88	806
Orthopedics	4,341	30.4	42.6	13	1	5	40	646
Pulmonary	4,565	120.2	128.1	75	1	31	170	1502
Renal	4,474	53.7	65.7	27	1	9	80	828
Cancer Surgery	3,268	27.3	49.8	9	1	3	30	657
Cardiothoracic Surgery	2,842	39.3	70.4	9	1	2	48	984
General Surgery	4,026	45.6	58.7	24	1	6	63	691
Neurosurgery	1,890	14.4	22.4	6	1	2	17	287
Orthopedic Surgery	3,854	172.8	236.8	85	1	20	243	4480

5.4 Service-Line Division-Level Risk Models

5.4.1 Hierarchical Logistic Regression Model

The results of the model performance for each risk model (service-line division) are shown in [Appendix H Hierarchical Logistic Regression Model Results](#). Tables show the full list of risk variables for each model, including the percent of patients with the risk variable, and the ORs with 95% confidence intervals for mortality risk in the Claims-Only Development Dataset. Results were based on estimated hierarchical logistic regression models.

Note: The Other Surgical Procedures and Other Non-Surgical Conditions divisions are included in the appendix to display the CCS in each division, and how the risk variables performed. As noted above, these are not included in the current version of the measure and will be reconsidered during measure reevaluation.

5.4.2 Service-Line Division-Level Risk Model Performance

[Table 5](#) summarizes each model's performance, including in each division the number of admissions, observed mortality rate, c-statistic, predictive ability, and residuals lack of fit in Sample 1 (S1) and Sample 2 (S2). For model validation, we used the Split Sample Dataset as described in [Section 4.2 Data Sources](#). The c statistic is a measure of how accurately a statistical model is able to distinguish between a patient with and without an outcome. While a higher c statistic is desirable, we do not want to maximize it by adjusting for factors that should not be adjusted for. The range of c statistic results is 0.75 to 0.84 which is consistent with or better than results we have seen for other 30-day mortality measures. Discrimination in predictive ability measures the ability to distinguish high-risk subjects from low-risk subjects. Therefore, we would hope to see a wide range between the lowest decile and highest decile, which these models show.

Table 5. Logistic Regression Model Performance, Non-Surgical and Surgical Divisions, Split Sample (July 1, 2013 – June 30, 2015)

Divisions	Data set Sample #	Number of Admissions	Observed Mortality Rate (%)	C-Statistic	Predictive Ability, % (lowest decile, highest decile)	Residuals Lack of Fit (Pearson Residual Fall %)			
						<-2	[-2, 0)	[0, 2)	[2+
Cancer	S1	39,692	19.17	0.75	(3, 50)	0.03	80.81	12.79	6.38
	S2	39,581	19.07	0.75	(3, 48)	0.02	80.92	12.61	6.46
Cardiac	S1	690,166	7.15	0.83	(0.3, 30)	0.03	92.83	2.72	4.42

Divisions	Data set Sample #	Number of Admissions	Observed Mortality Rate (%)	C-Statistic	Predictive Ability, % (lowest decile, highest decile)	Residuals Lack of Fit (Pearson Residual Fall %)			
						<-2	[-2, 0)	[0, 2)	[2+
	S2	690,695	7.12	0.83	(0.3, 30)	0.03	92.85	2.72	4.41
Gastro-intestinal	S1	354,010	5.06	0.83	(0.3, 23)	0.01	94.93	1.34	3.72
	S2	352,376	5.10	0.83	(0.3, 23)	0.01	94.89	1.39	3.71
Infectious Disease	S1	535,822	14.33	0.84	(0.5, 52)	0.09	85.58	9.82	4.5
	S2	535,307	14.4	0.84	(0.5, 52)	0.09	85.52	9.9	4.49
Neurology	S1	268,650	10.96	0.85	(0.4, 49)	0.14	88.89	6.45	4.51
	S2	268,639	11.08	0.85	(0.4, 50)	0.15	88.77	6.55	4.53
Orthopedic	S1	129,841	5.51	0.81	(0.5, 24)	0.02	94.47	1.47	4.04
	S2	130,111	5.39	0.80	(1, 23)	0.01	94.61	1.44	3.94
Pulmonary	S1	532,925	11.27	0.81	(1, 41)	0.06	88.67	5.77	5.51
	S2	531,325	11.28	0.81	(1, 41)	0.06	88.66	5.74	5.55
Renal	S1	238,391	8.69	0.78	(1, 29)	0.01	91.3	2.86	5.83
	S2	238,113	8.66	0.78	(1, 29)	0.01	91.34	2.8	5.86
Cancer Surgery	S1	90,651	2.58	0.82	(0.2, 13)	0.001	97.42	0.32	2.26
	S2	90,898	2.62	0.83	(0.1, 13)	0.001	97.38	0.37	2.25

Divisions	Data set Sample #	Number of Admissions	Observed Mortality Rate (%)	C-Statistic	Predictive Ability, % (lowest decile, highest decile)	Residuals Lack of Fit (Pearson Residual Fall %)			
						<-2	[-2, 0)	[0, 2)	[2+
Cardiothoracic Surgery	S1	110,343	6.65	0.81	(1, 29)	0.01	93.34	2.37	4.28
	S2	111,196	6.61	0.81	(1, 29)	0.02	93.37	2.36	4.25
General Surgery	S1	186,350	5.42	0.87	(0.2, 29)	0.02	94.57	2.26	3.15
	S2	186,855	5.49	0.87	(0.3, 29)	0.03	94.48	2.32	3.17
Neurosurgery	S1	27,356	8.24	0.91	(0.3, 48)	0.08	91.68	5.9	2.34
	S2	27,261	8.35	0.91	(0.1, 49)	0.07	91.57	5.95	2.4
Orthopedic Surgery	S1	666,309	1.75	0.90	(0.1, 12)	0.001	98.25	0.26	1.49
	S2	665,236	1.74	0.89	(0.1, 11)	0.001	98.26	0.25	1.49

5.5 Final Measure Results

5.5.1 Hospital-Level Overall RSMR Results

[Figure 3](#) below represents the distribution, by RSMR, of hospitals with at least 25 patients, which is the threshold used by CMS's existing mortality measures for public reporting. Hospital-level RSMRs range from 5.0% to 9.8%, with a slight skewing of the distribution curve towards lower mortality rates. This is supported by the finding that 102 hospitals (2.1%) were statistically better than the national average HWM rate while 6 hospitals (0.1%) were statistically worse, using 95% confidence intervals; an additional 256 hospitals (5.3%) were too low volume to determine whether they were statistically different from average ([Figure 3](#)). The next section reports division-level results across the nation.

Figure 3. Distribution of RSMR for Hospitals with at least 25 patients, Split Sample Dataset Sample 1 (July 1, 2013 – June 30, 2015)

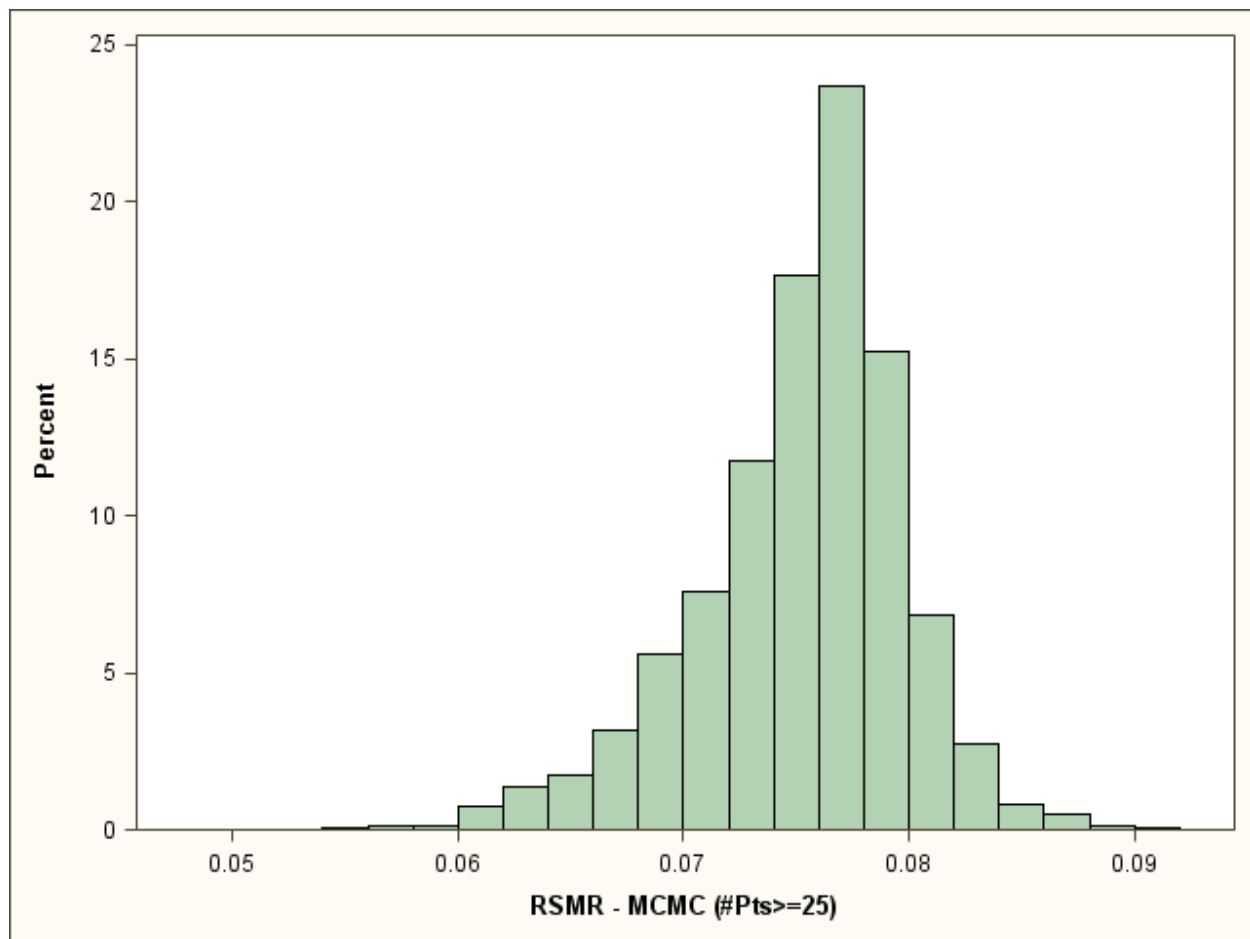


Table 6. Number and Percentage of Hospitals and their Outlier Category, Split Sample Dataset Sample 1 (July 1, 2013 – June 30, 2015) (N=4793)

Performance Category	# Hospitals	Percentage (%)
Better	102	2.1
No Different	4429	92.4
Worse	6	0.1
Too Small	256	5.3

5.5.2 Hospital-Level Service-Line Division-Level Results

[Table 7](#) and [Table 8](#) below show the distribution of hospitals by their division-level SMRs and RSMRs, respectively. The mean division-level RSMR ranges from 1.8% for the surgical orthopedics division to 19.3% for the non-surgical cancer division.

We report the number and percentage of hospitals with service-line division-level RSMRs that are statistically better or worse than the national average in [Table 9](#). The non-surgical pulmonary and non-surgical infectious disease divisions had the greatest number of outliers (200 and 302 hospitals, respectively), while the neurosurgery division had no outliers and the orthopedic and surgical cancer divisions had two outlier hospitals each.

Table 7. Standardized Mortality Ratio (SMR) Distribution by Service-Line Division for Development Sample (July 1, 2014 – June 30, 2015, final version) (N=4726)

Service-Line Division	# Hospitals	Mean	Std Dev	Median	Min	Max
Non-Surgical Cancer	3231	1.008	0.116	0.989	0.486	1.759
Non-Surgical Cardiac	4501	1.012	0.126	1.002	0.576	1.867
Non-Surgical Gastrointestinal	4457	1.009	0.104	0.995	0.639	1.950
Non-Surgical Infectious Disease	4552	1.017	0.153	0.997	0.427	1.813
Non-Surgical Neurology	4302	1.006	0.079	0.997	0.654	1.413
Non-Surgical Orthopedics	4341	1.005	0.083	0.993	0.626	1.647
Non-Surgical Pulmonary	4565	1.021	0.170	1.000	0.567	1.979
Non-Surgical Renal	4474	1.008	0.103	0.997	0.595	1.561
Surgical Cancer	3268	1.015	0.144	0.990	0.521	2.346
Surgical Cardiothoracic	2842	1.007	0.101	0.993	0.558	2.114
Surgical General	4026	1.006	0.087	0.995	0.645	1.541
Surgical Neurosurgery	1890	1.000	0.019	0.999	0.921	1.108
Surgical Orthopedics	3854	1.004	0.069	0.997	0.718	1.503

Table 8. Risk-Standardized Mortality Rate (RSMR) Distribution by Service-Line Division for Development Sample (July 1, 2014 – June 30, 2015, final version) (N=4726)

Service-Line Division	# Hospitals	Mean	Std Dev	Median	Min	Max
Non-Surgical Cancer	3231	19.3%	2.2%	18.9%	9.3%	33.7%

Service-Line Division	# Hospitals	Mean	Std Dev	Median	Min	Max
Non-Surgical Cardiac	4501	7.6%	0.9%	7.5%	4.3%	13.9%
Non-Surgical Gastrointestinal	4457	5.3%	0.5%	5.2%	3.4%	10.3%
Non-Surgical Infectious Disease	4552	15.0%	2.3%	14.7%	6.3%	26.8%
Non-Surgical Neurology	4302	11.3%	0.9%	11.2%	7.3%	15.9%
Non-Surgical Orthopedics	4341	5.5%	0.5%	5.5%	3.5%	9.1%
Non-Surgical Pulmonary	4565	11.5%	1.9%	11.2%	6.4%	22.2%
Non-Surgical Renal	4474	9.0%	0.9%	8.9%	5.3%	13.9%
Surgical Cancer	3268	2.6%	0.4%	2.5%	1.3%	6.0%
Surgical Cardiothoracic	2842	6.8%	0.7%	6.7%	3.7%	14.2%
Surgical General	4026	5.6%	0.5%	5.5%	3.6%	8.5%
Surgical Neurosurgery	1890	8.5%	0.2%	8.5%	7.8%	9.4%
Surgical Orthopedics	3854	1.8%	0.1%	1.8%	1.3%	2.7%

Table 9. Number and Percentage of Hospitals by Service-Line Division and Performance Category, Split Sample Dataset Sample 1 (July 1, 2013 – June 30, 2015) (N=4793)

Service-Line Division	Better than the National Average	Worse than the National Average	Total Number of Outliers	Number of Eligible Hospitals	Percentage of Outliers (%)
Neurosurgery	0	0	0	1,940	0.0
Cancer Surgery	2	0	2	3,279	0.1
Cardiothoracic Surgery	8	5	13	2,890	0.5
General Surgery	5	5	10	4,080	0.2
Orthopedic Surgery	0	2	2	3,886	0.1
Non-Surgical Cancer	17	4	21	3,313	0.6
Non-Surgical Orthopedics	2	5	7	4,396	0.2
Non-Surgical Renal	17	16	33	4,531	0.7
Non-Surgical Neurology	19	20	39	4,363	0.9
Non-Surgical Gastrointestinal	12	7	19	4,531	0.4
Non-Surgical Pulmonary	125	75	200	4,636	4.3
Non-Surgical Infectious Disease	201	101	302	4,616	6.5
Non-Surgical Cardiac	84	38	122	4,543	2.7

Question for public comment:

Do you have input on the hospital measure results?

5.6 Measure Testing Results

5.6.1 Data Element Reliability and Validity Testing Results

To ensure that we use data elements that are reliable, we avoid the use of fields that are thought to be coded inconsistently across hospitals or providers. Additionally, CMS has in place several hospital auditing programs used to assess overall claims code accuracy, to ensure appropriate billing and for overpayment recoupment. CMS routinely conducts data analysis to identify potential problem areas and detect fraud, and audits important data fields used in our measures.

The CORE Project Team has already demonstrated for a number of prior measures the validity of claims-based measures for profiling hospitals by comparing either the measure results or individual data elements against medical records. CMS validated the six NQF-endorsed claims-based measures currently in public reporting (AMI, heart failure, and pneumonia mortality and readmission) with models that used medical record-abstracted data for risk adjustment. Specifically, claims model validation was conducted by building comparable models using abstracted medical record data for risk adjustment for heart failure patients (National Heart Failure data), AMI patients (Cooperative Cardiovascular Project data) and pneumonia patients (National Pneumonia Project dataset). When both models were applied to the same patient population, the hospital risk-standardized rates estimated using the claims-based risk adjustment models had a high level of agreement with the results based on the medical record model, thus supporting the use of claims-based models for public reporting.

We have also completed two national, multi-site validation efforts for two procedure-based complications measures (for primary elective hip/knee arthroplasty and implantable cardioverter defibrillator [ICD]). Both projects demonstrated strong agreement between complications coded in claims and abstracted medical record data. Comparison of measure results obtained using a claims-only measure of mortality after isolated coronary artery bypass graft surgery compared to a registry-based measure also demonstrated high correlation.⁴¹ These validation efforts suggest that such claims data variables are valid across a variety of conditions, procedures, and outcomes, including mortality.

5.6.2 Internal Consistency Testing Results

Cronbach's alpha was used to gauge the internal consistency among RSMRs for the divisions. As guidance, if the divisions were entirely independent from one another, then Cronbach's alpha would be zero. The higher the Cronbach's alpha, the more the divisions have shared characteristics and probably measure the same underlying concept. Usually, a Cronbach's alpha less than 0.5 is unacceptable. The Cronbach's alpha for the claims-only HWM measures was 0.76, which is acceptable. This means all the RSMRs from different divisions are likely measuring the same concept, that is, quality of care.

Table 10. Cronbach's Alpha by Division to RSMR, Split Sample Dataset Sample 1 (July 1, 2013 – June 30, 2015)

Division	Correlation with RSMR	Cronbach's alpha
Surgical: Neurosurgery	0.15	0.79
Non-Surgical: Cancer	0.28	0.78
Surgical: Cancer	0.27	0.78
Surgical: CT	0.27	0.78
Non-Surgical: Orthopedics	0.28	0.78

Division	Correlation with RSMR	Cronbach's alpha
Surgical: General	0.33	0.78
Non-Surgical: Renal	0.40	0.77
Non-Surgical: Neurology	0.43	0.77
Non-Surgical: GI	0.43	0.77
Non-Surgical: Pulmonary	0.51	0.76
Non-Surgical: Infectious Disease	0.52	0.76
Surgical: Orthopedics	0.34	0.78
Non-Surgical: Cardiac	0.52	0.76

5.6.3 Measure Score Results

Measure Score Reliability Testing – RSMR

The ICC of the overall RSMR of the two split samples was 0.83, indicating strong correlation.

Measure Score Reliability Testing – Service-Line Division SMR

[Table 11](#) below compares the hospitals' division-level RSMRs in the Split Sample Dataset (comparing Sample 1 and Sample 2), and the degree of correlation between a hospital's division-level results using two randomly selected and completely distinct sets of their patients. The division-level reliability results range from ICC of 0.02 for neurosurgery (interpreted as slight reliability) to 0.6 for non-surgical infectious disease (substantial reliability).⁴² The neurosurgery division has fewer patients, fewer mortality events, and fewer hospitals with patients contributing to the division-level SMR than other service-line divisions, likely contributing to the very low reliability result. These results show the overall measure score has higher reliability between split samples (ICC=0.83) than any of the individual division level results.

Table 11. Number of Hospitals by Division and ICC Relationship of RSMR, Split Sample Datasets (Sample 1 and Sample 2; July 1, 2013 – June 30, 2015)

Division	# Hospitals	ICC of RSMR
Surgical: Neurosurgery	1671	0.02
Non-Surgical: Cancer	2873	0.35
Surgical: Cancer	3037	0.23
Surgical: CT	2513	0.38
Non-Surgical: Orthopedics	4220	0.26
Surgical: General	3870	0.27
Non-Surgical: Renal	4448	0.34
Non-Surgical: Neurology	4236	0.38
Non-Surgical: GI	4474	0.34
Non-Surgical: Pulmonary	4610	0.53
Non-Surgical: Infectious Disease	4567	0.61
Surgical: Orthopedics	3699	0.25

Division	# Hospitals	ICC of RSMR
Non-Surgical: Cardiac	4502	0.50
Overall RSMR (volume weighted)	4783	0.83

Measure Result Validity Testing – RSMR

To validate the overall RSMR, we calculated the hospital-level RSMR for each of the 22 hospitals in the Clinical Dataset for each of the four models (Claims-Only Model, Clinical-Only Model, Clinical + Principal Discharge Diagnoses Model, and Claims + Clinical Model (final hybrid measure risk model), described in [Section 4.7.3 Measure Score Testing](#) and in further detail in the Hybrid HWM Measure Report. We compared model discrimination and performance across these models and found similar c-statistics and performance across the models. The Pearson’s Correlation of the final hospital-level RSMRs in the Clinical Hybrid Dataset using the Claims-Only Model and the Claims + Clinical Risk Model (final hybrid measure risk model) was 0.97, supporting near perfect correlation between the Claims-Only Risk Model and a model that includes clinical data.

Measure Result Validity Testing – Service-Line Division RSMR

To further evaluate the service-line division-level results, we compared the performance (c-statistic) of the Claims-Only Model to the three other models created in the Clinical Hybrid Dataset ([Table 12](#)). These results show that the Claims-Only Model in the Clinical Hybrid Dataset had slightly higher performance, as measured by c-statistics, than the Clinical-Only Model for most divisions, and only slightly lower performance than the Claims + Clinical Model (final hybrid measure risk model), that added 10 clinical variables to the Claims-Only Model.

Assessment of face validity by the TEP is planned following update of the measure specifications in ICD-10 data.

Table 12. Comparison of C-Statistics by Division of Claims-Only Model, Clinical-Only, Clinical + Principal Discharge Diagnoses Model, and Final Hybrid (Clinical + Claims) Model, Using Clinical Hybrid Dataset (January 1, 2010 – December 31, 2015)

Division	Claims-Only Model C-Statistic	Clinical-Only Model C-Statistic	Clinical + Principal Discharge Diagnoses Model C-Statistic	Clinical + Claims (Final Hybrid) Model C-Statistic
Non-Surgical Cancer	0.83	0.79	0.84	0.87
Non-Surgical Cardiac	0.84	0.84	0.86	0.88
Non-Surgical Gastrointestinal	0.87	0.81	0.85	0.89
Non-Surgical Infectious Disease	0.78	0.79	0.79	0.83
Non-Surgical Pulmonary	0.76	0.75	0.78	0.80
Non-Surgical Renal	0.83	0.82	0.83	0.86
Non-Surgical Orthopedic	0.86	0.82	0.85	0.88

Division	Claims-Only Model C-Statistic	Clinical-Only Model C-Statistic	Clinical + Principal Discharge Diagnoses Model C-Statistic	Clinical + Claims (Final Hybrid) Model C-Statistic
Non-Surgical Neurology	0.81	0.74	0.80	0.83
Surgical Cardiothoracic	0.83	0.8	0.85	0.85
General Surgery	0.92	0.89	0.93	0.94
Surgical Neurosurgery	---	0.85	---	---
Surgical Orthopedics	0.92	0.89	0.92	0.93
Surgical Cancer	0.89	0.82-	0.88	0.91

5.7 Presenting Results

In developing this measure, our goal was to produce a valid, single summary measure of hospital-wide mortality that would be used by policymakers, clinicians, patients, and family caregivers to assess hospital quality of care. There are several considerations about how best to publicly present the results of this measure. In particular, we are considering both what level of detail should be presented and how the range of performance and statistical certainty for the results should be presented.

During the process of development, we consistently heard from stakeholders about the importance of having more detailed level information available, not only for hospitals, but also for the public. As we continue to build this measure, we will continue to explore how to present more granular information in a manner that is usable and accurate, without being misleading.

We also heard from stakeholders that this measure could be valuable in providing transparency about overall hospital performance if there is meaningful variation in provider performance. In addition to hearing public input on what results are shared and how, we would also like input on how CMS might report uncertainty around the RSMR. Currently, CMS's 30-day condition- and procedure- specific mortality measures report the RSMR with 95% interval estimates. These interval estimates are similar to 95% confidence intervals and represent the range of possible RSMR values within which the true RSMR falls into 95% percent of the time. This means that hospitals are unlikely to be incorrectly identified as a statistical outlier, but limits the number of hospitals identified as statistical outliers. Finally, we heard concerns from our TEP about hospitals that are considered "No Different From National Average" being less likely to proactively address quality issues. We have considered another approach that is more complex but provides additional information. This approach is to report the probability that a hospital is statistically different from average. For example, one might report three numbers for an individual hospital:

1. Hospital-level RSMR – For example, Hospital A has an RSMR of 9.6%. This is higher than the national average mortality rate of 8.1% and is currently how CMS currently reports mortality rates on Hospital Compare. Alternatively, CMS could report a related statistic, the SMR. For example, Hospital B has an SMR of 2.0. This results in an RSMR for the hospital that is two times higher than the national average.
2. Probability Worse Than Average – Hospital A has a Probability Worse Than Average of 90%. This indicates that in 90% of possible values for this hospital's RSMR, the true RSMR value for this

hospital is higher (worse) than average. This could replace or be reported in addition to the traditional performance categories CMS reports (Worse Than National Average, No Different From National Average, and Better Than National Average).

3. Probability Better Than Average – This value is complementary to the Probability Worse Than Average. Therefore, Hospital A, which has a Probability Worse Than Average of 90%, will have a Probability Better Than Average of 10%. This indicates that, in 10% of possible values for this hospital's RSMR, the true RSMR value for this hospital is not lower (better) than the average national mortality rate. In this example, this hospital would be considered No Different From National Average using CMS's current approach, but many would agree that this hospital's care could benefit from improvement.

CMS has not made any decisions about the implementation of this measure or how the results would be reported. We seek input from stakeholders about alternative approaches to reporting results for this measure and how this information would help patients and clinicians use this measure.

Question for public comment:

Do you have input on how the measure results might be presented to the public?

How could CMS present supplemental hospital performance information in public reporting, such as service-line division-level results, to create a more meaningful and usable measure?

How could CMS report more information about hospitals in a No Different From National Average group (defined using 95% confidence intervals) to help clinicians and patients use the measure results to improve patient care and make informed choices?

6. SUMMARY

This report summarizes the development, specifications, and testing to date of a hospital-level all-cause hospital-wide 30-day mortality measure based on administrative claims data. This measure benefited from consistent input from patients and clinicians throughout the development process.

This measure offers several important benefits. It provides CMS with a tool for broad performance assessment across a wider span of hospitals than most currently reported condition- and procedure-specific mortality measures. It allows for monitoring of an important, patient-centered outcome and complements CMS's existing claims-only and hybrid hospital-wide readmission measures without burdening hospitals or patients. We used a standard, accepted, and transparent approach to develop the measure. The measure provides more granular division-level performance information prioritized by both patients and clinicians. The results demonstrate a broad range of hospital performance, with overall RSMRs ranging from 5.0% to 9.8%. The measure demonstrates high reliability in a rigorous split sample evaluation that uses two completely distinct and non-overlapping groups of patients within each hospital. It produces similar risk prediction and demonstrates high correlation to hospital performance estimates obtained using clinical data.

The measure also has its challenges. While it identified few statistical outliers using traditional 95% confidence limits than most other outcome measures, this is not inconsistent with all other outcome measures: 2.6% of hospitals are identified as outliers for the claims-only HWM measure, compared with a range of 2.5% to 11.2% for other CMS condition- and procedure-specific mortality measures. It also currently excludes a number of patient groups, such as those originally defined in the Other Surgical Procedures or Other Non-Surgical Conditions service-line divisions. These exclusions were due to results suggesting challenges with adequate risk adjustment due to high patient heterogeneity and low mortality rates. During measure development, we felt it was critical to focus the measurement inclusion on patient groups for which mortality was a likely signal of hospital quality and for which we could ensure adequate risk adjustment. We elected to narrow the cohort to prioritize measure validity. We will revisit these exclusions during the transition to ICD-10 code data which may allow for the measure to include additional patients with adequate risk adjustment. Reporting meaningful results for both patients and clinicians is also challenging. During measure development, patients and clinicians expressed a preference for presenting supplemental, division-level information along with the overall hospital score. For CMS's existing publicly reported mortality measures, hospitals receive detailed, patient-level reports of their measure results, allowing targeted quality improvement. Our stakeholders strongly urged more transparency with publicly reported division-level results for this particular measure to make it more meaningful for patients and clinicians. We have not decided how best to display this information while appropriately communicating the statistical uncertainty around the division-level results. Finally, the measure was developed using ICD-9 data and requires a detailed reevaluation of the measure specifications to update to ICD-10 data prior to implementation. This reevaluation work is currently ongoing.

Measuring HWM is difficult. Earlier attempts did not exclude patients for whom mortality is likely not a quality signal, nor did they have the benefit of close patient and clinician engagement in measure design. Throughout our discussions with stakeholders, including our TEP, we heard support for the concept of measuring HWM and a strong desire for a measure that offers patients and providers meaningful, detailed, and statistically valid performance data. We present a hospital-wide mortality measure that was developed with a wide range of stakeholder and expert input that is based on learning

from prior measurement efforts. We have used rigorous methods to design a measure that offers meaningful performance data about as many hospitals and patients as possible. We created a statistically rigorous measure based only on administrative claims data that performs similarly to clinical data. We anticipate the transition to ICD-10 data will provide more opportunities for improving the measure and we look forward to the public's input to inform those improvements.

GLOSSARY

C-statistic: An indicator of the model's discriminant ability or ability to correctly classify those who have and have not died within 30 days of the start of the admission. Potential values range from 0.5, meaning no better than chance, to 1.0, an indication of perfect prediction. Perfect prediction implies that patients' outcomes can be predicted completely by their risk factors, and physicians and hospitals play no role in their patients' outcomes.

Case mix: The particular illness severity and age characteristics of patients with index admissions at a given hospital.

Cohort: The index admissions used to calculate the measure after inclusion and exclusion criteria have been applied.

Comorbidities: Medical conditions the patient had in addition to his/her primary reason for admission to the hospital.

Complications: Medical conditions that may have occurred as a consequence of care rendered during hospitalization.

Condition categories (CMS-CCs): Groupings of ICD-9 diagnosis codes in clinically relevant categories, from the Hierarchical Condition Categories (HCCs) system. CMS uses the grouping but not the hierarchical logic of the system to create risk factor variables. Description of the Condition Categories can be found at http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf.

Confidence interval (CI): A CI is a range of probable values for an estimate that characterizes the amount of associated uncertainty. For example, the 95% CI for the ORs associated with risk-adjustment variables in the model indicates there is 95% confidence that the OR lies between the lower and the upper limit of the interval. The 95% CI serves as a proxy for statistical significance for ORs; if the CI does not contain the value of 1.0, the association is considered significant.

Discharge condition category: A group of related discharge diagnosis ICD-9 codes (principal diagnoses), as grouped by the AHRQ CCS.

Electronic health record (EHR): A record in digital format that allows for systematic collection of electronic health information about individual patients or populations. It theoretically allows for sharing information across different healthcare settings.

Expected mortality: The number of deaths expected based on average hospital performance with a given hospital's case mix and service mix.

Hierarchical model: A widely accepted statistical method that enables fair evaluation of relative hospital performance by accounting for patient risk factors as well as the number of patients a hospital treats. This statistical model accounts for the structure of the data (patients clustered within hospitals) and calculates (1) how much variation in hospital mortality rates overall is accounted for by patients' individual risk factors (such as age and other medical conditions); and (2) how much variation is accounted for by hospital contribution to mortality risk.

Hybrid measure: A measure that uses two separate data sources. Specifically, the hybrid HWM measure uses Medicare claims data to derive the cohort, outcome, and comorbidities, and EHR-derived data to add patient-level clinical data into the risk adjustment. This is in comparison to only using Medicare claims as a single source of data for measure development and implementation.

Index admission: Any admission included in the measure calculation as the initial admission for an episode of care to which the outcome is attributed.

Interval estimate: Similar to a CI, the interval estimate is a range of probable values for the estimate that characterizes the amount of associated uncertainty. For example, a 95% interval estimate for a mortality rate indicates there is 95% confidence that the true value of the rate lies between the lower and the upper limit of the interval.

Medicare fee-for-service (FFS): Original Medicare plan in which providers receive a fee or payment for each individual service provided directly from Medicare. Only beneficiaries in Medicare FFS, not in managed care (Medicare Advantage), are included in this measure.

National observed mortality rate: All included hospitalizations with the outcome divided by all included hospitalizations.

Odds ratio (OR): The ORs express the relative odds of the outcome for each of the predictor variables. For example, the OR for Protein-calorie malnutrition (CC 21) represents the odds of the outcome for patients with that risk variable present relative to those without the risk variable present. The model coefficient for each risk variable is the log (odds) for that variable.

Outcome: The result of a broad set of healthcare activities that affect patients' well-being. For this measure, the outcome is mortality within 30 days of admission.

Predicted mortality: The number of deaths within 30 days, predicted based on the hospital's performance with its observed case mix and service mix.

Risk-adjustment variables: Patient demographics and comorbidities used to adjust for differences in case mix and service mix across hospitals.

Risk-standardized mortality rate: The risk-standardized mortality rate is the standardized mortality ratio (SMR) (see definition below), multiplied by the national observed mortality rate.

Service-line division: A group of index admissions for patients with related conditions or procedures categories that are likely treated by similar care teams. There were 15 defined cohorts in this report, with 13 being in the final measure. Each service-line division has its own risk model. They are Non-Surgical: Cancer, Cardiac, Gastrointestinal, Infectious Disease, Neurology, Orthopedics, Pulmonary, Renal; Surgical: Cancer, Cardiothoracic, General, Neurosurgery, Orthopedics.

Service mix: The particular conditions and procedures of the patients with index admissions at a given hospital.

Standardized mortality ratio (SMR): For each hospital, the numerator of the ratio is the number of deaths predicted for the hospital's patients, accounting for its observed mortality rate, the number of patients, and the hospital's case- and service-line mix. The denominator is the number of deaths expected nationally for that hospital's case/service-line mix. A ratio greater than one indicates that more patients died at that hospital than expected, compared to an average hospital with similar case/service-line mix. A ratio less than one indicates that the hospital's patients have fewer deaths than expected, compared to an average hospital with a similar case/service-line mix.

REFERENCES

1. James JT. A new, evidence-based estimate of patient harms associated with hospital care. *Journal of Patient Safety*. 2013;9(3):122-128.
2. Suter LG, Li SX, Grady JN, et al. National patterns of risk-standardized mortality and readmission after hospitalization for acute myocardial infarction, heart failure, and pneumonia: update on publicly reported outcomes measures based on the 2013 release. *Journal of General Internal Medicine*. 2014;29(10):1333-1340.
3. Peterson ED, Roe MT, Mulgund J, et al. Association between hospital process performance and outcomes among patients with acute coronary syndromes. *JAMA*. 2006;295(16):1912-1920.
4. Writing Group for the Checklist- I.C.U. Investigators, Brazilian Research in Intensive Care Network. Effect of a quality improvement intervention with daily round checklists, goal setting, and clinician prompting on mortality of critically ill patients: A randomized clinical trial. *JAMA*. 2016;315(14):1480-1490.
5. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). *Public Comment Summary Report: Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure*. February 2017.
6. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). Condition-Specific Measures Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Mortality Measures. 2016; <https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPages%2FQnetTier4&cid=1163010421830>. Accessed October 28, 2016.
7. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). Procedure-Specific Measure Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Mortality Measure. 2016; <https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPages%2FQnetTier4&cid=1163010421830>. Accessed October 28, 2016.
8. Institute of Medicine. *To Err is Human: Building a Safer Health System*. 1999; <https://iom.nationalacademies.org/~media/Files/Report%20Files/1999/To-Err-is-Human/To%20Err%20is%20Human%201999%20%20report%20brief.pdf>. Accessed January 20, 2016.
9. Classen DC, Resar R, Griffin F, et al. 'Global trigger tool' shows that adverse events in hospitals may be ten times greater than previously measured. *Health Affairs*. 2011;30(4):581-589.
10. Andel C, Davidow SL, Hollander M, Moreno DA. The economics of health care quality and medical errors. *Journal of Health Care Finance*. 2012;39(1):39-50.
11. Berwick DM, Calkins DR, McCannon CJ, Hackbarth AD. The 100,000 lives campaign: Setting a goal and a deadline for improving health care quality. *JAMA*. 2006;295(3):324-327.
12. Tablan O, Anderson L, Besser R, Bridges C, Hajjeh R. CDC; Healthcare Infection Control Practices Advisory Committee. Guidelines for preventing health-care-associated pneumonia, 2003: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recommendation Reports*. 2004;53(RR-3):1-36.
13. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *American Journal of Respiratory Critical Care Medicine*. 2005;171:388-416.
14. Resar R, Pronovost P, Haraden C, Simmonds T, Rainey T, Nolan T. Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. *Joint Commission Journal on Quality and Patient Safety*. 2005;31(5):243-248.
15. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction; A report of the American College of

- Cardiology/American Heart Association Task Force on Practice Guidelines (committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). *Journal of the American College of Cardiology*. 2004;44(3):E1-e211.
16. Centers for Medicare & Medicaid Services. Hospital Quality Initiative Overview. 2005; <http://www.allhealth.org/briefingmaterials/HospitalQualityInitiativeOverview-CMS-512.pdf>. Accessed January 20, 2016.
 17. Joint Commission. 2005 Joint Commission National Patient Safety Goals: Practical Strategies and Helpful Solutions for Meeting These Goals. 2005; <http://teacherweb.com/NY/StBarnabas/Law-PublicPolicy/JCINT-2005.pdf>. Accessed January 20, 2016.
 18. O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clinical Infectious Diseases*. 2002;35(11):1281-1307.
 19. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Committee HICPA. Guideline for prevention of surgical site infection, 1999. *American Journal of Infection Control*. 1999;27(2):97-134.
 20. The Joint Commission. Surgical Care Improvement Project. 2005; http://www.jointcommission.org/surgical_care_improvement_project/. Accessed January 20, 2016.
 21. Whittington J, Simmonds T, Jacobsen D. *Reducing hospital mortality rates*. Institute for Healthcare Improvement; 2005.
 22. Poteliakhoff E. Update on IHI's 100k Lives Campaign. October 2006; <http://hpm.org/us/c8/5.pdf>. Accessed January 20, 2016.
 23. Curry LA, Linnander EL, Brewster AL, Ting H, Krumholz HM, Bradley EH. Organizational culture change in U.S. hospitals: A mixed methods longitudinal intervention study. *Implementation Science*. 2015;10:29.
 24. Shahian DM, Iezzoni LI, Meyer GS, Kirle L, Normand SL. Hospital-wide mortality as a quality metric: Conceptual and methodological challenges. *American Journal of Medical Quality: The Official Journal of the American College of Medical Quality*. 2012;27(2):112-123.
 25. Health and Social Care Information Centre. Summary Hospital-Level Mortality Indicator. 2015; http://www.hscic.gov.uk/media/19099/SHMI-specification/pdf/SHMI_specification.pdf. Accessed January 11, 2016.
 26. Blumberg MS. Comments on HCFA hospital death rate statistical outliers. *Health Care Financing Administration. Health Services Research*. 1987;21(6):715-739.
 27. Green J, Wintfeld N, Sharkey P, Passman LJ. The importance of severity of illness in assessing hospital mortality. *JAMA*. 1990;263(2):241-246.
 28. Wen E, Sandoval C, Zelmer J, Webster G. Understanding and using the hospital standardized mortality ratio in Canada: Challenges and opportunities. *HealthcarePapers*. 2008;8(4):26-36; discussion 69-75.
 29. Brien SE, Ghali WA. CIHI's hospital standardized mortality ratio: Friend or foe? *HealthcarePapers*. 2008;8(4):57-61; discussion 69-75.
 30. Hawkes N. Patient coding and the ratings game. *BMJ*. 2010;340.
 31. Black N. Assessing the quality of hospitals. *BMJ*. 2010;340.
 32. Lilford R, Pronovost P. Using hospital mortality rates to judge hospital performance: A bad idea that just won't go away. *BMJ*. 2010;340.
 33. Jarman B, Gault S, Alves B, et al. Explaining differences in English hospital death rates using routinely collected data. *BMJ*. 1999;318(7197):1515-1520.
 34. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). *Public Comment Technical Report: Hybrid Hospital-Wide (All-Condition, All-Procedure) Risk-Standardized Mortality Measure*. 2017.

35. Centers for Medicare & Medicaid Services. Measures Management System. 2016; https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/index.html?redirect=/MMS/19_MeasuresManagementSystemBlueprint.asp. Accessed October 28, 2016.
36. Krumholz HM, Brindis RG, Brush JE, et al. Standards for statistical models used for public reporting of health outcomes: An American Heart Association Scientific Statement from the Quality of Care and Outcomes Research Interdisciplinary Writing Group: Cosponsored by the Council on Epidemiology and Prevention and the Stroke Council Endorsed by the American College of Cardiology Foundation. *Circulation*. 2006;113(3):456-462.
37. Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project. Clinical Classifications Software (CCS). 2015; <http://www.hcup-us.ahrq.gov/toolssoftware/ccs/CCSUsersGuide.pdf>. Accessed October 25, 2016.
38. Pope GC, Ellis RP, Ash AS, et al. Principal inpatient diagnostic cost group model for Medicare risk adjustment. 2001.
39. Klein LR. Textbook of econometrics. 1953.
40. National Quality Forum. National Voluntary Consensus Standards for Patient Outcomes. 2009; http://www.qualityforum.org/projects/Patient_Outcome_Measures_Phases1-2.aspx. Accessed October 28, 2016.
41. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). 2016 Procedure-Specific Measure Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Mortality Measures: Isolated Coronary Artery Bypass Graft (CABG) Surgery - Version 3.0. March 2016. <https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1228774398696>. Accessed November 9, 2017.
42. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977:159-174.

APPENDIX A – Acknowledgement Details

We would like to thank the members of the Technical Expert Panel (TEP). The TEP members provided important insight and feedback on key measure decisions for the development of the hospital-wide mortality measure.

Disclaimer: The views, thoughts, and opinions expressed in this report belong solely to the author and do not represent endorsement by any entity or individual, including the Technical Working Group and Technical Expert Panel members and the organizations those members are affiliated with, as well as other contributors and consultants. Acknowledgment of input does not imply endorsement of the methodology and policy decisions.

TEP Members:

Jonathan Bae, MD – Associate Chief Medical Officer for Patient Safety and Clinical Quality, Duke University Health System, Durham, NC

Jeanne Black, PhD, MBA – Manager of Health Policy and Program Evaluation, Cedars-Sinai Health System, Los Angeles, CA

John Bott, MBA, MS – Manager, Healthcare Ratings, Consumer Reports, Yonkers, NY

Roger Dmochowski, MD, MMHC, FACS – Executive Medical Director of Quality, Safety, and Risk, Vanderbilt University Medical Center, Nashville, TN

Richard Dutton, MD, MBA – Chief Quality Officer, United States Anesthesia Partners, Houston, TX

Chris Ghaemmaghani, MD – Chief Medical Officer and Senior Associate Dean for Clinical Affairs, University of Virginia Health System and University of Virginia School of Medicine, Charlottesville, VA

Gaye Hyre – Patient/Family Caregiver Representative, and Council Member, CT State Innovation Model for Healthcare Equity and Access Council, Hartford, CT

Irene Katzan, MD, MS – Director of Neurological Institute for Outcomes Research and Evaluation, Cleveland Clinic, Cleveland, OH

Amy Kelley, MD, MSHS – Associate Professor and Staff Physician of Geriatrics and Palliative Medicine, Icahn School of Medicine at Mt Sinai, New York, NY

Brenda Matti-Orozco, MD, FACP – Chief of Division of General Internal Medicine and Palliative Medicine and Hospice Medical Director, Morristown Medical Center and Atlantic Home Care & Hospice, Morristown, NJ

Colleen O'Leary, MSN, RN, AOCNS – Associate Director Nursing Education and Evidence-based Practice, and Director at Large, The Ohio State University James Cancer Hospital and Solove Research Institute, Westerville, OH

Jyotirmay Sharma, MD, FACS – Associate Professor of Surgery and Medical Officer in Division of Healthcare Quality and Promotion, Emory University School of Medicine and Centers for Disease Control, Atlanta, GA

Fredda Valdeck, LSMW – Patient Advocate, and Director, Aging in Place Initiative, United Hospital Fund, New York, NY

We would also like to give thanks to the members of our Technical Working Group who generously gave their time to provide guidance on key clinical and statistical decisions.

Technical Working Group Members:

Dr. Lee Fleisher, MD – Chair, Department of Anesthesiology and Critical Care, University of Pennsylvania Health System; and Vice-Chair of the Consensus Standards Advisory Committee (CSAC) and co-chair of the Surgery Standing Committee of the NQF.

Dr. Cary P. Gross, MD – Yale Professor of Medicine (General Medicine), in the Institute for Social and Policy Studies and of Epidemiology (Chronic Diseases); and Director and founder of Yale's Cancer Outcomes Public Policy and Effectiveness Research (COPPER). Dr. Gross served from March 2016 to July 2016.

Dr. Leora Horwitz, MD, MHS – Associate Professor in the Departments of Population Health and Medicine at New York University School of Medicine; founding director of the Center for Healthcare Innovation and Delivery Science, New York University Langone Medical Center, and of the Division of Healthcare Delivery Science, Department of Population Health, New York University School of Medicine.

Mr. Kristopher Huffman, MS – Senior Statistician, American College of Surgeons.

Dr. David M. Shahian, MD – Professor of Surgery at Harvard Medical School; Vice President of the Massachusetts General Hospital (MGH) Center for Quality and Safety; and Associate Director of the MGH Codman Center for Clinical Effectiveness in Surgery; NQF Board and Executive Committee member; Chair of The Society of Thoracic Surgeons (STS) Council on Quality, Research, and Patient Safety and the STS Quality Measurement Task Force.

APPENDIX B – AHRQ CCSs for Cancer and Metastatic Cancer

Table 13. AHRQ CCS Primary Discharge Diagnosis Categories for Cancer, Not Included in Initial Index Cohort of Measure if Patient Also Enrolled in Hospice

AHRQ Diagnosis CCS	Description of CCS
11	Cancer of head and neck
12	Cancer of esophagus
13	Cancer of stomach
14	Cancer of colon
15	Cancer of rectum and anus
16	Cancer of liver and intrahepatic bile duct
17	Cancer of pancreas
18	Cancer of other GI organs; peritoneum
19	Cancer of bronchus; lung
20	Cancer; other respiratory and intrathoracic
21	Cancer of bone and connective tissue
22	Melanomas of skin
23	Other non-epithelial cancer of skin
24	Cancer of breast
25	Cancer of uterus
26	Cancer of cervix
27	Cancer of ovary
28	Cancer of other female genital organs
29	Cancer of prostate
30	Cancer of testis
31	Cancer of other male genital organs
32	Cancer of bladder
33	Cancer of kidney and renal pelvis
34	Cancer of other urinary organs
35	Cancer of brain and nervous system
36	Cancer of thyroid
37	Hodgkin's disease
38	Non-Hodgkin's lymphoma
39	Leukemias
40	Multiple myeloma
41	Cancer; other and unspecified primary
43	Malignant neoplasm without specification of site
44	Neoplasms of unspecified nature or uncertain behavior
45	Maintenance chemotherapy; radiotherapy

Table 14. ICD-9 Discharge Diagnosis Codes for Metastatic Cancer Based Upon AHRQ CCS ICD-9 Crosswalk, Not Included in Initial Cohort of Measure

AHRQ Diagnosis CCS	Diagnosis CCS Description	AHRQ ICD-9 Crosswalk	ICD-9 Code Description
43	Malignant neoplasm without specification of site	1990	Disseminated malignant neoplasm without specification of site
43	Malignant neoplasm without specification of site	20920	Malignant carcinoid tumor of unknown primary site
43	Malignant neoplasm without specification of site	20979	Secondary neuroendocrine tumor of other sites
43	Malignant neoplasm without specification of site	20975	Secondary Merkel cell carcinoma
43	Malignant neoplasm without specification of site	20970	Secondary neuroendocrine tumor, unspecified site
42	Secondary malignancies	1977	Malignant neoplasm of liver, secondary
42	Secondary malignancies	20973	Secondary neuroendocrine tumor of bone
42	Secondary malignancies	1968	Secondary and unspecified malignant neoplasm of lymph nodes of multiple sites
42	Secondary malignancies	1969	Secondary and unspecified malignant neoplasm of lymph nodes, site unspecified
42	Secondary malignancies	1978	Secondary malignant neoplasm of other digestive organs and spleen
42	Secondary malignancies	51181	Malignant pleural effusion
42	Secondary malignancies	1976	Secondary malignant neoplasm of retroperitoneum and peritoneum
42	Secondary malignancies	1984	Secondary malignant neoplasm of other parts of nervous system
42	Secondary malignancies	1973	Secondary malignant neoplasm of other respiratory organs
42	Secondary malignancies	1970	Secondary malignant neoplasm of lung
42	Secondary malignancies	1972	Secondary malignant neoplasm of pleura
42	Secondary malignancies	20972	Secondary neuroendocrine tumor of liver

AHRQ Diagnosis CCS	Diagnosis CCS Description	AHRQ ICD-9 Crosswalk	ICD-9 Code Description
42	Secondary malignancies	1983	Secondary malignant neoplasm of brain and spinal cord
42	Secondary malignancies	1985	Secondary malignant neoplasm of bone and bone marrow
42	Secondary malignancies	1961	Secondary and unspecified malignant neoplasm of intrathoracic lymph nodes
42	Secondary malignancies	1974	Secondary malignant neoplasm of small intestine including duodenum
42	Secondary malignancies	1962	Secondary and unspecified malignant neoplasm of intra-abdominal lymph nodes
42	Secondary malignancies	1971	Secondary malignant neoplasm of mediastinum
42	Secondary malignancies	19889	Secondary malignant neoplasm of other specified sites
42	Secondary malignancies	1975	Secondary malignant neoplasm of large intestine and rectum
42	Secondary malignancies	19881	Secondary malignant neoplasm of breast
42	Secondary malignancies	1980	Secondary malignant neoplasm of kidney
42	Secondary malignancies	1981	Secondary malignant neoplasm of other urinary organs
42	Secondary malignancies	19882	Secondary malignant neoplasm of genital organs
42	Secondary malignancies	20971	Secondary neuroendocrine tumor of distant lymph nodes
42	Secondary malignancies	1982	Secondary malignant neoplasm of skin
42	Secondary malignancies	20974	Secondary neuroendocrine tumor of peritoneum
42	Secondary malignancies	1987	Secondary malignant neoplasm of adrenal gland
42	Secondary malignancies	1963	Secondary and unspecified malignant neoplasm of lymph nodes of axilla and upper limb
42	Secondary malignancies	1966	Secondary and unspecified malignant neoplasm of intrapelvic lymph nodes
42	Secondary malignancies	1965	Secondary and unspecified malignant neoplasm of lymph nodes of inguinal region and lower limb
42	Secondary malignancies	1986	Secondary malignant neoplasm

AHRQ Diagnosis CCS	Diagnosis CCS Description	AHRQ ICD-9 Crosswalk	ICD-9 Code Description
			of ovary
42	Secondary malignancies	1960	Secondary and unspecified malignant neoplasm of lymph nodes of head, face, and neck

APPENDIX C – Procedure Categories Defining the Surgery Service-Line Divisions

The Surgical Cancer service-line division is defined by having any of the procedures and principal discharge diagnosis of cancer along with a major surgical procedure and is therefore not represented in the table below.

Table 15. Frequency and 30-day Observed Mortality Rate of Surgical Procedures Grouped by AHRQ CCS Surgical Procedure Algorithm (Claims-only) Dataset (July 1, 2012 – June 30, 2014)

Defining Surgical Procedure AHRQ CCS	CCS Description	Surgical Division of Procedure	Frequency of Procedure	% of Total Procedures	30-Day Observed Mortality Rate (%)
36	Lobectomy or pneumonectomy	Cardiothoracic	13,801	1.1	2.3
42	Other OR Rx procedures on respiratory system and mediastinum	Cardiothoracic	9,186	0.7	7.6
43	Heart valve procedures	Cardiothoracic	30,914	2.5	4.1
44	Coronary artery bypass graft (CABG)	Cardiothoracic	33,394	2.7	2.2
49	Other OR heart procedures	Cardiothoracic	39,153	3.1	12.7
66	Procedures on spleen	General	1,964	0.2	6.7
67	Other therapeutic procedures; hemic and lymphatic system	General	26,200	2.1	3.1
72	Colostomy; temporary and permanent	General	6,904	0.6	16.0
73	Ileostomy and other enterostomy	General	5,955	0.5	19.8
74	Gastrectomy; partial and total	General	4,206	0.3	2.9
75	Small bowel resection	General	13,282	1.1	12.1
78	Colorectal resection	General	39,417	3.1	3.8
79	Local excision of large intestine lesion (not endoscopic)	General	162	0.0	2.5
80	Appendectomy	General	8,540	0.7	1.2
84	Cholecystectomy and common duct exploration	General	40,558	3.2	2.1
85	Inguinal and femoral hernia repair	General	6,718	0.5	2.8
86	Other hernia repair	General	14,452	1.2	2.0
89	Exploratory laparotomy	General	2,982	0.2	26.0
90	Excision; lysis peritoneal adhesions	General	18,210	1.5	4.0

Defining Surgical Procedure AHRQ CCS	CCS Description	Surgical Division of Procedure	Frequency of Procedure	% of Total Procedures	30-Day Observed Mortality Rate (%)
94	Other OR upper GI therapeutic procedures	General	13,433	1.1	6.2
96	Other OR lower GI therapeutic procedures	General	13,067	1.0	4.5
99	Other OR gastrointestinal therapeutic procedures	General	16,075	1.3	6.0
105	Kidney transplant	General	1,076	0.1	1.1
166	Lumpectomy; quadrantectomy of breast	General	428	0.0	1.4
167	Mastectomy	General	1,847	0.2	0.8
176	Organ transplantation (other than bone marrow, corneal or kidney)	General	349	0.0	4.0
10	Thyroidectomy; partial or complete	Other	1,678	0.1	1.1
12	Other therapeutic endocrine procedures	Other	3,016	0.2	1.5
13	Corneal transplant	Other	37	0.0	8.1
14	Glaucoma procedures	Other	25	0.0	8.0
15	Lens and cataract procedures	Other	159	0.0	2.5
16	Repair of retinal tear; detachment	Other	10	0.0	0.0
17	Destruction of lesion of retina and choroid	Other	44	0.0	0.0
20	Other intraocular therapeutic procedures	Other	357	0.0	2.2
21	Other extraocular muscle and orbit therapeutic procedures	Other	497	0.0	2.2
22	Tympanoplasty	Other	5	0.0	0.0
23	Myringotomy	Other	204	0.0	5.9
24	Mastoidectomy	Other	46	0.0	4.4
26	Other therapeutic ear procedures	Other	1,098	0.1	5.3
28	Plastic procedures on nose	Other	1,120	0.1	3.8
30	Tonsillectomy and/or adenoidectomy	Other	39	0.0	5.1
33	Other OR therapeutic procedures on nose; mouth and pharynx	Other	2,846	0.2	2.3
51	Endarterectomy; vessel of head and neck	Other	28,807	2.3	0.9
52	Aortic resection; replacement or anastomosis	Other	16,145	1.3	4.5

Defining Surgical Procedure AHRQ CCS	CCS Description	Surgical Division of Procedure	Frequency of Procedure	% of Total Procedures	30-Day Observed Mortality Rate (%)
53	Varicose vein stripping; lower limb	Other	54	0.0	1.9
55	Peripheral vascular bypass	Other	7,604	0.6	4.4
56	Other vascular bypass and shunt; not heart	Other	1,562	0.1	12.9
59	Other OR procedures on vessels of head and neck	Other	9,606	0.8	9.9
60	Embolectomy and endarterectomy of lower limbs	Other	11,451	0.9	7.0
101	Transurethral excision; drainage; or removal urinary obstruction	Other	18,813	1.5	3.9
103	Nephrotomy and nephrostomy	Other	6,107	0.5	8.0
104	Nephrectomy; partial or complete	Other	8,202	0.7	1.1
106	Genitourinary incontinence procedures	Other	173	0.0	0.0
112	Other OR therapeutic procedures of urinary tract	Other	6,543	0.5	2.7
113	Transurethral resection of prostate (TURP)	Other	6,274	0.5	1.5
114	Open prostatectomy	Other	3,796	0.3	0.3
118	Other OR therapeutic procedures; male genital	Other	1,489	0.1	3.0
119	Oophorectomy; unilateral and bilateral	Other	4,937	0.4	0.4
120	Other operations on ovary	Other	195	0.0	0.5
123	Other operations on fallopian tubes	Other	274	0.0	0.7
124	Hysterectomy; abdominal and vaginal	Other	817	0.1	0.2
125	Other excision of cervix and uterus	Other	268	0.0	1.1
129	Repair of cystocele and rectocele; obliteration of vaginal vault	Other	776	0.1	0.1
131	Other non-OR therapeutic procedures; female organs	Other	401	0.0	8.5
132	Other OR therapeutic procedures; female organs	Other	4,017	0.3	0.7
135	Forceps; vacuum; and breech delivery	Other	2	0.0	0.0
144	Treatment; facial fracture or dislocation	Other	627	0.1	4.6
160	Other therapeutic procedures on muscles and tendons	Other	33,900	2.7	3.4
164	Other OR therapeutic procedures on musculoskeletal system	Other	2,228	0.2	4.2

Defining Surgical Procedure AHRQ CCS	CCS Description	Surgical Division of Procedure	Frequency of Procedure	% of Total Procedures	30-Day Observed Mortality Rate (%)
172	Skin graft	Other	3,815	0.3	2.5
175	Other OR therapeutic procedures on skin and breast	Other	2,116	0.2	1.0
1	Incision and excision of CNS	Neurosurgery	10,168	0.8	12.0
2	Insertion; replacement; or removal of extracranial ventricular shunt	Neurosurgery	2,833	0.2	2.1
9	Other OR therapeutic nervous system procedures	Neurosurgery	18,677	1.5	7.2
3	Laminectomy; excision intervertebral disc	Orthopedic	22,478	1.8	0.6
142	Partial excision bone	Orthopedic	37,321	3.0	1.3
143	Bunionectomy or repair of toe deformities	Orthopedic	126	0.0	1.6
145	Treatment; fracture or dislocation of radius and ulna	Orthopedic	7,340	0.6	2.2
146	Treatment; fracture or dislocation of hip and femur	Orthopedic	93,421	7.4	5.3
147	Treatment; fracture or dislocation of lower extremity (other than hip or femur)	Orthopedic	17,693	1.4	1.7
148	Other fracture and dislocation procedure	Orthopedic	17,869	1.4	2.1
150	Division of joint capsule; ligament or cartilage	Orthopedic	1,265	0.1	0.2
151	Excision of semilunar cartilage of knee	Orthopedic	497	0.0	0.4
152	Arthroplasty knee	Orthopedic	214,167	17.1	0.2
153	Hip replacement; total and partial	Orthopedic	150,327	12.0	1.9
154	Arthroplasty other than hip or knee	Orthopedic	27,746	2.2	0.3
157	Amputation of lower extremity	Orthopedic	17,973	1.4	7.5
158	Spinal fusion	Orthopedic	26,935	2.2	0.6
161	Other OR therapeutic procedures on bone	Orthopedic	17,529	1.4	2.6
162	Other OR therapeutic procedures on joints	Orthopedic	16,277	1.3	2.3
Total	--	--	1,255,095	100.0	3.3

APPENDIX D – Condition Categories Assigned to the Non-Surgical Divisions

Table 16. AHRQ CCSs Assigned to the Non-Surgical Divisions and CCS Description

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Cancer		
Cancer	11	Cancer of head and neck
Cancer	12	Cancer of esophagus
Cancer	13	Cancer of stomach
Cancer	14	Cancer of colon
Cancer	15	Cancer of rectum and anus
Cancer	16	Cancer of liver and intrahepatic bile duct
Cancer	17	Cancer of pancreas
Cancer	18	Cancer of other GI organs; peritoneum
Cancer	19	Cancer of bronchus; lung
Cancer	20	Cancer; other respiratory and intrathoracic
Cancer	21	Cancer of bone and connective tissue
Cancer	22	Melanomas of skin
Cancer	23	Other non-epithelial cancer of skin
Cancer	24	Cancer of breast
Cancer	25	Cancer of uterus
Cancer	26	Cancer of cervix
Cancer	27	Cancer of ovary
Cancer	28	Cancer of other female genital organs
Cancer	29	Cancer of prostate
Cancer	30	Cancer of testis
Cancer	31	Cancer of other male genital organs
Cancer	32	Cancer of bladder
Cancer	33	Cancer of kidney and renal pelvis
Cancer	34	Cancer of other urinary organs
Cancer	35	Cancer of brain and nervous system
Cancer	36	Cancer of thyroid
Cancer	37	Hodgkin's disease
Cancer	38	Non-Hodgkin's lymphoma
Cancer	39	Leukemias
Cancer	40	Multiple myeloma
Cancer	41	Cancer; other and unspecified primary

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Cancer	43	Malignant neoplasm without specification of site
Cancer	44	Neoplasms of unspecified nature or uncertain behavior
Cancer	45	Maintenance chemotherapy; radiotherapy
Cardiac		
Cardiac	96	Heart valve disorders
Cardiac	97	Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease)
Cardiac	100	Acute myocardial infarction
Cardiac	101	Coronary atherosclerosis and other heart disease
Cardiac	102	Nonspecific chest pain
Cardiac	103	Pulmonary heart disease
Cardiac	104	Other and ill-defined heart disease
Cardiac	105	Conduction disorders
Cardiac	106	Cardiac dysrhythmias
Cardiac	107	Cardiac arrest and ventricular fibrillation
Cardiac	108	Congestive heart failure; nonhypertensive
Cardiac	213	Cardiac and circulatory congenital anomalies
Cardiac	245	Syncope
Cardiac	249	Shock
Gastrointestinal		
Gastrointestinal	6	Hepatitis
Gastrointestinal	120	Hemorrhoids
Gastrointestinal	138	Esophageal disorders
Gastrointestinal	139	Gastroduodenal ulcer (except hemorrhage)
Gastrointestinal	140	Gastritis and duodenitis
Gastrointestinal	141	Other disorders of stomach and duodenum
Gastrointestinal	142	Appendicitis and other appendiceal conditions
Gastrointestinal	143	Abdominal hernia
Gastrointestinal	144	Regional enteritis and ulcerative colitis
Gastrointestinal	145	Intestinal obstruction without hernia
Gastrointestinal	146	Diverticulosis and diverticulitis
Gastrointestinal	147	Anal and rectal conditions
Gastrointestinal	148	Peritonitis and intestinal abscess
Gastrointestinal	149	Biliary tract disease
Gastrointestinal	150	Liver disease; alcohol related
Gastrointestinal	151	Other liver diseases
Gastrointestinal	152	Pancreatic disorders (not diabetes)

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Gastrointestinal	153	Gastrointestinal hemorrhage
Gastrointestinal	154	Noninfectious gastroenteritis
Gastrointestinal	155	Other gastrointestinal disorders
Gastrointestinal	214	Digestive congenital anomalies
Gastrointestinal	250	Nausea and vomiting
Gastrointestinal	251	Abdominal pain
Infectious Diseases		
Infectious Disease	1	Tuberculosis
Infectious Disease	2	Septicemia (except in labor)
Infectious Disease	3	Bacterial infection; unspecified site
Infectious Disease	4	Mycoses
Infectious Disease	5	HIV infection
Infectious Disease	7	Viral infection
Infectious Disease	8	Other infections; including parasitic
Infectious Disease	9	Sexually transmitted infections (not HIV or hepatitis)
Infectious Disease	76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
Infectious Disease	77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
Infectious Disease	135	Intestinal infection
Infectious Disease	159	Urinary tract infections
Infectious Disease	197	Skin and subcutaneous tissue infections
Infectious Disease	201	Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease)
Infectious Disease	246	Fever of unknown origin
Neurology		
Neurology	78	Other CNS infection and poliomyelitis
Neurology	79	Parkinson's disease
Neurology	80	Multiple sclerosis
Neurology	81	Other hereditary and degenerative nervous system conditions
Neurology	82	Paralysis
Neurology	83	Epilepsy; convulsions
Neurology	85	Coma; stupor; and brain damage
Neurology	95	Other nervous system disorders
Neurology	109	Acute cerebrovascular disease
Neurology	110	Occlusion or stenosis of precerebral arteries
Neurology	111	Other and ill-defined cerebrovascular disease
Neurology	112	Transient cerebral ischemia

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Neurology	113	Late effects of cerebrovascular disease
Neurology	216	Nervous system congenital anomalies
Orthopedics		
Orthopedics	235	Open wounds of head; neck; and trunk
Orthopedics	236	Open wounds of extremities
Orthopedics	239	Superficial injury; contusion
Orthopedics	244	Other injuries and conditions due to external causes
Orthopedics	203	Osteoarthritis
Orthopedics	204	Other non-traumatic joint disorders
Orthopedics	205	Spondylosis; intervertebral disc disorders; other back problems
Orthopedics	207	Pathological fracture
Orthopedics	208	Acquired foot deformities
Orthopedics	209	Other acquired deformities
Orthopedics	212	Other bone disease and musculoskeletal deformities
Orthopedics	225	Joint disorders and dislocations; trauma-related
Orthopedics	226	Fracture of neck of femur (hip)
Orthopedics	228	Skull and face fractures
Orthopedics	229	Fracture of upper limb
Orthopedics	230	Fracture of lower limb
Orthopedics	231	Other fractures
Orthopedics	232	Sprains and strains
Pulmonary		
Pulmonary	56	Cystic fibrosis
Pulmonary	122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)
Pulmonary	123	Influenza
Pulmonary	125	Acute bronchitis
Pulmonary	126	Other upper respiratory infections
Pulmonary	127	Chronic obstructive pulmonary disease and bronchiectasis
Pulmonary	128	Asthma
Pulmonary	129	Aspiration pneumonitis; food/vomitus
Pulmonary	130	Pleurisy; pneumothorax; pulmonary collapse
Pulmonary	131	Respiratory failure; insufficiency; arrest (adult)
Pulmonary	132	Lung disease due to external agents
Pulmonary	133	Other lower respiratory disease
Renal		
Renal	55	Fluid and electrolyte disorders

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Renal	98	Essential hypertension
Renal	99	Hypertension with complications and secondary hypertension
Renal	156	Nephritis; nephrosis; renal sclerosis
Renal	157	Acute and unspecified renal failure
Renal	158	Chronic kidney disease
Other Conditions [Please note this division was excluded from the cohort, but was included in this table for transparency]		
Other Conditions	237	Complication of device; implant or graft
Other Conditions	238	Complications of surgical procedures or medical care
Other Conditions	198	Other inflammatory condition of skin
Other Conditions	199	Chronic ulcer of skin
Other Conditions	200	Other skin disorders
Other Conditions	48	Thyroid disorders
Other Conditions	49	Diabetes mellitus without complication
Other Conditions	50	Diabetes mellitus with complications
Other Conditions	51	Other endocrine disorders
Other Conditions	53	Disorders of lipid metabolism
Other Conditions	58	Other nutritional; endocrine; and metabolic disorders
Other Conditions	206	Osteoporosis
Other Conditions	92	Otitis media and related conditions
Other Conditions	94	Other ear and sense organ disorders
Other Conditions	124	Acute and chronic tonsillitis
Other Conditions	134	Other upper respiratory disease
Other Conditions	136	Disorders of teeth and jaw
Other Conditions	137	Diseases of mouth; excluding dental
Other Conditions	46	Benign neoplasm of uterus
Other Conditions	160	Calculus of urinary tract
Other Conditions	161	Other diseases of kidney and ureters
Other Conditions	162	Other diseases of bladder and urethra
Other Conditions	163	Genitourinary symptoms and ill-defined conditions
Other Conditions	164	Hyperplasia of prostate
Other Conditions	165	Inflammatory conditions of male genital organs
Other Conditions	166	Other male genital disorders
Other Conditions	167	Nonmalignant breast conditions
Other Conditions	168	Inflammatory diseases of female pelvic organs
Other Conditions	169	Endometriosis
Other Conditions	170	Prolapse of female genital organs

Non-Surgical Division	AHRQ Diagnosis CCS	Description
Other Conditions	171	Menstrual disorders
Other Conditions	172	Ovarian cyst
Other Conditions	173	Menopausal disorders
Other Conditions	174	Female infertility
Other Conditions	175	Other female genital disorders
Other Conditions	215	Genitourinary congenital anomalies
Other Conditions	59	Deficiency and other anemia
Other Conditions	60	Acute posthemorrhagic anemia
Other Conditions	61	Sickle cell anemia
Other Conditions	62	Coagulation and hemorrhagic disorders
Other Conditions	63	Diseases of white blood cells
Other Conditions	64	Other hematologic conditions
Other Conditions	247	Lymphadenitis
Other Conditions	54	Gout and other crystal arthropathies
Other Conditions	57	Immunity disorders
Other Conditions	202	Rheumatoid arthritis and related disease
Other Conditions	210	Systemic lupus erythematosus and connective tissue disorders
Other Conditions	211	Other connective tissue disease
Other Conditions	253	Allergic reactions
Other Conditions	84	Headache; including migraine
Other Conditions	93	Conditions associated with dizziness or vertigo
Other Conditions	10	Immunizations and screening for infectious disease
Other Conditions	47	Other and unspecified benign neoplasm
Other Conditions	52	Nutritional deficiencies
Other Conditions	217	Other congenital anomalies
Other Conditions	252	Malaise and fatigue
Other Conditions	255	Administrative/social admission
Other Conditions	256	Medical examination/evaluation
Other Conditions	257	Other aftercare
Other Conditions	258	Other screening for suspected conditions (not mental disorders or infectious disease)
Other Conditions	259	Residual codes; unclassified
Other Conditions	86	Cataract
Other Conditions	87	Retinal detachments; defects; vascular occlusion; and retinopathy
Other Conditions	88	Glaucoma
Other Conditions	89	Blindness and vision defects
Other Conditions	90	Inflammation; infection of eye (except that caused by tuberculosis)

Non-Surgical Division	AHRQ Diagnosis CCS	Description
		or sexually transmitted disease)
Other Conditions	91	Other eye disorders
Other Conditions	653	Delirium, dementia, and amnestic and other cognitive disorders
Other Conditions	241	Poisoning by psychotropic agents
Other Conditions	242	Poisoning by other medications and drugs
Other Conditions	243	Poisoning by nonmedicinal substances
Other Conditions	660	Alcohol-related disorders
Other Conditions	661	Substance-related disorders
Other Conditions	663	Screening and history of mental health and substance abuse codes
Other Conditions	114	Peripheral and visceral atherosclerosis
Other Conditions	115	Aortic; peripheral; and visceral artery aneurysms
Other Conditions	116	Aortic and peripheral arterial embolism or thrombosis
Other Conditions	117	Other circulatory disease
Other Conditions	118	Phlebitis; thrombophlebitis and thromboembolism
Other Conditions	119	Varicose veins of lower extremity
Other Conditions	121	Other diseases of veins and lymphatics
Other Conditions	248	Gangrene

APPENDIX E – Candidate Comorbid Risk Variables

Table 17. Candidate Risk Variables and Associated Condition Category (CC)

Risk Adjustment Variable	CC
Age	N/A
Transfer from Outside ED	N/A
Opportunistic/Chronic Infections	CC 1, 3-6, 39
Lymphoma & Other Cancers	CC 10
TIA and Other Cerebrovascular Disease	CC 101, 102
Vascular Disease with Complications	CC 106, 107
Vascular Disease	CC 108
Other Circulatory Disease	CC 109
Other Cancers & Heart or Respiratory Tumors	CC 11-13
Fibrosis of Lung and Other Chronic Lung Disorders	CC 110, 112
Chronic Obstructive Pulmonary Disease	CC 111
Asthma	CC 113
Pneumonia	CC 114-116
Pleural Effusion/Pneumothorax	CC 117
Other Respiratory Disorders	CC 118
Eye Infections and Retinal Disorders	CC 120-122, 124, 125
Glaucoma	CC 126
Other Eye Disorders	CC 128
Other ENT and Mouth Disorders	CC 129, 131
Hearing Loss	CC 130
Transplant Status	CC 132, 186, 187
Dialysis or Severe Chronic Kidney Disease	CC 134, 136, 137
Acute or Unspecified Renal Failure	CC 135, 140
Mild to Moderate Chronic Kidney Disease	CC 138, 139
Other Benign Tumors	CC 14-16
Other Renal or Urinary Tract Disorders	CC 141, 145
Urinary Obstruction and Retention	CC 142
Urinary Incontinence	CC 143
Urinary Tract Infection	CC 144
Female Genital Disorders	CC 147, 148
Male Genital Disorders	CC 149
Pressure Ulcer	CC 157-160
Burns, Non-pressure Ulcers	CC 161-163
Cellulitis, Local Skin Infection	CC 164
Other Dermatological Disorders	CC 165

Risk Adjustment Variable	CC
Other Head Injuries or Concussion	CC 167, 168
Amputation Status and Major Fractures Including Vertebral, Hip, and Other	CC 169-171, 173, 189, 190
Diabetes	CC 17-19
Other Injuries	CC 172, 174
Poisonings and Allergic and Inflammatory Reactions	CC 175
Complications of Care	CC 176, 177
Major Symptoms, Abnormalities	CC 178
Minor Symptoms, Signs, Findings	CC 179
Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	CC 2
Protein-Calorie Malnutrition	CC 21
Morbid Obesity	CC 22
Other Significant Endocrine and Metabolic Disorders	CC 23
Disorders of Fluid/Electrolyte/Acid-Base Balance	CC 24
Disorders of Lipoid Metabolism	CC 25
Other Endocrine/Metabolic/Nutritional Disorders	CC 26
Liver Failure	CC 27, 30
Cirrhosis & Chronic Hepatitis	CC 28, 29
Other Liver & Biliary Disease	CC 31, 32
Intestinal Obstruction/Perforation, Peptic Ulcer, Hemorrhage, and Other Specified GI Disorders	CC 33, 36
Other GI Disorders	CC 34, 35, 37, 38
Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	CC 40
Disorders of the Vertebrae and Spinal Discs	CC 41
Osteoarthritis of Hip or Knee	CC 42
Osteoporosis and Other Bone/Cartilage Disorders	CC 43
Other Musculoskeletal and Connective Tissue Disorders	CC 44, 45
Hematologic or Immunity Disorders	CC 46-48
Iron Deficiency and Other/Unspecified Anemias and Blood Disease	CC 49
Delirium and Encephalopathy	CC 50
Dementia and Other Nonpsychotic Organic Brain Syndromes	CC 51-53
Drug/Alcohol Dependence or Psychosis	CC 54, 55
Drug/Alcohol Abuse, Without Dependence	CC 56
Psychosis: Schizophrenia, Reactive, and Unspecified	CC 57, 59
Major Depressive, Bipolar, and Paranoid Disorders	CC 58
Other Psychiatric Disorders	CC 60, 63
Depression	CC 61

Risk Adjustment Variable	CC
Anxiety Disorders	CC 62
Other Developmental Disorders	CC 64-68
Other Infectious Diseases	CC 7
Paralytic Syndromes	CC 70-72, 103, 104
Neuromuscular Disorders	CC 73-76, CC78
Seizure Disorders and Convulsions	CC 79
Metastatic & Severe Cancers	CC 8, 9
Coma/Brain Compression/Anoxic Injury and Severe Head Injury	CC 80, 166
Polyneuropathy, Mononeuropathy, and Other Neurological Conditions/Injuries	CC 81
Respiratory Failure, Respirator Dependence, Shock	CC 82-84
Congestive Heart Failure	CC 85
Acute Myocardial Infarction	CC 86
Angina and Unstable Angina	CC 87, 88
Coronary Atherosclerosis/Other Chronic Ischemic Heart Disease	CC 89
Other and Unspecified Heart Disease	CC 90, 92, 93, 98
Valvular and Rheumatic Heart Disease	CC 91
Hypertension and Hypertensive Heart Disease	CC 94, 95
Heart Rhythm and Conduction Disorders	CC 96, 97
Cerebral Hemorrhage, Stroke, Late Effects of Stroke	CC 99, 100, 105

Note: Descriptions of the Condition Categories can be found at

http://www.cms.hhs.gov/Reports/downloads/pope_2000_2.pdf

Note: The “Other Surgical Procedures” and “Other Non-Surgical Conditions” Divisions (italicized in the table below) were excluded from the cohort, but included in the table below for transparency

Table 18. Risk Model C-Statistics Comparing All Potential Risk Variables to Limited (20) Risk Variables, Development Dataset (July 1, 2014 – June 30, 2015)

Division (ordered by # of patients)	Number of Patients	C-Statistic All Candidate Risk Variables + CCS	C-Statistic 20 Variables + CCS (significant in 13/15 divisions)
Neurosurgery	28,561	0.91	0.91
Non-Surgical Cancer	38,395	0.76	0.75
Surgical Cancer	89,380	0.84	0.82
Surgical Cardiothoracic	113,815	0.82	0.80
Non-Surgical Orthopedics	132,237	0.82	0.81
<i>Other Surgical Procedures</i>	168,391	0.88	0.87
General Surgery	186,559	0.88	0.87
Non-Surgical Renal	241,608	0.80	0.78

Division (ordered by # of patients)	Number of Patients	C-Statistic All Candidate Risk Variables + CCS	C-Statistic 20 Variables + CCS (significant in 13/15 divisions)
Non-Surgical Neurology	270,839	0.86	0.85
Non-Surgical Gastrointestinal	351,795	0.84	0.83
<i>Other Non-Surgical Conditions</i>	<i>430,300</i>	<i>0.81</i>	<i>0.80</i>
Non-Surgical Pulmonary	550,689	0.82	0.81
Non-Surgical Infectious Disease	558,747	0.85	0.84
Orthopedic Surgery	668,389	0.90	0.90
Non-Surgical Cardiac	684,261	0.84	0.84

APPENDIX F – Potential Complications of Care

To identify potential complications of care, we first searched the secondary diagnosis codes in the index admission claim and identified the presence of any ICD-9 code associated with a CMS-CC (see table below). If these codes appeared only in the index admission claim, we flagged them because they are potential to complications of care. Next, we determined if these potential complications of care were associated with a “present on admission” code. Any potential complication of care with an associated “present on admission” code was kept in the risk model; any potential complication of care without an associated “present on admission” code was removed (indicated by an “X” in the table below) under the assumption that it represented a complication of care.

Table 19. Complications of Care by CC if Not Indicated as Present on Admission

Description	Variable	Variables Considered Potential Complications of Care (Not Used in Risk Adjustment) if Occurred Only During Index Admission (indicated by “X”)
Age, years	N/A	--
Pneumonia	CC 114 Aspiration and Specified Bacterial Pneumonias	X
	CC 115 Pneumococcal Pneumonia, Empyema, Lung Abscess	X
	CC 116 Viral and Unspecified Pneumonia, Pleurisy	--
Dialysis or Severe Chronic Kidney Disease	CC 134 Dialysis Status	X
	CC 136 Chronic Kidney Disease, Stage 5	--
	CC 137 Chronic Kidney Disease, Severe (Stage 4)	--
Acute or Unspecified Renal Failure	CC 135 Acute Renal Failure	X
	CC 140 Unspecified Renal Failure	X
Poisonings and Allergic and Inflammatory Reactions	CC 175 Poisonings and Allergic and Inflammatory Reactions	X
Minor Symptoms, Signs, Findings	CC 179 Minor Symptoms, Signs, Findings	--
Protein-Calorie Malnutrition	CC 21 Protein-Calorie Malnutrition	--
Disorders of Fluid/Electrolyte/Acid-Base Balance	CC 24 Disorders of Fluid/Electrolyte/Acid-Base Balance	X
Disorders of Lipoid Metabolism	CC 25 Disorders of Lipoid Metabolism	--
Liver Failure	CC 27 End-Stage Liver Disease	--
	CC 30 Acute Liver Failure/Disease	X
Other Gastrointestinal Disorders	CC 34 Chronic Pancreatitis	--
	CC 35 Inflammatory Bowel Disease	--
	CC 37 Appendicitis	--

Description	Variable	Variables Considered Potential Complications of Care (Not Used in Risk Adjustment) if Occurred Only During Index Admission (indicated by "X")
	CC 38 Other Gastrointestinal Disorders	--
Other Musculoskeletal and Connective Tissue Disorders	CC 44 Congenital/Developmental Skeletal and Connective Tissue Disorders	--
	CC 45 Other Musculoskeletal and Connective Tissue Disorders	--
Hematologic or Immunity Disorders	CC 46 Severe Hematological Disorders	--
	CC 47 Disorders of Immunity	--
	CC 48 Coagulation Defects and Other Specified Hematological Disorders	X
Dementia and Other Nonpsychotic Organic Brain Syndromes	CC 51 Dementia With Complications	--
	CC 52 Dementia Without Complications	--
	CC 53 Nonpsychotic Organic Brain Syndromes/Conditions	--
Other Infectious Diseases	CC 7 Other Infectious Diseases	X
Metastatic & Severe Cancers	CC 8 Metastatic Cancer and Acute Leukemia	--
	CC 9 Lung and Other Severe Cancers	--
Coma/Brain Compression/Anoxic Injury and Severe Head Injury	CC 80 Coma, Brain Compression/Anoxic	X
	CC 166 Severe Head Injury	X
Respiratory Failure, Respirator Dependence, Shock	CC 82 Respirator Dependence/Tracheostomy Status	X
	CC 83 Respiratory Arrest	X
	CC 84 Cardio-Respiratory Failure and Shock	X
Congestive Heart Failure	CC 85 Congestive Heart Failure	X
Hypertension and Hypertensive Heart Disease	CC 94 Hypertensive Heart Disease	--
	CC 95 Hypertension	--

APPENDIX G – Heterogeneous CCS Modifications

Below are the final CCSs, which were slightly modified to be more homogeneous, based on an overall ICC ≥ 0.05 . We indicate where specific ICD codes were excluded, added, or moved below.

Based on 3 independent clinician reviews, with resolution of disagreement by consensus, we clinically divided CCSs into the following categories:

- Acute cerebrovascular disease
 - Intracranial hemorrhage:
 - Unspecified intracranial hemorrhage
 - Intracerebral hemorrhage
 - Subarachnoid hemorrhage
 - Subdural hemorrhage
 - Other
- Alcohol-related disorders:
 - Alcohol-related liver disease
 - Alcoholic cirrhosis of liver
 - Acute alcoholic hepatitis
 - Alcoholic liver damage, unspecified
 - Alcoholic fatty liver
 - Other
- Aortic; peripheral; and visceral artery aneurysms
 - Ruptured
 - Thoracoabdominal aneurysm, ruptured
 - Aortic aneurysm of unspecified site, ruptured
 - Thoracic aneurysm, ruptured
 - Abdominal aneurysm, ruptured
 - ADD: Rupture of artery (from CCS: Other circulatory disease)
 - Dissection aorta
 - Dissection of aorta, unspecified site
 - Dissection of aorta, thoracoabdominal
 - Dissection of aorta, thoracic
 - Dissection of aorta, abdominal
 - Other
- Cardiac arrest and ventricular fibrillation:
 - Cardiac arrest
 - Ventricular fibrillation and ventricular flutter
- Coagulation and hemorrhagic disorders
 - **EXCLUDE:** Defibrination syndrome
 - Include and keep as one CCS all others
- Coma, stupor, and brain damage:
 - **EXCLUDE:**
 - Anoxic brain damage (already done)

- Persistent vegetative state (already done)
 - Coma
 - Keep and rename CCS:
 - Other alteration of consciousness
- Gastroduodenal ulcer (except hemorrhage)
 - Gastrointestinal Perforation
 - **ADD:** PERFORATION OF INTESTINE (from CCS: Other gastrointestinal disorders)
 - Chronic or unspecified peptic ulcer of unspecified site with perforation, with obstruction
 - Acute peptic ulcer of unspecified site with perforation, without mention of obstruction
 - Acute duodenal ulcer with perforation, with obstruction
 - Chronic or unspecified peptic ulcer of unspecified site with perforation, without mention of obstruction
 - Acute gastric ulcer with perforation, without mention of obstruction
 - Acute duodenal ulcer with perforation, without mention of obstruction
 - Chronic or unspecified gastric ulcer with perforation, without mention of obstruction
 - Acute gastric ulcer with perforation, with obstruction
 - Chronic or unspecified gastric ulcer with perforation, with obstruction
 - Chronic or unspecified duodenal ulcer with perforation, with obstruction
 - Chronic or unspecified duodenal ulcer with perforation, without mention of obstruction
 - Chronic or unspecified gastrojejunal ulcer with perforation, without mention of obstruction
 - Acute gastrojejunal ulcer with perforation, without mention of obstruction
 - Chronic or unspecified gastrojejunal ulcer with perforation, with obstruction
 - Acute peptic ulcer of unspecified site with perforation, with obstruction
 - Ulcer Without perforation
- Joint disorders and dislocations; trauma-related
 - KEEP AS IS
- Nutritional deficiencies:
 - **ADD:** ADULT FAILURE TO THRIVE (From CCS: Other nutritional; endocrine; and metabolic disorders)
 - Otherwise keep as is
- Other aftercare
 - KEEP AS IS
- Other and ill-defined heart disease
 - Myocardial infarction sequelae
 - Rupture of papillary muscle
 - Acquired cardiac septal defect
 - Rupture of chordae tendineae

- Certain sequelae of myocardial infarction, not elsewhere classified, other
 - Other heart disease
- Other circulatory disease
 - (Move rupture of artery to split CCS above of ruptured aneurysms)
 - Non-orthostatic hypotension/hemorrhage
 - Chronic hypotension
 - Hemorrhage, unspecified
 - Other specified hypotension
 - Hypotension, unspecified
 - Other
- Other CNS infection and poliomyelitis
 - **EXCLUDE:**
 - Other and unspecified Creutzfeldt-Jakob disease (already done)
 - Progressive multifocal leukoencephalopathy
 - Variant Creutzfeldt-Jakob disease
 - Other and unspecified prion disease of central nervous system
 - Otherwise keep as is
- Other gastrointestinal disorders
 - (Move perforation of intestine to split CCS with ulcers with perforation as above)
 - Otherwise keep as is
- Other hereditary and degenerative nervous system disorders
 - **EXCLUDE:** amyotrophic lateral sclerosis
 - Otherwise keep as is
- Other injuries and conditions due to external causes
 - **EXCLUDE:**
 - Asphyxiation and strangulation
 - Asphyxia
 - Drowning and nonfatal submersion
 - Foreign body in airway
 - Foreign body in trachea
 - Foreign body in respiratory tree, unspecified
 - Foreign body in larynx
 - Foreign body in pharynx
 - Foreign body in other specified parts bronchus and lung
 - Foreign body in main bronchus
 - Others
- Other liver diseases
 - Chronic liver disease
 - Hepatorenal syndrome
 - Other sequelae of chronic liver disease
 - Unspecified disorder of liver
 - Hepatic encephalopathy

- Cirrhosis of liver without mention of alcohol
 - Other chronic nonalcoholic liver disease
 - Unspecified chronic liver disease without mention of alcohol
 - Other ascites
 - Biliary cirrhosis
 - Jaundice, unspecified, not of newborn
 - Portal hypertension
- Other
- Other nervous system disorders
 - **EXCLUDE:** Brain death (already done)
 - **MOVE:** Neoplasm related pain into Surgical Cancer or Non-Surgical Cancer Service-Line Divisions, as appropriate
 - Encephalopathy
 - Metabolic encephalopathy
 - Encephalopathy, unspecified
 - Other encephalopathy
 - Toxic encephalopathy
 - Others
- Other nutritional; endocrine; and metabolic disorders
 - (Move adult failure to thrive to CCS: nutritional deficiencies, as above)
 - Gammaglobulinemias and hypercalcemia
 - Hypercalcemia
 - Amyloidosis, unspecified
 - Other disorders of plasma protein metabolism
 - Other amyloidosis
 - Other paraproteinemias
 - Macroglobulinemia
 - Monoclonal paraproteinemia
 - Polyclonal hypergammaglobulinemia
 - Other
- Peritonitis and intestinal abscess
 - Peritonitis
 - Pneumococcal peritonitis
 - Spontaneous bacterial peritonitis
 - Choleperitonitis
 - Unspecified peritonitis
 - Peritonitis (acute) generalized
 - Other specified peritonitis
 - Other suppurative peritonitis
 - Other Abdominal cavity infections/abscesses
 - Peritoneal abscess
 - Abscess of intestine

- Sclerosing mesenteritis
 - Other retroperitoneal abscess
 - Other retroperitoneal infection
- Rheumatoid arthritis and related disease
 - KEEP AS IS

APPENDIX H –Hierarchical Logistic Regression Model Results

Below are tables for each of the 15 divisions, showing the hierarchical logistic regression results. We also ran the logistical regression model, but did not include it in this report due to the size of the tables. Although only 13 divisions were included in the cohort, all 15 divisions originally evaluated during measure development are included here for transparency. The two divisions that were excluded, “Other Surgical Procedures” and “Other Non-Surgical Conditions”, are listed as tables at the bottom of this appendix.

Where risk factors have duplicative rows with CCS ending in _1 or _2 or _3, these are the highly heterogeneous CCSs that were clinically modified through one of three mechanisms: 1) Splitting the CCS into more than one CCS; or 2) Moving ICD-9 codes from one CCS into another more clinically coherent CCS; or 3) Excluding ICD-9 codes that were clinically different from others in the CCS, for which quality of care was less likely to impact survival, and where there were a small number of patients. The changes are described in detail in [Appendix G: Heterogeneous CCS Modifications](#).

The CCS with no parameter estimates and odds ratios were results of CCS with zero mortality events. These CCS were combined with the next lowest mortality CCS. See [Section 4.5.3 Service Mix Risk Adjustment: Risk Variables Based on Principal Discharge Diagnosis Code CCSs](#).

Table 20. Non-Surgical Cancer Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	76.7 (7.6)	0.0333 (0.002)	1.034 (1.030, 1.038)
Cancer of head and neck (CCS 11)	2.20	1.0881 (0.121)	2.963 (2.337, 3.756)
Cancer of esophagus (CCS 12)	1.93	1.2188 (0.121)	3.385 (2.670, 4.291)
Cancer of stomach (CCS 13)	2.63	1.0207 (0.1148)	2.773 (2.214, 3.472)
Cancer of colon (CCS 14)	3.68	1.0908 (0.1046)	2.980 (2.427, 3.658)
Cancer of rectum and anus (CCS 15)	2.22	0.2373 (0.1537)	1.266 (0.936, 1.711)
Cancer of liver and intrahepatic bile duct (CCS 16)	3.92	1.842 (0.0947)	6.308 (5.239, 7.595)
Cancer of pancreas (CCS 17)	5.58	1.4075 (0.0901)	4.082 (3.41, 4.871)
Cancer of other GI organs; peritoneum (CCS 18)	2.30	1.1807 (0.117)	3.254 (2.587, 4.093)
Cancer of bronchus; lung (CCS 19)	16.02	1.4225 (0.0785)	4.146 (3.555, 4.836)
Cancer; other respiratory and intrathoracic (CCS 20)	0.46	0.9429 (0.2507)	2.552 (1.560, 4.174)
Cancer of bone and connective tissue (CCS 21)	0.68	1.2085 (0.189)	3.349 (2.312, 4.850)
Influenza (CCS 23)	0.62	-0.0179 (0.2909)	0.977 (0.552, 1.729)
Cancer of breast (CCS 24)	0.71	1.0238 (0.1932)	2.787 (1.909, 4.070)
Cancer of uterus (CCS 25)	0.81	1.2607 (0.1756)	3.538 (2.509, 4.990)
Cancer of cervix (CCS 26)	0.31	0.2494 (0.3662)	1.275 (0.621, 2.618)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Cancer of ovary (CCS 27)	1.22	1.581 (0.1339)	4.855 (3.735, 6.312)
Cancer of other female genital organs (CCS 28)	0.15	0.3565 (0.5356)	1.425 (0.498, 4.074)
Cancer of prostate (CCS 29)	0.92	0.7768 (0.181)	2.174 (1.525, 3.100)
Cancer of bladder (CCS 32)	1.07	1.0051 (0.1556)	2.733 (2.014, 3.707)
Cancer of kidney and renal pelvis (CCS 33)	1.10	0.9118 (0.1629)	2.489 (1.809, 3.426)
Cancer of brain and nervous system (CCS 35)	4.12	1.2991 (0.1126)	3.670 (2.943, 4.576)
Cancer of thyroid (CCS 36)	0.55	0.795 (0.2787)	2.211 (1.280, 3.819)
Non-Hodgkin's lymphoma (CCS 38)	7.61	1.4632 (0.0838)	4.319 (3.665, 5.090)
Leukemias (CCS 39)	9.84	2.0128 (0.078)	7.482 (6.422, 8.717)
Multiple myeloma (CCS 40)	6.07	0.8979 (0.0922)	2.456 (2.050, 2.942)
Cancer; other and unspecified primary (CCS 41)	0.69	1.65 (0.1682)	5.212 (3.749, 7.247)
Malignant neoplasm without specification of site (CCS 43)	1.90	1.7011 (0.1114)	5.473 (4.399, 6.808)
Neoplasms of unspecified nature or uncertain behavior (CCS 44)	9.34	0.7944 (0.087)	2.212 (1.866, 2.624)
Maintenance chemotherapy; radiotherapy (CCS 45)	11.37	Reference	Reference
Other Infectious Diseases (CC 7)	13.40	-0.105 (0.0415)	0.901 (0.830, 0.977)
Metastatic & Severe Cancers (CC 8,9)	18.71	0.4192 (0.0385)	1.521 (1.411, 1.641)
Protein-Calorie Malnutrition (CC 21)	16.82	0.4595 (0.0353)	1.584 (1.478, 1.697)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	41.49	0.3436 (0.0309)	1.410 (1.327, 1.498)
Disorders of Lipoid Metabolism (CC 25)	46.28	-0.119 (0.0294)	0.888 (0.838, 0.940)
Liver Failure (CC 27,30)	2.62	0.8646 (0.0761)	2.373 (2.044, 2.754)
Other GI Disorders (CC 34-38)	55.72	-0.2836 (0.0301)	0.753 (0.710, 0.799)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	31.80	-0.1216 (0.0311)	0.885 (0.833, 0.941)
Hematologic or Immunity Disorders (CC 46-48)	29.80	0.2751 (0.0358)	1.317 (1.228, 1.413)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	11.32	0.1894 (0.0422)	1.208 (1.112, 1.313)
Coma/Brain Compression/Anoxic	4.16	0.1942 (0.0904)	1.213 (1.016, 1.448)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Injury and Severe Head Injury (CC 80, 166)			
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	10.77	0.5475 (0.0425)	1.729 (1.591, 1.879)
Congestive Heart Failure (CC 85)	18.53	0.162 (0.0355)	1.176 (1.097, 1.260)
Hypertension and Hypertensive Heart Disease (CC 94,95)	61.16	-0.2116 (0.0301)	0.809 (0.763, 0.859)
Pneumonia (CC 114-116)	18.34	0.3532 (0.0364)	1.424 (1.326, 1.529)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	3.74	-0.0497 (0.0708)	0.951 (0.828, 1.093)
Acute or Unspecified Renal Failure (CC 135,140)	21.26	0.3445 (0.0344)	1.411 (1.319, 1.509)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	10.91	-0.1273 (0.0499)	0.880 (0.798, 0.970)
Minor Symptoms, Signs, Findings (CC 179)	56.15	0.6287 (0.0316)	1.875 (1.763, 1.995)

Table 21. Non-Surgical Cardiac Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	78.6 (7.9)	0.0536 (0.0007)	1.055 (1.054, 1.056)
Heart valve disorders (CCS 96)	0.72	0.2641 (0.0719)	1.302 (1.131, 1.499)
Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease) (CCS 97)	0.82	Reference	Reference
Acute myocardial infarction (CCS 100)	16.51	0.6016 (0.0553)	1.825 (1.638, 2.034)
Coronary atherosclerosis and other heart disease (CCS 101)	8.43	-0.8832 (0.0632)	0.413 (0.365, 0.468)
Nonspecific chest pain (CCS 102)	6.05	-1.6049 (0.073)	0.201 (0.174, 0.232)
Pulmonary heart disease (CCS 103)	5.03	-0.0836 (0.0585)	0.920 (0.820, 1.032)
Other and ill-defined heart disease (CCS 104_2)	0.31	-0.6492 (0.1417)	0.522 (0.396, 0.690)
Conduction disorders (CCS 105)	2.68	-0.777 (0.0692)	0.460 (0.401, 0.527)
Cardiac dysrhythmias (CCS 106)	24.90	-0.6566 (0.0559)	0.519 (0.465, 0.579)
Cardiac arrest and ventricular fibrillation (CCS 107_1)	0.03	4.059 (0.3228)	57.916 (30.762, 109.041)
Cardiac arrest and ventricular fibrillation (CCS 107_2)	0.29	1.2159 (0.0796)	3.373 (2.886, 3.943)
Congestive heart failure; nonhypertensive (CCS 108)	28.93	-0.1823 (0.0551)	0.833 (0.748, 0.928)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Cardiac and circulatory congenital anomalies (CCS 213)	0.05	-1.1246 (0.3777)	0.325 (0.155, 0.681)
Syncope (CCS 245)	5.20	-1.5582 (0.0698)	0.211 (0.184, 0.241)
Shock (CCS 249)	0.05	1.8248 (0.1347)	6.202 (4.762, 8.076)
Other Infectious Diseases (CC 7)	9.25	-0.0708 (0.0152)	0.932 (0.904, 0.960)
Metastatic & Severe Cancers (CC 8,9)	1.94	0.8377 (0.0266)	2.311 (2.194, 2.434)
Protein-Calorie Malnutrition (CC 21)	4.74	0.5456 (0.0166)	1.726 (1.671, 1.783)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	32.12	0.3049 (0.0114)	1.357 (1.326, 1.387)
Disorders of Lipoid Metabolism (CC 25)	64.54	-0.3179 (0.0108)	0.728 (0.712, 0.743)
Liver Failure (CC 27,30)	0.90	0.9036 (0.0339)	2.468 (2.310, 2.638)
Other GI Disorders (CC 34-38)	40.35	-0.1551 (0.0109)	0.856 (0.838, 0.875)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	32.78	-0.1589 (0.0111)	0.853 (0.835, 0.872)
Hematologic or Immunity Disorders (CC 46-48)	8.78	0.1169 (0.0154)	1.124 (1.091, 1.158)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	14.48	0.4292 (0.0123)	1.536 (1.500, 1.573)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.65	1.8782 (0.0369)	6.541 (6.0858, 7.032)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	16.68	0.7368 (0.012)	2.089 (2.041, 2.139)
Congestive Heart Failure (CC 85)	51.43	0.2927 (0.0132)	1.240 (1.306, 1.375)
Hypertension and Hypertensive Heart Disease (CC 94,95)	63.21	-0.3127 (0.0111)	0.731 (0.716, 0.748)
Pneumonia (CC 114-116)	15.15	0.3035 (0.0121)	1.355 (1.323, 1.387)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	7.61	0.3023 (0.0159)	1.353 (1.311, 1.396)
Acute or Unspecified Renal Failure (CC 135,140)	20.59	0.4088 (0.0118)	1.505 (1.471, 1.540)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	5.50	-0.1432 (0.019)	0.867 (0.835, 0.899)
Minor Symptoms, Signs, Findings (CC 179)	41.08	0.7571 (0.0114)	2.132 (2.085, 2.180)

Table 22. Non-Surgical Gastrointestinal Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	78.1 (7.9)	0.0569 (0.0012)	1.059 (1.056, 1.061)
Hepatitis (CCS 6)	0.50	Reference	Reference
Hemorrhoids (CCS 120)	1.63	-1.4875 (0.1141)	0.226 (0.181, 0.283)
Esophageal disorders (CCS 138)	3.75	-1.161 (0.089)	0.313 (0.263, 0.373)
Gastroduodenal ulcer (except hemorrhage) (CCS 139_1)	0.22	1.1457 (0.1172)	3.145 (2.499, 3.957)
Gastroduodenal ulcer (except hemorrhage) (CCS 139_2)	1.01	-1.4418 (0.1393)	0.236 (0.180, 0.311)
Gastritis and duodenitis (CCS 140)	3.39	-1.2785 (0.0924)	0.278 (0.232, 0.334)
Other disorders of stomach and duodenum (CCS 141)	2.56	-0.9965 (0.0901)	0.369 (0.309, 0.440)
Appendicitis and other appendiceal conditions (CCS 142)	0.25	-1.6621 (0.3052)	0.190 (0.104, 0.345)
Abdominal hernia (CCS 143)	1.22	-0.5467 (0.1001)	0.579 (0.476, 0.704)
Regional enteritis and ulcerative colitis (CCS 144)	1.31	-1.126 (0.1188)	0.324 (0.257, 0.409)
Intestinal obstruction without hernia (CCS 145)	14.81	-0.7744 (0.0782)	0.461 (0.395, 0.537)
Diverticulosis and diverticulitis (CCS 146)	15.09	-1.5741 (0.0819)	0.207 (0.176, 0.243)
Anal and rectal conditions (CCS 147)	0.68	-1.0867 (0.1312)	0.337 (0.261, 0.436)
Peritonitis and intestinal abscess (CCS 148_1)	0.21	0.495 (0.1201)	1.640 (1.296, 2.076)
Peritonitis and intestinal abscess (CCS 148_2)	0.34	-0.7643 (0.1606)	0.466 (0.340, 0.638)
Biliary tract disease (CCS 149)	5.21	-0.9487 (0.0829)	0.387 (0.329, 0.456)
Other liver diseases (CCS 151_1)	2.81	0.0895 (0.0771)	1.094 (0.940, 1.272)
Other liver diseases (CCS 151_2)	0.62	0.1189 (0.0983)	1.126 (0.929, 1.365)
Pancreatic disorders (not diabetes) (CCS 152)	6.20	-0.8289 (0.083)	0.437 (0.371, 0.514)
Gastrointestinal hemorrhage (CCS 153)	22.82	-0.6532 (0.0764)	0.520 (0.448, 0.604)
Noninfectious gastroenteritis (CCS 154)	5.33	-1.601 (0.0914)	0.202 (0.169, 0.241)
Other gastrointestinal disorders (CCS 155)	5.93	-0.9788 (0.0817)	0.376 (0.320, 0.441)
Digestive congenital anomalies (CCS 214)	0.04	-1.8087 (0.607)	0.164 (0.050, 0.538)
Nausea and vomiting (CCS 250)	1.13	-1.5273 (0.1218)	0.217 (0.171, 0.276)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Abdominal pain (CCS 251)	2.93	-1.2692 (0.0975)	0.281 (0.232, 0.340)
Other Infectious Diseases (CC 7)	12.51	-0.1678 (0.0224)	0.846 (0.809, 0.884)
Metastatic & Severe Cancers (CC 8,9)	3.33	1.0339 (0.0308)	2.812 (2.647, 2.987)
Protein-Calorie Malnutrition (CC 21)	8.19	0.6769 (0.0215)	1.968 (1.887, 2.052)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	41.99	0.3316 (0.0186)	1.393 (1.343, 1.445)
Disorders of Lipoid Metabolism (CC 25)	52.42	-0.2114 (0.0172)	0.809 (0.783, 0.837)
Liver Failure (CC 27,30)	4.19	0.7947 (0.0343)	2.214 (2.070, 2.368)
Other GI Disorders (CC 34-38)	70.98	-0.4753 (0.0182)	0.622 (0.600, 0.644)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	34.25	-0.1275 (0.0177)	0.880 (0.850, 0.911)
Hematologic or Immunity Disorders (CC 46-48)	10.97	0.2011 (0.0225)	1.223 (1.170, 1.278)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	15.06	0.4857 (0.0194)	1.625 (1.565, 1.688)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.26	0.9338 (0.092)	2.544 (2.124, 3.047)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	7.24	0.4046 (0.025)	1.499 (1.427, 1.574)
Congestive Heart Failure (CC 85)	21.12	0.3783 (0.0188)	1.460 (1.407, 1.515)
Hypertension and Hypertensive Heart Disease (CC 94,95)	64.93	-0.2692 (0.0179)	0.764 (0.738, 0.791)
Pneumonia (CC 114-116)	9.22	0.3848 (0.0226)	1.469 (1.406, 1.536)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	5.38	0.3415 (0.0288)	1.407 (1.330, 1.489)
Acute or Unspecified Renal Failure (CC 135,140)	20.05	0.4305 (0.0187)	1.538 (1.483, 1.595)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	5.43	-0.1237 (0.0299)	0.884 (0.833, 0.937)
Minor Symptoms, Signs, Findings (CC 179)	41.62	0.7998 (0.0188)	2.225 (2.145, 2.308)

Table 23. Non-Surgical Infectious Disease Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	79.3 (8.0)	0.0463 (0.0006)	1.047 (1.046, 1.049)
Tuberculosis (CCS 1)	0.05	2.1415 (0.7353)	8.512 (2.014, 35.97)
Septicemia (except in labor) (CCS 2)	52.02	2.6127 (0.7081)	13.636 (3.403, 54.633)
Bacterial infection; unspecified site (CCS 3)	0.11	2.3267 (0.7203)	10.244 (2.497, 42.035)
Mycoses (CCS 4)	0.59	2.1378 (0.7103)	8.48 (2.108, 34.124)
HIV infection (CCS 5)	0.08	2.6258 (0.7215)	13.815 (3.359, 56.822)
Viral infection (CCS 7)	1.27	0.959 (0.712)	2.609 (0.646, 10.532)
Other infections; including parasitic (CCS 8)	0.32	0.8585 (0.7268)	2.36 (0.568, 9.805)
Sexually transmitted infections (not HIV or hepatitis) (CCS 9)	0.04	Reference	Reference
Meningitis (except that caused by tuberculosis or sexually transmitted disease) (CCS 76)	0.24	2.107 (0.7174)	8.223 (2.016, 33.548)
Encephalitis (except that caused by tuberculosis or sexually transmitted disease) (CCS 77)	0.21	2.7667 (0.7144)	15.906 (3.922, 64.511)
Intestinal infection (CCS 135)	6.60	1.2155 (0.7086)	3.372 (0.841, 13.523)
Urinary tract infections (CCS 159)	23.32	1.334 (0.7082)	3.796 (0.947, 15.214)
Skin and subcutaneous tissue infections (CCS 197)	13.38	0.9739 (0.7085)	2.648 (0.66, 10.619)
Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease) (CCS 201)	0.73	1.5247 (0.7124)	4.594 (1.137, 18.559)
Fever of unknown origin (CCS 246)	1.05	0.8391 (0.7128)	2.314 (0.572, 9.358)
Other Infectious Diseases (CC 7)	34.36	-0.3073 (0.0103)	0.735 (0.721, 0.75)
Metastatic & Severe Cancers (CC 8,9)	3.60	0.8062 (0.0195)	2.239 (2.155, 2.327)
Protein-Calorie Malnutrition (CC 21)	13.80	0.5057 (0.0111)	1.658 (1.623, 1.695)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	58.06	0.298 (0.0106)	1.347 (1.32, 1.375)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Disorders of Lipoid Metabolism (CC 25)	50.46	-0.2263 (0.0093)	0.797 (0.783, 0.812)
Liver Failure (CC 27,30)	2.36	1.0008 (0.022)	2.72 (2.605, 2.84)
Other GI Disorders (CC 34-38)	49.28	-0.2351 (0.0094)	0.791 (0.776, 0.805)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	38.08	-0.1519 (0.0096)	0.859 (0.843, 0.875)
Hematologic or Immunity Disorders (CC 46-48)	14.27	0.2544 (0.0117)	1.29 (1.261, 1.319)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	30.54	0.411 (0.0098)	1.508 (1.48, 1.538)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	1.15	0.98 (0.0301)	2.664 (2.512, 2.826)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	21.14	0.8616 (0.0105)	2.367 (2.319, 2.416)
Congestive Heart Failure (CC 85)	29.60	0.251 (0.0097)	1.285 (1.261, 1.31)
Hypertension and Hypertensive Heart Disease (CC 94,95)	60.72	-0.1696 (0.0097)	0.844 (0.828, 0.86)
Pneumonia (CC 114-116)	32.70	0.2625 (0.0103)	1.3 (1.274, 1.327)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	6.89	0.3903 (0.0158)	1.477 (1.432, 1.524)
Acute or Unspecified Renal Failure (CC 135,140)	35.50	0.4585 (0.0095)	1.582 (1.552, 1.612)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	7.05	-0.0468 (0.0159)	0.954 (0.925, 0.985)
Minor Symptoms, Signs, Findings (CC 179)	53.25	0.7979 (0.0103)	2.221 (2.176, 2.266)

Table 24. Non-Surgical Pulmonary Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	78.5 (8.0)	0.0452 (0.0007)	1.046 (1.045, 1.048)
Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122)	37.07	-0.3561 (0.0281)	0.7 (0.663, 0.74)
Influenza (CCS 123)	3.92	-0.9413 (0.0426)	0.39 (0.359, 0.424)
Acute bronchitis (CCS 125)	2.43	-1.9093 (0.0748)	0.148 (0.128, 0.172)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other upper respiratory infections (CCS 126)	0.74	-1.7107 (0.1224)	0.181 (0.142, 0.23)
Chronic obstructive pulmonary disease and bronchiectasis (CCS 127)	24.67	-0.8639 (0.0299)	0.422 (0.398, 0.447)
Asthma (CCS 128)	5.34	-1.352 (0.0472)	0.259 (0.236, 0.284)
Aspiration pneumonitis; food/vomitus (CCS 129)	7.44	0.5391 (0.0299)	1.714 (1.617, 1.818)
Pleurisy; pneumothorax; pulmonary collapse (CCS 130)	2.56	-0.1714 (0.0387)	0.842 (0.781, 0.909)
Respiratory failure; insufficiency; arrest (adult) (CCS 131)	12.73	0.782 (0.0287)	2.186 (2.066, 2.312)
Lung disease due to external agents (CCS 132)	0.19	0.0279 (0.1003)	1.028 (0.845, 1.252)
Other lower respiratory disease (CCS 133)	2.91	Reference	Reference
Other Infectious Diseases (CC 7)	14.93	-0.1136 (0.013)	0.893 (0.87, 0.916)
Metastatic & Severe Cancers (CC 8,9)	4.14	0.966 (0.019)	2.627 (2.532, 2.727)
Protein-Calorie Malnutrition (CC 21)	10.11	0.5666 (0.0129)	1.762 (1.718, 1.807)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	44.05	0.2292 (0.0105)	1.258 (1.232, 1.284)
Disorders of Lipoid Metabolism (CC 25)	51.48	-0.1981 (0.01)	0.82 (0.804, 0.837)
Liver Failure (CC 27,30)	0.86	0.6958 (0.038)	2.005 (1.861, 2.161)
Other GI Disorders (CC 34-38)	46.43	-0.2176 (0.0101)	0.804 (0.789, 0.821)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	33.87	-0.167 (0.0105)	0.846 (0.829, 0.864)
Hematologic or Immunity Disorders (CC 46-48)	10.13	0.1105 (0.0145)	1.117 (1.086, 1.149)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	19.94	0.3518 (0.0113)	1.422 (1.39, 1.453)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	1.07	1.807 (0.0314)	6.092 (5.729, 6.478)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	29.58	0.5522 (0.0107)	1.737 (1.701, 1.774)
Congestive Heart Failure (CC 85)	38.02	0.3003 (0.0103)	1.35 (1.323, 1.378)
Hypertension and Hypertensive	62.66	-0.2111 (0.0104)	0.81 (0.793, 0.826)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Heart Disease (CC 94,95)			
Pneumonia (CC 114-116)	27.21	0.1191 (0.0109)	1.126 (1.103, 1.151)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	5.59	0.1401 (0.0188)	1.15 (1.109, 1.194)
Acute or Unspecified Renal Failure (CC 135,140)	19.96	0.3074 (0.0113)	1.36 (1.33, 1.39)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	7.37	-0.13 (0.0171)	0.878 (0.849, 0.908)
Minor Symptoms, Signs, Findings (CC 179)	50.58	0.7579 (0.011)	2.134 (2.088, 2.181)

Table 25. Non-Surgical Renal Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Names	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	79.2 (8.0)	0.0565 (0.0011)	1.058 (1.056, 1.06)
Fluid and electrolyte disorders (CCS 55)	30.14	0.1589 (0.0278)	1.172 (1.11, 1.238)
Essential hypertension (CCS 98)	3.74	-1.5907 (0.1187)	0.204 (0.161, 0.257)
Hypertension with complications and secondary hypertension (CCS 99)	17.07	Reference	Reference
Nephritis; nephrosis; renal sclerosis (CCS 156)	0.30	0.1916 (0.1625)	1.211 (0.881, 1.665)
Acute and unspecified renal failure (CCS 157)	46.63	0.5715 (0.0249)	1.771 (1.687, 1.86)
Chronic kidney disease (CCS 158)	0.79	0.5829 (0.0801)	1.791 (1.531, 2.096)
Other diseases of kidney and ureters (CCS 161)	1.33	-0.0427 (0.0906)	0.958 (0.802, 1.144)
Other Infectious Diseases (CC 7)	18.78	-0.1673 (0.0194)	0.846 (0.814, 0.879)
Metastatic & Severe Cancers (CC 8,9)	3.28	1.0367 (0.0326)	2.82 (2.645, 3.006)
Protein-Calorie Malnutrition (CC 21)	11.02	0.6782 (0.0197)	1.97 (1.896, 2.048)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	63.79	0.1714 (0.0199)	1.187 (1.142, 1.234)
Disorders of Lipoid Metabolism (CC 25)	55.45	-0.2409 (0.0162)	0.786 (0.761, 0.811)
Liver Failure (CC 27,30)	1.49	1.1103 (0.0441)	3.035 (2.784, 3.309)

Risk Variable Names	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other GI Disorders (CC 34-38)	51.40	-0.2593 (0.0162)	0.772 (0.747, 0.797)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	40.08	-0.1869 (0.0163)	0.83 (0.804, 0.856)
Hematologic or Immunity Disorders (CC 46-48)	11.12	0.3394 (0.0213)	1.404 (1.347, 1.464)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	25.44	0.4853 (0.0169)	1.625 (1.572, 1.679)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.44	0.9413 (0.0795)	2.563 (2.194, 2.995)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	11.38	0.4054 (0.0223)	1.5 (1.436, 1.567)
Congestive Heart Failure (CC 85)	36.10	0.482 (0.0173)	1.619 (1.565, 1.675)
Hypertension and Hypertensive Heart Disease (CC 94,95)	46.16	-0.1703 (0.0173)	0.843 (0.815, 0.873)
Pneumonia (CC 114-116)	13.50	0.409 (0.02)	1.505 (1.447, 1.566)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	16.69	0.2694 (0.0209)	1.309 (1.257, 1.364)
Acute or Unspecified Renal Failure (CC 135,140)	24.28	0.1574 (0.0186)	1.17 (1.128, 1.214)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	7.47	-0.0473 (0.0272)	0.954 (0.904, 1.006)
Minor Symptoms, Signs, Findings (CC 179)	52.07	0.7286 (0.0179)	2.072 (2.001, 2.146)

Table 26. Non-Surgical Orthopedic Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	81.2 (7.9)	0.0544 (0.002)	1.056 (1.052, 1.06)
Osteoarthritis (CCS 203)	2.43	-1.0141 (0.1615)	0.363 (0.264, 0.498)
Other non-traumatic joint disorders (CCS 204)	3.70	-0.64 (0.1116)	0.527 (0.424, 0.656)
Spondylosis; intervertebral disc disorders; other back problems (CCS 205)	14.75	-0.3953 (0.0747)	0.673 (0.582, 0.78)
Pathological fracture (CCS 207)	5.22	0.2008 (0.0772)	1.222 (1.051, 1.422)
Other acquired deformities (CCS 209)	0.20	-0.1961 (0.3665)	0.822 (0.401, 1.686)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other bone disease and musculoskeletal deformities (CCS 212)	1.25	-0.4072 (0.1681)	0.666 (0.479, 0.925)
Joint disorders and dislocations; trauma-related (CCS 225)	0.38	-0.4579 (0.2945)	0.633 (0.355, 1.127)
Fracture of neck of femur (hip) (CCS 226)	4.41	1.5291 (0.0668)	4.614 (4.048, 5.26)
Skull and face fractures (CCS 228)	2.21	-0.0372 (0.1097)	0.963 (0.777, 1.194)
Fracture of upper limb (CCS 229)	6.78	0.0245 (0.076)	1.025 (0.883, 1.189)
Fracture of lower limb (CCS 230)	5.79	0.2177 (0.0775)	1.243 (1.068, 1.447)
Other fractures (CCS 231)	36.72	0.1561 (0.0606)	1.169 (1.038, 1.316)
Sprains and strains (CCS 232)	1.95	-0.681 (0.1502)	0.506 (0.377, 0.679)
Open wounds of head; neck; and trunk (CCS 235)	1.59	-0.3578 (0.1324)	0.699 (0.539, 0.906)
Open wounds of extremities (CCS 236)	1.13	-0.3485 (0.1704)	0.706 (0.505, 0.985)
Superficial injury; contusion (CCS 239)	5.76	-0.328 (0.0851)	0.72 (0.61, 0.851)
Other injuries and conditions due to external causes (CCS 244_1)	0.75	1.0223 (0.1072)	2.78 (2.253, 3.43)
Other injuries and conditions due to external causes (CCS 244_2)	4.99	Reference	Reference
Other Infectious Diseases (CC 7)	11.69	-0.2234 (0.0394)	0.8 (0.74, 0.864)
Metastatic & Severe Cancers (CC 8,9)	1.81	0.9347 (0.0696)	2.546 (2.222, 2.918)
Protein-Calorie Malnutrition (CC 21)	5.81	0.6042 (0.0395)	1.83 (1.694, 1.977)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	31.49	0.1672 (0.0291)	1.182 (1.117, 1.251)
Disorders of Lipoid Metabolism (CC 25)	48.12	-0.2081 (0.0274)	0.812 (0.77, 0.857)
Liver Failure (CC 27,30)	0.61	0.8651 (0.1145)	2.375 (1.898, 2.973)
Other GI Disorders (CC 34-38)	43.90	-0.2384 (0.0278)	0.788 (0.746, 0.832)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	43.05	-0.2382 (0.0278)	0.788 (0.746, 0.832)
Hematologic or Immunity Disorders (CC 46-48)	7.54	0.1695 (0.0426)	1.185 (1.09, 1.288)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	24.29	0.5245 (0.0277)	1.69 (1.6, 1.784)
Coma/Brain Compression/Anoxic	0.37	1.8433 (0.1151)	6.318 (5.042, 7.916)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Injury and Severe Head Injury (CC 80, 166)			
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	7.11	0.585 (0.0407)	1.795 (1.657, 1.944)
Congestive Heart Failure (CC 85)	20.18	0.5292 (0.0299)	1.698 (1.601, 1.8)
Hypertension and Hypertensive Heart Disease (CC 94,95)	65.31	-0.3008 (0.0282)	0.74 (0.7, 0.782)
Pneumonia (CC 114-116)	8.90	0.5489 (0.0366)	1.731 (1.612, 1.86)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	4.07	0.563 (0.0514)	1.756 (1.588, 1.942)
Acute or Unspecified Renal Failure (CC 135,140)	13.14	0.3553 (0.0343)	1.427 (1.334, 1.526)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	4.50	-0.2958 (0.0585)	0.744 (0.663, 0.834)
Minor Symptoms, Signs, Findings (CC 179)	44.11	0.7061 (0.0289)	2.026 (1.915, 2.144)

Table 27. Non-Surgical Neurology Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	78.8 (7.9)	0.0634 (0.001)	1.065 (1.063, 1.068)
Other CNS infection and poliomyelitis (CCS 78)	0.14	0.9202 (0.1944)	2.51 (1.714, 3.674)
Parkinson`s disease (CCS 79)	1.07	0.3258 (0.0999)	1.385 (1.139, 1.685)
Multiple sclerosis (CCS 80)	0.31	0.2917 (0.2355)	1.339 (0.844, 2.124)
Other hereditary and degenerative nervous system conditions (CCS 81)	1.82	0.0324 (0.0871)	1.033 (0.871, 1.225)
Paralysis (CCS 82)	0.21	0.3354 (0.201)	1.398 (0.943, 2.074)
Epilepsy; convulsions (CCS 83)	8.07	-0.0055 (0.0548)	0.995 (0.893, 1.107)
Coma; stupor; and brain damage (CCS 85)	0.77	0.5824 (0.0926)	1.79 (1.493, 2.147)
Other nervous system disorders (CCS 95_1)	7.40	0.5555 (0.0503)	1.743 (1.579, 1.924)
Other nervous system disorders (CCS 95_2)	6.24	Reference	Reference
Acute cerebrovascular disease (CCS 109_1)	8.17	2.2103 (0.0468)	9.118 (8.32, 9.994)
Acute cerebrovascular disease	47.59	1.3056 (0.0441)	3.69 (3.384, 4.023)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
(CCS 109_2)			
Occlusion or stenosis of precerebral arteries (CCS 110)	1.26	-0.5704 (0.1373)	0.565 (0.432, 0.74)
Other and ill-defined cerebrovascular disease (CCS 111)	0.98	-0.0742 (0.133)	0.928 (0.715, 1.205)
Transient cerebral ischemia (CCS 112)	14.85	-1.0996 (0.0651)	0.333 (0.293, 0.378)
Late effects of cerebrovascular disease (CCS 113)	1.13	0.0849 (0.0967)	1.089 (0.901, 1.316)
Other Infectious Diseases (CC 7)	10.39	-0.1061 (0.0224)	0.899 (0.861, 0.94)
Metastatic & Severe Cancers (CC 8,9)	1.53	0.8325 (0.0459)	2.299 (2.101, 2.516)
Protein-Calorie Malnutrition (CC 21)	5.45	0.3707 (0.0252)	1.449 (1.379, 1.522)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	30.77	0.1265 (0.0166)	1.135 (1.099, 1.172)
Disorders of Lipoid Metabolism (CC 25)	61.02	-0.3466 (0.0148)	0.707 (0.687, 0.728)
Liver Failure (CC 27,30)	0.52	0.5862 (0.0775)	1.797 (1.544, 2.092)
Other GI Disorders (CC 34-38)	35.43	-0.2439 (0.0158)	0.784 (0.76, 0.808)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	38.52	-0.2477 (0.0153)	0.781 (0.758, 0.804)
Hematologic or Immunity Disorders (CC 46-48)	7.07	0.0559 (0.0255)	1.058 (1.006, 1.112)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	27.64	0.323 (0.0157)	1.381 (1.339, 1.424)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	5.24	1.4583 (0.0235)	4.299 (4.105, 4.501)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	8.23	1.176 (0.0208)	3.241 (3.112, 3.376)
Congestive Heart Failure (CC 85)	19.84	0.3178 (0.017)	1.374 (1.329, 1.421)
Hypertension and Hypertensive Heart Disease (CC 94,95)	72.48	-0.1736 (0.0167)	0.841 (0.814, 0.869)
Pneumonia (CC 114-116)	9.16	0.5205 (0.0208)	1.683 (1.616, 1.753)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	3.97	0.3401 (0.0333)	1.405 (1.316, 1.5)
Acute or Unspecified Renal Failure (CC 135,140)	14.04	0.1776 (0.02)	1.194 (1.149, 1.242)
Poisonings and Allergic and	4.39	-0.2739 (0.0335)	0.76 (0.712, 0.812)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Inflammatory Reactions (CC 175)			
Minor Symptoms, Signs, Findings (CC 179)	48.19	1.0072 (0.0161)	2.738 (2.653, 2.826)

Table 28. Surgical Cardiothoracic Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	75.0 (6.6)	0.0496 (0.002)	1.051 (1.047, 1.055)
Septicemia (except in labor) (CCS 2)	1.30	0.1739 (0.1813)	1.19 (0.834, 1.698)
Other and unspecified benign neoplasm (CCS 47)	0.60	-1.4579 (0.3789)	0.233 (0.111, 0.489)
Heart valve disorders (CCS 96)	28.33	-0.6794 (0.1685)	0.507 (0.364, 0.705)
Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease) (CCS 97)	1.73	-0.4444 (0.1902)	0.641 (0.442, 0.931)
Hypertension with complications and secondary hypertension (CCS 99)	0.27	Reference	Reference
Acute myocardial infarction (CCS 100)	15.41	0.6715 (0.1673)	1.957 (1.41, 2.717)
Coronary atherosclerosis and other heart disease (CCS 101)	27.62	-0.7488 (0.1704)	0.473 (0.339, 0.66)
Pulmonary heart disease (CCS 103)	0.11	0.6379 (0.3029)	1.892 (1.045, 3.427)
Other and ill-defined heart disease (CCS 104_2)	0.05	0.7916 (0.4113)	2.207 (0.986, 4.941)
Conduction disorders (CCS 105)	0.17	-0.5555 (0.3586)	0.574 (0.284, 1.159)
Cardiac dysrhythmias (CCS 106)	10.05	-1.2011 (0.1768)	0.301 (0.213, 0.425)
Cardiac arrest and ventricular fibrillation (CCS 107_2)	0.17	0.76 (0.2407)	2.138 (1.334, 3.428)
Congestive heart failure; nonhypertensive (CCS 108)	2.61	-0.1916 (0.1752)	0.826 (0.586, 1.164)
Acute cerebrovascular disease (CCS 109_2)	0.13	0.0918 (0.3378)	1.096 (0.565, 2.125)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_2)	0.45	1.7408 (0.1971)	5.702 (3.875, 8.39)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_3)	0.71	0.135 (0.2248)	1.145 (0.737, 1.778)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122)	0.87	0.1289 (0.196)	1.138 (0.775, 1.671)
CCS 127	0.32	-0.0124 (0.2541)	0.988 (0.6, 1.625)
Pleurisy; pneumothorax; pulmonary collapse (CCS 130)	2.14	-0.5161 (0.1863)	0.597 (0.414, 0.86)
Respiratory failure; insufficiency; arrest (adult) (CCS 131)	0.40	0.6342 (0.2048)	1.886 (1.262, 2.817)
Other lower respiratory disease (CCS 133)	2.24	-0.9241 (0.2119)	0.397 (0.262, 0.601)
Other upper respiratory disease (CCS 134)	0.25	-1.0218 (0.3738)	0.36 (0.173, 0.749)
Abdominal hernia (CCS 143)	0.05	0.0734 (0.5701)	1.076 (0.352, 3.29)
Acute and unspecified renal failure (CCS 157)	0.12	0.3593 (0.2861)	1.432 (0.818, 2.509)
Cardiac and circulatory congenital anomalies (CCS 213)	0.57	-0.6162 (0.292)	0.54 (0.305, 0.957)
Complication of device; implant or graft (CCS 237)	2.31	0.0163 (0.1819)	1.016 (0.712, 1.452)
Complications of surgical procedures or medical care (CCS 238)	1.02	-0.6391 (0.2089)	0.528 (0.35, 0.795)
Other Infectious Diseases (CC 7)	5.16	-0.3235 (0.055)	0.724 (0.65, 0.806)
Metastatic & Severe Cancers (CC 8,9)	1.48	0.5424 (0.086)	1.72 (1.453, 2.036)
Protein-Calorie Malnutrition (CC 21)	5.16	0.4129 (0.0444)	1.511 (1.385, 1.649)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	17.48	0.3154 (0.0329)	1.371 (1.285, 1.462)
Disorders of Lipoid Metabolism (CC 25)	71.60	-0.3104 (0.0285)	0.733 (0.693, 0.775)
Liver Failure (CC 27, 30)	1.02	0.914 (0.078)	2.494 (2.141, 2.907)
Other GI Disorders (CC 34-38)	38.72	-0.2773 (0.0287)	0.758 (0.716, 0.802)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	27.35	-0.1799 (0.0311)	0.835 (0.786, 0.888)
Hematologic or Immunity Disorders (CC 46-48)	9.41	0.1055 (0.0403)	1.111 (1.027, 1.203)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	3.96	0.2247 (0.0539)	1.252 (1.126, 1.391)
Coma/Brain Compression/Anoxic	0.60	1.3424 (0.094)	3.828 (3.184, 4.602)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Injury and Severe Head Injury (CC 80, 166)			
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	12.07	0.863 (0.0329)	2.37 (2.222, 2.528)
Congestive Heart Failure (CC 85)	40.26	0.3426 (0.0295)	1.409 (1.329, 1.492)
Hypertension and Hypertensive Heart Disease (CC 94,95)	66.42	-0.269 (0.0286)	0.764 (0.723, 0.808)
Pneumonia (CC 114-116)	11.11	0.1563 (0.0367)	1.169 (1.088, 1.256)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	4.17	0.4927 (0.0491)	1.637 (1.487, 1.802)
Acute or Unspecified Renal Failure (CC 135,140)	10.41	0.2132 (0.0367)	1.238 (1.152, 1.33)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	3.09	-0.0397 (0.0651)	0.961 (0.846, 1.092)
Minor Symptoms, Signs, Findings (CC 179)	35.42	0.4314 (0.0276)	1.539 (1.458, 1.625)

Table 29. Surgical General Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	75.2 (7.2)	0.0601 (0.0016)	1.062 (1.059, 1.065)
Septicemia (except in labor) (CCS 2)	6.53	1.8958 (0.2001)	6.658 (4.498, 9.855)
Benign neoplasm of uterus (CCS 46)	0.11	-0.0033 (0.7416)	0.997 (0.233, 4.264)
Other and unspecified benign neoplasm (CCS 47)	4.75	-0.0878 (0.2208)	0.916 (0.594, 1.412)
Diabetes mellitus with complications (CCS 50)	0.24	0.6019 (0.3163)	1.826 (0.982, 3.393)
Fluid and electrolyte disorders (CCS 55)	0.14	1.614 (0.2689)	5.023 (2.965, 8.508)
Other nutritional; endocrine; and metabolic disorders (CCS 58_2)	2.40	-0.5338 (0.3045)	0.586 (0.323, 1.065)
Deficiency and other anemia (CCS 59)	0.11	1.2792 (0.3168)	3.594 (1.931, 6.687)
Coagulation and hemorrhagic disorders (CCS 62)	0.09	1.4039 (0.3692)	4.071 (1.975, 8.393)
Other hematologic conditions (CCS 64)	0.07	1.6502 (0.3456)	5.208 (2.645, 10.253)
Other nervous system disorders (CCS 95_2)	0.09	0.2914 (0.5037)	1.338 (0.499, 3.592)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Hypertension with complications and secondary hypertension (CCS 99)	0.54	Reference	Reference
Acute myocardial infarction (CCS 100)	0.14	1.7561 (0.2619)	5.79 (3.465, 9.673)
Coronary atherosclerosis and other heart disease (CCS 101)	0.06	1.473 (0.3795)	4.362 (2.073, 9.177)
Pulmonary heart disease (CCS 103)	0.06	1.4406 (0.3493)	4.223 (2.13, 8.374)
Cardiac dysrhythmias (CCS 106)	0.22	1.2735 (0.2587)	3.573 (2.152, 5.934)
Congestive heart failure; nonhypertensive (CCS 108)	0.21	1.1329 (0.2456)	3.105 (1.919, 5.024)
Acute cerebrovascular disease (CCS 109_2)	0.15	1.9273 (0.252)	6.871 (4.193, 11.26)
Occlusion or stenosis of precerebral arteries (CCS 110)	0.17	-1.0937 (0.7367)	0.335 (0.079, 1.419)
Peripheral and visceral atherosclerosis (CCS 114)	1.22	2.5725 (0.2046)	13.098 (8.771, 19.56)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_1)	0.10	4.5408 (0.2602)	93.769 (56.314, 156.136)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_3)	0.12	2.4601 (0.269)	11.706 (6.909, 19.832)
Phlebitis; thrombophlebitis and thromboembolism (CCS 118)	0.03	1.6928 (0.4478)	5.435 (2.26, 13.072)
Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122)	0.32	1.7376 (0.2286)	5.684 (3.631, 8.896)
Chronic obstructive pulmonary disease and bronchiectasis (CCS 127)	0.19	1.8583 (0.2441)	6.413 (3.974, 10.348)
Aspiration pneumonitis; food/vomitus (CCS 129)	0.17	1.3305 (0.2498)	3.783 (2.318, 6.173)
Pleurisy; pneumothorax; pulmonary collapse (CCS 130)	0.07	1.4545 (0.3332)	4.283 (2.229, 8.229)
Respiratory failure; insufficiency; arrest (adult) (CCS 131)	0.24	1.958 (0.2331)	7.085 (4.486, 11.189)
Other lower respiratory disease (CCS 133)	0.17	0.9637 (0.3192)	2.621 (1.402, 4.9)
Intestinal infection (CCS 135)	0.11	1.8541 (0.2704)	6.386 (3.759, 10.848)
Esophageal disorders (CCS 138)	0.96	0.364 (0.257)	1.439 (0.87, 2.382)
Gastroduodenal ulcer (except hemorrhage) (CS 139_1)	1.65	1.7874 (0.2058)	5.974 (3.991, 8.942)
Gastroduodenal ulcer (except	0.10	1.2149 (0.3677)	3.37 (1.639, 6.928)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
hemorrhage) (CS 139_2)			
Gastritis and duodenitis (CCS 140)	0.03	0.6258 (0.6497)	1.87 (0.523, 6.681)
Other disorders of stomach and duodenum (CCS 141)	0.47	0.9598 (0.2393)	2.611 (1.634, 4.174)
Appendicitis and other appendiceal conditions (CCS 142)	5.01	-0.3626 (0.222)	0.696 (0.45, 1.075)
Abdominal hernia (CCS 143)	16.08	0.3617 (0.2016)	1.436 (0.967, 2.132)
Regional enteritis and ulcerative colitis (CCS 144)	0.43	0.7034 (0.276)	2.021 (1.176, 3.471)
Intestinal obstruction without hernia (CCS 145)	8.85	1.0298 (0.2012)	2.801 (1.888, 4.154)
Diverticulosis and diverticulitis (CCS 146)	5.18	0.6834 (0.2062)	1.981 (1.322, 2.967)
Anal and rectal conditions (CCS 147)	2.03	-0.1531 (0.2343)	0.858 (0.542, 1.358)
Peritonitis and intestinal abscess (CCS 148_1)	0.06	1.626 (0.3308)	5.084 (2.659, 9.721)
Peritonitis and intestinal abscess (CCS 148_2)	0.19	1.1449 (0.2878)	3.142 (1.788, 5.523)
Biliary tract disease (CCS 149)	20.30	-0.2898 (0.2027)	0.748 (0.503, 1.114)
Other liver diseases (CCS 151_1)	0.11	0.8507 (0.3179)	2.341 (1.256, 4.366)
Other liver diseases (CCS 151_2)	0.15	0.8346 (0.3566)	2.304 (1.145, 4.634)
Pancreatic disorders (not diabetes) (CCS 152)	2.70	-0.1114 (0.2231)	0.895 (0.578, 1.385)
Gastrointestinal hemorrhage (CCS 153)	0.71	1.6254 (0.2142)	5.081 (3.339, 7.731)
Noninfectious gastroenteritis (CCS 154)	0.09	1.3535 (0.3461)	3.871 (1.964, 7.628)
Other gastrointestinal disorders (CCS 155)	3.69	0.1247 (0.2113)	1.133 (0.749, 1.714)
Acute and unspecified renal failure (CCS 157)	0.31	1.4101 (0.2316)	4.097 (2.602, 6.45)
Chronic kidney disease (CCS 158)	0.12	-0.0453 (0.4971)	0.956 (0.361, 2.532)
Urinary tract infections (CCS 159)	0.13	1.7082 (0.2723)	5.519 (3.236, 9.412)
Other diseases of kidney and ureters (CCS 161)	0.14	-0.1561 (0.5487)	0.855 (0.292, 2.508)
Other diseases of bladder and urethra (CCS 162)	0.45	0.2343 (0.2979)	1.264 (0.705, 2.266)
Hyperplasia of prostate (CCS 164)	0.07	--	--
Nonmalignant breast conditions (CCS 167)	0.09	--	--
Inflammatory diseases of female	0.06	-0.6661 (1.031)	0.514 (0.068, 3.876)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
pelvic organs (CCS 168)			
Prolapse of female genital organs (CCS 170)	0.50	-0.7047 (0.4932)	0.494 (0.188, 1.3)
Ovarian cyst (CCS 172)	0.12	-0.0152 (0.6182)	0.985 (0.293, 3.308)
Menopausal disorders (CCS 173)	0.02	--	--
Other female genital disorders (CCS 175)	0.50	0.3805 (0.2934)	1.463 (0.823, 2.6)
Skin and subcutaneous tissue infections (CCS 197)	0.20	0.4967 (0.3395)	1.643 (0.845, 3.196)
Chronic ulcer of skin (CCS 199)	0.07	1.6695 (0.3309)	5.31 (2.776, 10.155)
Spondylosis; intervertebral disc disorders; other back problems (CCS 205)	2.95	-1.0933 (0.296)	0.335 (0.188, 0.599)
Other acquired deformities (CCS 209)	0.66	-2.4707 (0.7323)	0.085 (0.02, 0.355)
Other connective tissue disease (CCS 211)	0.03	0.5813 (0.7693)	1.788 (0.396, 8.077)
Other bone disease and musculoskeletal deformities (CCS 212)	0.09	-0.7063 (1.0197)	0.493 (0.067, 3.641)
Digestive congenital anomalies (CCS 214)	0.12	0.4276 (0.4694)	1.534 (0.611, 3.849)
Other congenital anomalies (CCS 217)	0.22	--	--
Other fractures (CCS 231)	0.10	2.4721 (0.2667)	11.848 (7.025, 19.983)
Complication of device; implant or graft (CCS 237)	2.09	0.8723 (0.2096)	2.392 (1.586, 3.608)
Complications of surgical procedures or medical care (CCS 238)	2.92	0.713 (0.2087)	2.04 (1.355, 3.071)
Other injuries and conditions due to external causes (CCS 244_2)	0.12	1.0645 (0.3613)	2.899 (1.428, 5.886)
Lymphadenitis (CCS 247)	0.13	0.2163 (0.4683)	1.241 (0.496, 3.109)
Abdominal pain (CCS 251)	0.11	1.3957 (0.3313)	4.038 (2.109, 7.73)
Residual codes; unclassified (CCS 259)	0.06	-0.175 (0.7547)	0.839 (0.191, 3.685)
Other Infectious Diseases (CC 7)	9.62	-0.2155 (0.0334)	0.806 (0.755, 0.861)
Metastatic & Severe Cancers (CC 8,9)	2.22	0.501 (0.0545)	1.65 (1.483, 1.837)
Protein-Calorie Malnutrition (CC 21)	10.86	0.426 (0.0273)	1.531 (1.451, 1.615)
Disorders of	28.73	0.258 (0.0261)	1.294 (1.23, 1.362)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Fluid/Electrolyte/Acid-Base Balance (CC 24)			
Disorders of Lipoid Metabolism (CC 25)	49.06	-0.1505 (0.0239)	0.86 (0.821, 0.901)
Liver Failure (CC 27, 30)	1.39	0.8863 (0.0606)	2.426 (2.154, 2.732)
Other GI Disorders (CC 34-38)	59.75	-0.2199 (0.0244)	0.803 (0.765, 0.842)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	29.95	-0.1031 (0.0252)	0.902 (0.859, 0.948)
Hematologic or Immunity Disorders (CC 46-48)	7.09	0.2365 (0.0336)	1.267 (1.186, 1.353)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	7.49	0.2311 (0.0324)	1.26 (1.182, 1.343)
CC 80	0.23	0.6302 (0.1298)	1.878 (1.456, 2.422)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	6.74	0.5057 (0.033)	1.658 (1.554, 1.769)
Congestive Heart Failure (CC 85)	14.58	0.4505 (0.0267)	1.569 (1.489, 1.654)
Hypertension and Hypertensive Heart Disease (CC 94,95)	63.81	-0.1995 (0.0249)	0.819 (0.78, 0.86)
Pneumonia (CC 114-116)	8.78	0.3968 (0.0297)	1.487 (1.403, 1.576)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	4.10	0.358 (0.045)	1.43 (1.31, 1.562)
Acute or Unspecified Renal Failure (CC 135,140)	13.97	0.3869 (0.0273)	1.472 (1.396, 1.553)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	3.30	-0.0434 (0.0487)	0.958 (0.87, 1.053)
Minor Symptoms, Signs, Findings (CC 179)	33.28	0.7055 (0.0247)	2.025 (1.929, 2.125)

Table 30. Surgical Cancer Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	74.5 (6.8)	0.057 (0.0033)	1.059 (1.052, 1.065)
Cancer of head and neck (CCS 11)	2.95	-0.2378 (0.1862)	0.788 (0.547, 1.136)
Cancer of esophagus (CCS 12)	0.71	0.4735 (0.2268)	1.606 (1.029, 2.504)
Cancer of stomach (CCS 13)	1.75	0.5556 (0.1675)	1.743 (1.255, 2.42)
Cancer of colon (CCS 14)	17.12	0.0984 (0.1275)	1.103 (0.859, 1.417)
Cancer of rectum and anus (CCS 15)	4.48	0.001 (0.154)	1.001 (0.74, 1.354)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Cancer of liver and intrahepatic bile duct (CCS 16)	0.98	0.5946 (0.2091)	1.812 (1.203, 2.731)
Cancer of pancreas (CCS 17)	1.56	0.5056 (0.1782)	1.658 (1.169, 2.351)
Cancer of other GI organs; peritoneum (CCS 18)	1.64	0.5743 (0.1742)	1.776 (1.262, 2.499)
Cancer of bronchus; lung (CCS 19)	13.40	0.1525 (0.1331)	1.165 (0.897, 1.512)
Cancer; other respiratory and intrathoracic (CCS 20)	0.16	0.3797 (0.4325)	1.462 (0.626, 3.412)
Cancer of bone and connective tissue (CCS 21)	1.46	-0.5075 (0.2609)	0.602 (0.361, 1.004)
Melanomas of skin (CCS 22)	0.36	-0.8132 (0.5341)	0.443 (0.156, 1.263)
Other non-epithelial cancer of skin (CCS 23)	1.07	-1.4245 (0.3624)	0.241 (0.118, 0.49)
Cancer of breast (CCS 24)	5.76	-1.6306 (0.2442)	0.196 (0.121, 0.316)
Cancer of uterus (CCS 25)	4.59	-0.9058 (0.2153)	0.404 (0.265, 0.616)
Cancer of cervix (CCS 26)	0.32	-0.0656 (0.4747)	0.936 (0.369, 2.374)
Cancer of ovary (CCS 27)	1.34	-0.523 (0.2762)	0.593 (0.345, 1.018)
Cancer of other female genital organs (CCS 28)	0.95	-1.85 (0.5574)	0.157 (0.053, 0.469)
Cancer of prostate (CCS 29)	13.17	-1.5469 (0.2134)	0.213 (0.14, 0.323)
Cancer of other male genital organs (CCS 31)	0.12	-1.2467 (1.0226)	0.287 (0.039, 2.133)
Cancer of bladder (CCS 32)	6.44	0.0451 (0.1392)	1.046 (0.796, 1.374)
Cancer of kidney and renal pelvis (CCS 33)	8.80	-0.5606 (0.1578)	0.571 (0.419, 0.778)
Cancer of other urinary organs (CCS 34)	1.07	-0.5265 (0.2844)	0.591 (0.338, 1.031)
Cancer of brain and nervous system (CCS 35)	2.17	0.8362 (0.1878)	2.308 (1.597, 3.335)
Cancer of thyroid (CCS 36)	0.91	-0.5093 (0.3602)	0.601 (0.297, 1.217)
Non-Hodgkin's lymphoma (CCS 38)	2.05	1.2365 (0.1417)	3.443 (2.608, 4.546)
Leukemias (CCS 39)	0.19	1.71 (0.2453)	5.529 (3.418, 8.942)
Multiple myeloma (CCS 40)	0.26	0.9992 (0.2822)	2.716 (1.562, 4.723)
Cancer; other and unspecified primary (CCS 41)	0.42	-0.6736 (0.4765)	0.51 (0.2, 1.297)
Malignant neoplasm without specification of site (CCS 43)	0.26	0.4205 (0.3631)	1.523 (0.747, 3.103)
Neoplasms of unspecified nature or uncertain behavior (CCS 44)	3.54	Reference	Reference
Other Infectious Diseases (CC 7)	4.27	-0.1896 (0.0836)	0.827 (0.702, 0.975)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Metastatic & Severe Cancers (CC 8,9)	4.45	0.0545 (0.0853)	1.056 (0.893, 1.248)
Protein-Calorie Malnutrition (CC 21)	6.01	0.734 (0.0592)	2.083 (1.855, 2.34)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	12.98	0.264 (0.0563)	1.302 (1.166, 1.454)
Disorders of Lipoid Metabolism (CC 25)	47.71	-0.152 (0.0463)	0.859 (0.784, 0.94)
Liver Failure (CC 27, 30)	0.60	0.9428 (0.1536)	2.567 (1.9, 3.469)
Other GI Disorders (CC 34-38)	43.74	-0.2144 (0.0469)	0.807 (0.736, 0.885)
Other Musculoskeletal and Connective Tissue Disorders (CC 44,45)	24.32	-0.1507 (0.0516)	0.86 (0.777, 0.952)
Hematologic or Immunity Disorders (CC 46-48)	4.93	0.44 (0.0701)	1.553 (1.353, 1.781)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	4.52	0.3598 (0.0726)	1.433 (1.243, 1.652)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	1.63	0.121 (0.1686)	1.129 (0.811, 1.571)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	3.09	0.3146 (0.0835)	1.37 (1.163, 1.613)
Congestive Heart Failure (CC 85)	9.13	0.4995 (0.0579)	1.648 (1.471, 1.846)
Hypertension and Hypertensive Heart Disease (CC 94,95)	61.91	-0.196 (0.0472)	0.822 (0.749, 0.902)
Pneumonia (CC 114-116)	5.70	0.8358 (0.0623)	2.307 (2.042, 2.606)
Dialysis or Severe Chronic Kidney Disease (CC 134,136,137)	1.86	0.6639 (0.1024)	1.942 (1.589, 2.374)
Acute or Unspecified Renal Failure (CC 135,140)	6.29	0.2992 (0.0666)	1.349 (1.184, 1.537)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	2.36	-0.2582 (0.1095)	0.772 (0.623, 0.957)
Minor Symptoms, Signs, Findings (CC 179)	28.27	0.7035 (0.0478)	2.021 (1.84, 2.219)

Table 31. Neurosurgery Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	74.5 (6.5)	0.0405 (0.004)	1.041 (1.033, 1.049)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Septicemia (except in labor) (CCS 2)	0.69	2.186 (0.2911)	8.9 (5.031, 15.745)
Other and unspecified benign neoplasm (CCS 47)	10.41	-0.1084 (0.2628)	0.897 (0.536, 1.502)
Other CNS infection and poliomyelitis (CCS 78)	0.68	1.6035 (0.3311)	4.971 (2.598, 9.511)
Parkinson`s disease (CCS 79)	4.09	-0.81 (0.4658)	0.445 (0.179, 1.109)
Other hereditary and degenerative nervous system conditions (CCS 81)	11.46	-0.5048 (0.2667)	0.604 (0.358, 1.018)
Other nervous system disorders (CCS 95_2)	5.11	Reference	Reference
Acute cerebrovascular disease (CCS 109_1)	22.23	2.0529 (0.2236)	7.791 (5.026, 12.077)
Acute cerebrovascular disease (CCS 109_2)	1.25	3.2405 (0.2514)	25.546 (15.606, 41.817)
Other and ill-defined cerebrovascular disease (CCS 111)	0.41	1.5169 (0.4126)	4.558 (2.03, 10.233)
Spondylosis; intervertebral disc disorders; other back problems (CCS 205)	22.95	-0.7006 (0.2677)	0.496 (0.294, 0.839)
Pathological fracture (CCS 207)	0.74	0.1837 (0.5151)	1.202 (0.438, 3.298)
Other acquired deformities (CCS 209)	3.65	-1.562 (0.5023)	0.21 (0.078, 0.561)
Other connective tissue disease (CCS 211)	0.53	-0.6856 (1.0202)	0.504 (0.068, 3.721)
Other bone disease and musculoskeletal deformities (CCS 212)	0.97	-0.3495 (0.6264)	0.705 (0.207, 2.407)
Nervous system congenital anomalies (CCS 216)	0.36	--	--
Other congenital anomalies (CCS 217)	0.65	-0.8458 (1.0167)	0.429 (0.059, 3.148)
Fracture of upper limb (CCS 229)	1.11	0.274 (0.4267)	1.315 (0.57, 3.035)
Other fractures (CCS 231)	6.18	0.9862 (0.2441)	2.681 (1.662, 4.326)
Complication of device; implant or graft (CCS 237)	3.87	-0.2188 (0.3183)	0.804 (0.431, 1.499)
Complications of surgical procedures or medical care (CCS 238)	2.66	0.3001 (0.309)	1.35 (0.737, 2.473)
Other Infectious Diseases (CC 7)	6.98	-0.4414 (0.0985)	0.643 (0.53, 0.78)
Metastatic & Severe Cancers (CC 8, 9)	1.18	0.1788 (0.2069)	1.196 (0.797, 1.794)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Protein-Calorie Malnutrition (CC 21)	4.51	-0.2231 (0.0929)	0.8 (0.667, 0.96)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	17.43	0.0996 (0.0625)	1.105 (0.977, 1.249)
Disorders of Lipoid Metabolism (CC 25)	49.13	-0.2096 (0.0558)	0.811 (0.727, 0.905)
Liver Failure (CC 27, 30)	0.38	0.4563 (0.2767)	1.578 (0.917, 2.715)
Other GI Disorders (CC 34, 35, 37, 38)	41.06	-0.4162 (0.0594)	0.66 (0.587, 0.741)
Other Musculoskeletal and Connective Tissue Disorders (CC 44, 45)	35.11	-0.332 (0.0621)	0.717 (0.635, 0.81)
Hematologic or Immunity Disorders (CC 46-48)	5.80	0.4107 (0.0844)	1.508 (1.278, 1.779)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	25.61	0.5723 (0.0565)	1.772 (1.587, 1.98)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	15.33	0.464 (0.0604)	1.59 (1.413, 1.79)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	9.05	1.238 (0.0655)	3.449 (3.033, 3.921)
Congestive Heart Failure (CC 85)	9.00	0.3707 (0.0744)	1.449 (1.252, 1.676)
Hypertension and Hypertensive Heart Disease (CC 94, 95)	68.04	-0.0544 (0.063)	0.947 (0.837, 1.071)
Pneumonia (CC 114-116)	6.70	-0.0024 (0.0802)	0.998 (0.852, 1.167)
Dialysis or Severe Chronic Kidney Disease (CC 134, 136, 137)	1.50	0.504 (0.1539)	1.655 (1.224, 2.238)
Acute or Unspecified Renal Failure (CC 135, 140)	5.63	0.2078 (0.0906)	1.231 (1.031, 1.47)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	2.94	-0.1548 (0.1397)	0.857 (0.651, 1.126)
Minor Symptoms, Signs, Findings (CC 179)	35.33	1.0942 (0.0582)	2.987 (2.665, 3.348)

Table 32. Surgical Orthopedic Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	75.6 (7.3)	0.058 (0.0015)	1.06 (1.057, 1.063)
Septicemia (except in labor) (CCS)	0.66	0.7802 (0.4614)	2.182 (0.883, 5.39)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
2)			
Diabetes mellitus with complications (CCS 50)	1.29	-0.2811 (0.4628)	0.755 (0.305, 1.87)
Gout and other crystal arthropathies (CCS 54)	0.03	-1.9467 (1.089)	0.143 (0.017, 1.206)
Fluid and electrolyte disorders (CCS 55)	0.03	-0.9066 (0.6051)	0.404 (0.123, 1.322)
Other CNS infection and poliomyelitis (CCS 78)	0.02	-0.0524 (0.6308)	0.949 (0.276, 3.267)
Other hereditary and degenerative nervous system conditions (CCS 81)	0.07	-0.7243 (0.5749)	0.485 (0.157, 1.496)
Other nervous system disorders (CCS 95_1)	0.01	Reference	Reference
Other nervous system disorders (CCS 95_2)	0.04	--	--
Acute myocardial infarction (CCS 100)	0.03	0.5597 (0.5096)	1.75 (0.645, 4.751)
Cardiac dysrhythmias (CCS 106)	0.07	0.0161 (0.5024)	1.016 (0.38, 2.721)
Congestive heart failure; nonhypertensive (CCS 108)	0.04	0.1837 (0.4926)	1.202 (0.458, 3.155)
Acute cerebrovascular disease (CCS 109_2)	0.04	1.3221 (0.4883)	3.751 (1.44, 9.77)
Peripheral and visceral atherosclerosis (CCS 114)	0.18	0.1035 (0.4727)	1.109 (0.439, 2.801)
Aortic and peripheral arterial embolism or thrombosis (CCS 116)	0.03	0.9517 (0.5078)	2.59 (0.957, 7.008)
Other circulatory disease (CCS 117_2)	0.03	0.4142 (0.5339)	1.513 (0.531, 4.309)
Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122)	0.04	0.3702 (0.4958)	1.448 (0.548, 3.826)
Chronic obstructive pulmonary disease and bronchiectasis (CCS 127)	0.03	0.4065 (0.5263)	1.501 (0.535, 4.212)
Respiratory failure; insufficiency; arrest (adult) (CCS 131)	0.04	1.2734 (0.4885)	3.573 (1.371, 9.308)
Gastrointestinal hemorrhage (CCS 153)	0.02	0.4412 (0.5474)	1.555 (0.532, 4.545)
Acute and unspecified renal failure (CCS 157)	0.05	-0.0522 (0.5033)	0.949 (0.354, 2.545)
Urinary tract infections (CCS 159)	0.04	-0.6818 (0.5459)	0.506 (0.173, 1.474)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Skin and subcutaneous tissue infections (CCS 197)	0.11	-0.3841 (0.5113)	0.681 (0.25, 1.855)
Chronic ulcer of skin (CCS 199)	0.10	-0.1615 (0.4882)	0.851 (0.327, 2.215)
Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease) (CCS 201)	0.71	-0.5355 (0.4684)	0.585 (0.234, 1.466)
Rheumatoid arthritis and related disease (CCS 202)	0.13	-1.419 (0.6765)	0.242 (0.064, 0.911)
Osteoarthritis (CCS 203)	47.52	-2.4592 (0.4616)	0.086 (0.035, 0.211)
Other non-traumatic joint disorders (CCS 204)	0.73	-1.9833 (0.5344)	0.138 (0.048, 0.392)
Spondylosis; intervertebral disc disorders; other back problems (CCS 205)	11.07	-1.5085 (0.463)	0.221 (0.089, 0.548)
Pathological fracture (CCS 207)	1.19	-0.4057 (0.4629)	0.666 (0.269, 1.651)
Acquired foot deformities (CCS 208)	0.03	-1.3693 (1.0914)	0.254 (0.03, 2.159)
Other acquired deformities (CCS 209)	1.38	-1.6602 (0.4922)	0.19 (0.072, 0.499)
Other connective tissue disease (CCS 211)	0.37	-1.1601 (0.5175)	0.313 (0.114, 0.864)
Other bone disease and musculoskeletal deformities (CCS 212)	1.05	-1.2572 (0.4788)	0.284 (0.111, 0.727)
Other congenital anomalies (CCS 217)	0.39	-1.2982 (0.5426)	0.273 (0.094, 0.791)
Joint disorders and dislocations; trauma-related (CCS 225)	0.39	-0.7915 (0.4886)	0.453 (0.174, 1.181)
Fracture of neck of femur (hip) (CCS 226)	17.34	-0.2176 (0.4593)	0.804 (0.327, 1.979)
Skull and face fractures (CCS 228)	0.01	-0.1051 (0.7647)	0.9 (0.201, 4.03)
Fracture of upper limb (CCS 229)	2.42	-0.9728 (0.4637)	0.378 (0.152, 0.938)
Fracture of lower limb (CCS 230)	4.10	-0.3669 (0.4606)	0.693 (0.281, 1.709)
Other fractures (CCS 231)	1.10	-0.445 (0.4637)	0.641 (0.258, 1.59)
Sprains and strains (CCS 232)	0.11	--	--
Open wounds of extremities (CCS 236)	0.03	0.6317 (0.5617)	1.881 (0.625, 5.656)
Complication of device; implant or graft (CCS 237)	5.87	-0.9533 (0.4616)	0.385 (0.156, 0.953)
Complications of surgical procedures or medical care (CCS 238)	0.47	-0.0948 (0.469)	0.91 (0.363, 2.281)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other injuries and conditions due to external causes (CCS 244_2)	0.01	0.3974 (0.7767)	1.488 (0.325, 6.819)
Syncope (CCS 245)	0.03	-1.6975 (0.8617)	0.183 (0.034, 0.991)
Gangrene (CCS 248)	0.46	0.1942 (0.4637)	1.214 (0.489, 3.013)
Other aftercare (CCS 257)	0.08	-2.0305 (0.8251)	0.131 (0.026, 0.661)
Other Infectious Diseases (CC 7)	6.73	-0.2057 (0.0291)	0.814 (0.769, 0.862)
Metastatic & Severe Cancers (CC 8, 9)	0.72	0.6665 (0.064)	1.947 (1.718, 2.207)
Protein-Calorie Malnutrition (CC 21)	2.88	0.6887 (0.0283)	1.991 (1.884, 2.105)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	13.63	0.0924 (0.0236)	1.097 (1.047, 1.149)
Disorders of Lipoid Metabolism (CC 25)	50.63	-0.1373 (0.0207)	0.872 (0.837, 0.908)
Liver Failure (CC 27, 30)	0.26	0.8006 (0.0892)	2.227 (1.87, 2.652)
Other GI Disorders (CC 34, 35, 37, 38)	41.94	-0.1496 (0.0209)	0.861 (0.826, 0.897)
Other Musculoskeletal and Connective Tissue Disorders (CC 44, 45)	32.47	-0.1756 (0.0215)	0.839 (0.804, 0.875)
Hematologic or Immunity Disorders (CC 46-48)	4.40	0.1681 (0.0324)	1.183 (1.11, 1.261)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	9.52	0.6594 (0.0219)	1.934 (1.852, 2.018)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.11	0.2771 (0.1408)	1.319 (1.001, 1.739)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	2.78	0.1537 (0.0358)	1.166 (1.087, 1.251)
Congestive Heart Failure (CC 85)	9.97	0.7087 (0.0228)	2.031 (1.942, 2.124)
Hypertension and Hypertensive Heart Disease (CC 94, 95)	66.42	-0.2729 (0.0215)	0.761 (0.73, 0.794)
Pneumonia (CC 114-116)	3.67	0.5883 (0.0289)	1.801 (1.702, 1.906)
Dialysis or Severe Chronic Kidney Disease (CC 134, 136, 137)	2.03	0.7435 (0.0362)	2.103 (1.959, 2.258)
Acute or Unspecified Renal Failure (135, 140)	5.18	0.1665 (0.0284)	1.181 (1.117, 1.249)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	2.11	-0.2872 (0.0481)	0.75 (0.683, 0.825)
Minor Symptoms, Signs, Findings (CC 179)	25.65	0.6806 (0.0217)	1.975 (1.893, 2.061)

Table 33. Non-Surgical Mixed Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	77.7 (7.9)	0.0477 (0.001)	1.049 (1.047, 1.051)
Other and unspecified benign neoplasm (CCS 47)	0.70	0.6516 (0.3541)	1.919 (0.958, 3.841)
Thyroid disorders (CCS 48)	0.43	0.8553 (0.3553)	2.352 (1.172, 4.719)
Diabetes mellitus without complication (CCS 49)	0.21	0.5411 (0.3844)	1.718 (0.809, 3.649)
Diabetes mellitus with complications (CCS 50)	8.04	0.7061 (0.3425)	2.026 (1.035, 3.964)
Other endocrine disorders (CCS 51)	2.26	0.7002 (0.3448)	2.014 (1.025, 3.959)
Nutritional deficiencies (CCS 52)	0.92	1.6879 (0.3444)	5.408 (2.754, 10.622)
Gout and other crystal arthropathies (CCS 54)	0.78	-0.3788 (0.3712)	0.685 (0.331, 1.417)
Other nutritional; endocrine; and metabolic disorders (CCS 58_1)	0.71	1.5012 (0.3461)	4.487 (2.277, 8.843)
Other nutritional; endocrine; and metabolic disorders (CCS 58_2)	0.57	0.3871 (0.3602)	1.473 (0.727, 2.984)
Deficiency and other anemia (CCS 59)	7.66	0.8581 (0.3422)	2.359 (1.206, 4.613)
Acute post-hemorrhagic anemia (CCS 60)	2.04	0.7076 (0.3447)	2.029 (1.032, 3.988)
Sickle cell anemia (CCS 61)	0.03	-0.2244 (0.704)	0.799 (0.201, 3.176)
Coagulation and hemorrhagic disorders (CCS 62)	0.72	1.507 (0.3472)	4.513 (2.285, 8.913)
Diseases of white blood cells (CCS 63)	1.26	1.0079 (0.3456)	2.74 (1.392, 5.393)
Other hematologic conditions (CCS 64)	0.09	1.0826 (0.4072)	2.952 (1.329, 6.559)
Headache; including migraine (CCS 84)	0.77	-0.366 (0.387)	0.693 (0.325, 1.481)
Retinal detachments; defects; vascular occlusion; and retinopathy (CCS 87)	0.15	-0.3372 (0.539)	0.714 (0.248, 2.053)
Blindness and vision defects (CCS 89)	0.23	-0.826 (0.5087)	0.438 (0.162, 1.187)
Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease) (CCS 90)	0.27	0.2351 (0.3937)	1.265 (0.585, 2.737)
Other eye disorders (CCS 91)	0.19	-0.5308 (0.497)	0.588 (0.222, 1.558)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Otitis media and related conditions (CCS 92)	0.11	0.117 (0.4716)	1.124 (0.446, 2.833)
Conditions associated with dizziness or vertigo (CCS 93)	3.16	-1.2714 (0.3677)	0.28 (0.136, 0.577)
Other ear and sense organ disorders (CCS 94)	0.12	Reference	Reference
Peripheral and visceral atherosclerosis (CCS 114)	4.83	1.3628 (0.3427)	3.907 (1.996, 7.648)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_1)	0.12	5.5934 (0.3629)	268.65 (131.92, 547.096)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_2)	0.35	3.2421 (0.3469)	25.588 (12.965, 50.502)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_3)	0.82	1.6431 (0.3482)	5.171 (2.613, 10.231)
Aortic and peripheral arterial embolism or thrombosis (CCS 116)	0.66	1.8735 (0.3469)	6.511 (3.299, 12.851)
Other circulatory disease (CCS 117_1)	1.52	1.2065 (0.3442)	3.342 (1.702, 6.561)
Other circulatory disease (CCS 117_2)	4.11	0.2106 (0.3445)	1.234 (0.628, 2.425)
Phlebitis; thrombophlebitis and thromboembolism (CCS 118)	5.69	0.5089 (0.3432)	1.663 (0.849, 3.259)
Varicose veins of lower extremity (CCS 119)	0.07	-0.1252 (0.5395)	0.882 (0.307, 2.54)
Other diseases of veins and lymphatics (CCS 121)	0.70	0.5201 (0.3553)	1.682 (0.838, 3.375)
Acute and chronic tonsillitis (CCS 124)	0.04	0.0044 (0.7915)	1.004 (0.213, 4.739)
Other upper respiratory disease (CCS 134)	0.92	0.7793 (0.3495)	2.18 (1.099, 4.325)
Disorders of teeth and jaw (CCS 136)	0.22	0.3356 (0.3994)	1.399 (0.639, 3.06)
Diseases of mouth; excluding dental (CCS 137)	0.46	0.7723 (0.3571)	2.165 (1.075, 4.358)
Calculus of urinary tract (CCS 160)	2.02	-0.3447 (0.36)	0.708 (0.35, 1.435)
Other diseases of bladder and urethra (CCS 162)	0.36	0.813 (0.3628)	2.255 (1.107, 4.591)
Genitourinary symptoms and ill-defined conditions (CCS 163)	1.28	0.5874 (0.3482)	1.799 (0.909, 3.56)
Hyperplasia of prostate (CCS 164)	0.47	0.2486 (0.3675)	1.282 (0.624, 2.635)
Inflammatory conditions of male genital organs (CCS 165)	0.66	0.0047 (0.3745)	1.005 (0.482, 2.093)
Other male genital disorders (CCS 166)	0.08	0.6775 (0.4377)	1.969 (0.835, 4.643)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
166)			
Nonmalignant breast conditions (CCS 167)	0.14	0.1808 (0.4706)	1.198 (0.476, 3.014)
Inflammatory diseases of female pelvic organs (CCS 168)	0.09	0.8583 (0.4286)	2.359 (1.018, 5.465)
Prolapse of female genital organs (CCS 170)	0.01	0.8083 (0.8298)	2.244 (0.441, 11.412)
Menopausal disorders (CCS 173)	0.08	0.3334 (0.4633)	1.396 (0.563, 3.461)
Other female genital disorders (CCS 175)	0.11	0.7491 (0.4068)	2.115 (0.953, 4.695)
Other inflammatory condition of skin (CCS 198)	0.25	1.2567 (0.3631)	3.514 (1.725, 7.159)
Chronic ulcer of skin (CCS 199)	1.10	1.2549 (0.3454)	3.508 (1.782, 6.902)
Other skin disorders (CCS 200)	0.13	0.2687 (0.4396)	1.308 (0.553, 3.097)
Rheumatoid arthritis and related disease (CCS 202)	0.28	0.4272 (0.3871)	1.533 (0.718, 3.274)
Systemic lupus erythematosus and connective tissue disorders (CCS 210)	0.12	1.6597 (0.3758)	5.258 (2.517, 10.983)
Other connective tissue disease (CCS 211)	4.42	0.4219 (0.3438)	1.525 (0.777, 2.991)
Genitourinary congenital anomalies (CCS 215)	0.03	0.5195 (0.6822)	1.681 (0.442, 6.401)
Other congenital anomalies (CCS 217)	0.03	0.8989 (0.6311)	2.457 (0.713, 8.464)
Complication of device; implant or graft (CCS 237)	10.98	1.0304 (0.3419)	2.802 (1.434, 5.477)
Complications of surgical procedures or medical care (CCS 238)	8.75	0.5867 (0.3425)	1.798 (0.919, 3.518)
Poisoning by psychotropic agents (CCS 241)	0.61	0.7341 (0.356)	2.084 (1.037, 4.187)
Poisoning by other medications and drugs (CCS 242)	1.68	0.5876 (0.3465)	1.8 (0.912, 3.549)
Poisoning by nonmedicinal substances (CCS 243)	0.22	1.0394 (0.3752)	2.827 (1.355, 5.899)
Lymphadenitis (CCS 247)	0.05	0.9727 (0.465)	2.645 (1.063, 6.58)
Gangrene (CCS 248)	0.35	2.2038 (0.3483)	9.059 (4.577, 17.931)
Malaise and fatigue (CCS 252)	1.42	0.6348 (0.3469)	1.887 (0.956, 3.723)
Allergic reactions (CCS 253)	0.52	0.0566 (0.3719)	1.058 (0.51, 2.194)
Other aftercare (CCS 257)	0.06	0.3097 (0.5217)	1.363 (0.49, 3.79)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other screening for suspected conditions (not mental disorders or infectious disease) (CCS 258)	0.04	-0.4595 (0.677)	0.632 (0.168, 2.381)
Residual codes; unclassified (CCS 259)	3.41	0.9201 (0.3432)	2.51 (1.281, 4.917)
Delirium, dementia, and amnestic and other cognitive disorders (CCS 653)	4.86	1.2095 (0.3424)	3.352 (1.713, 6.558)
Alcohol-related disorders (CCS 660_1)	0.48	2.0925 (0.3477)	8.105 (4.1, 16.021)
Alcohol-related disorders (CCS 660_2)	1.63	0.2734 (0.351)	1.314 (0.661, 2.615)
Substance-related disorders (CCS 661)	1.33	0.5075 (0.3488)	1.661 (0.838, 3.291)
Other Infectious Diseases (CC 7)	18.26	-0.1233 (0.0178)	0.884 (0.854, 0.915)
Metastatic & Severe Cancers (CC 8, 9)	4.21	0.973 (0.0257)	2.646 (2.516, 2.783)
Protein-Calorie Malnutrition (CC 21)	9.11	0.6087 (0.0183)	1.838 (1.773, 1.905)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	42.70	0.3188 (0.0161)	1.375 (1.333, 1.419)
Disorders of Lipoid Metabolism (CC 25)	54.63	-0.2404 (0.0147)	0.786 (0.764, 0.809)
Liver Failure (CC 27, 30)	1.83	0.753 (0.0396)	2.123 (1.965, 2.295)
Other GI Disorders (CC 34, 35, 37, 38)	48.32	-0.2202 (0.0149)	0.802 (0.779, 0.826)
Other Musculoskeletal and Connective Tissue Disorders (CC 44, 45)	37.25	-0.1605 (0.015)	0.852 (0.827, 0.877)
Hematologic or Immunity Disorders (CC 46-48)	12.56	0.2841 (0.0186)	1.329 (1.281, 1.378)
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	21.58	0.3733 (0.0162)	1.453 (1.407, 1.499)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.73	1.0844 (0.0508)	2.958 (2.678, 3.267)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	9.76	0.4632 (0.0202)	1.589 (1.528, 1.653)
Congestive Heart Failure (CC 85)	25.16	0.3658 (0.0158)	1.442 (1.398, 1.487)
Hypertension and Hypertensive Heart Disease (CC 94, 95)	62.46	-0.2881 (0.0155)	0.75 (0.727, 0.773)
Pneumonia (CC 114-116)	11.32	0.4335 (0.0186)	1.543 (1.488, 1.6)

Risk Variable Name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Dialysis or Severe Chronic Kidney Disease (CC 134, 136, 137)	8.52	0.3607 (0.0223)	1.434 (1.373, 1.498)
Acute or Unspecified Renal Failure (135, 140)	23.36	0.2324 (0.0162)	1.262 (1.222, 1.302)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	7.74	-0.0714 (0.0235)	0.931 (0.889, 0.975)
Minor Symptoms, Signs, Findings (CC 179)	46.94	0.6821 (0.0162)	1.978 (1.916, 2.042)

Table 34. Surgical Mixed Division Hierarchical Logistic Regression Model Risk Factor Frequencies and Odds Ratios, Split Sample Dataset, Sample 1 (July 1, 2013 – June 30, 2015)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Age: mean (standard deviation)	75.3 (6.9)	0.0501 (0.002)	1.051 (1.047, 1.056)
Septicemia (except in labor) (CCS 2)	3.89	0.9908 (0.2821)	2.694 (1.55, 4.683)
Benign neoplasm of uterus (CCS 46)	0.35	-2.1359 (0.9765)	0.118 (0.017, 0.801)
Other and unspecified benign neoplasm (CCS 47)	2.43	-1.3126 (0.3529)	0.269 (0.135, 0.537)
Thyroid disorders (CCS 48)	0.82	-1.4804 (0.4998)	0.227 (0.085, 0.606)
Diabetes mellitus with complications (CCS 50)	1.21	0.0889 (0.3025)	1.093 (0.604, 1.978)
Other endocrine disorders (CCS 51)	0.39	-0.9488 (0.4991)	0.387 (0.146, 1.03)
Fluid and electrolyte disorders (CCS 55)	0.15	0.2427 (0.3833)	1.275 (0.601, 2.702)
Other nutritional; endocrine; and metabolic disorders (CCS 58_2)	0.06	-0.3626 (0.7898)	0.696 (0.148, 3.272)
Deficiency and other anemia (CCS 59)	0.07	0.4208 (0.4459)	1.523 (0.636, 3.65)
Acute post-hemorrhagic anemia (CCS 60)	0.03	0.5136 (0.6115)	1.671 (0.504, 5.541)
Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease) (CCS 90)	0.08	0.4075 (0.5105)	1.503 (0.553, 4.088)
Other eye disorders (CCS 91)	0.06	0.014 (0.5964)	1.014 (0.315, 3.264)
Otitis media and related conditions (CCS 92)	0.06	-0.6252 (0.7827)	0.535 (0.115, 2.482)
Other ear and sense organ disorders (CCS 94)	0.06	-1.0684 (1.05)	0.344 (0.044, 2.69)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Other nervous system disorders (CCS 95_1)	0.03	0.4498 (0.5681)	1.568 (0.515, 4.775)
Other nervous system disorders (CCS 95_2)	0.18	-0.0831 (0.503)	0.92 (0.343, 2.467)
Heart valve disorders (CCS 96)	0.10	0.5939 (0.3968)	1.811 (0.832, 3.942)
Hypertension with complications and secondary hypertension (CCS 99)	0.16	Reference	Reference
Acute myocardial infarction (CCS 100)	0.28	1.6685 (0.3064)	5.304 (2.909, 9.671)
Coronary atherosclerosis and other heart disease (CCS 101)	0.21	0.6321 (0.3841)	1.881 (0.886, 3.995)
Pulmonary heart disease (CCS 103)	0.08	0.833 (0.415)	2.3 (1.02, 5.189)
Cardiac dysrhythmias (CCS 106)	0.33	0.6231 (0.3234)	1.865 (0.99, 3.515)
Congestive heart failure; nonhypertensive (CCS 108)	0.30	0.9476 (0.3052)	2.579 (1.418, 4.692)
Acute cerebrovascular disease (CCS 109_1)	0.30	1.5875 (0.3064)	4.891 (2.683, 8.918)
Acute cerebrovascular disease (CCS 109_2)	2.77	1.59 (0.2836)	4.903 (2.813, 8.548)
Occlusion or stenosis of precerebral arteries (CCS 110)	18.14	-0.9341 (0.287)	0.393 (0.224, 0.689)
Other and ill-defined cerebrovascular disease (CCS 111)	0.79	-0.5293 (0.3739)	0.589 (0.283, 1.226)
Transient cerebral ischemia (CCS 112)	0.16	-0.5005 (0.535)	0.606 (0.213, 1.73)
Peripheral and visceral atherosclerosis (CCS 114)	6.20	0.0637 (0.2864)	1.066 (0.608, 1.869)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_1)	0.70	2.7112 (0.2873)	15.044 (8.566, 26.421)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_2)	0.32	1.5597 (0.3129)	4.756 (2.576, 8.781)
Aortic; peripheral; and visceral artery aneurysms (CCS 115_3)	9.30	0.061 (0.2847)	1.063 (0.608, 1.857)
Aortic and peripheral arterial embolism or thrombosis (CCS 116)	1.53	1.0472 (0.2879)	2.85 (1.621, 5.011)
Other circulatory disease (CCS 117_2)	0.21	0.3324 (0.3807)	1.394 (0.661, 2.94)
Phlebitis; thrombophlebitis and thromboembolism (CCS 118)	0.12	1.1142 (0.3612)	3.047 (1.501, 6.185)
Other diseases of veins and lymphatics (CCS 121)	0.17	0.5396 (0.3821)	1.715 (0.811, 3.627)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122)	0.21	0.8004 (0.3237)	2.227 (1.181, 4.2)
Acute and chronic tonsillitis (CCS 124)	0.08	--	--
Other upper respiratory infections (CCS 126)	0.10	0.0577 (0.5875)	1.06 (0.335, 3.351)
Chronic obstructive pulmonary disease and bronchiectasis (CCS 127)	0.12	0.1238 (0.4112)	1.132 (0.506, 2.534)
Aspiration pneumonitis; food/vomitus (CCS 129)	0.07	0.9947 (0.3698)	2.704 (1.31, 5.582)
Respiratory failure; insufficiency; arrest (adult) (CCS 131)	0.24	1.0699 (0.3188)	2.914 (1.56, 5.444)
Other upper respiratory disease (CCS 134)	0.27	-0.3223 (0.4287)	0.724 (0.313, 1.678)
Disorders of teeth and jaw (CCS 136)	0.19	-0.2316 (0.48)	0.793 (0.31, 2.032)
Diseases of mouth; excluding dental (CCS 137)	0.20	-1.7867 (0.7692)	0.167 (0.037, 0.756)
Esophageal disorders (CCS 138)	0.18	-0.6331 (0.5365)	0.531 (0.186, 1.52)
Abdominal hernia (CCS 143)	0.13	-1.0718 (0.7706)	0.342 (0.076, 1.551)
Intestinal obstruction without hernia (CCS 145)	0.06	-0.3317 (0.5976)	0.718 (0.222, 2.316)
Other liver diseases (CCS 151_1)	0.11	1.2705 (0.351)	3.563 (1.791, 7.088)
Gastrointestinal hemorrhage (CCS 153)	0.11	1.4373 (0.3452)	4.209 (2.14, 8.28)
Other gastrointestinal disorders (CCS 155)	0.07	0.6552 (0.4589)	1.926 (0.783, 4.733)
Acute and unspecified renal failure (CCS 157)	0.99	0.6132 (0.2916)	1.845 (1.042, 3.268)
Urinary tract infections (CCS 159)	1.32	0.0815 (0.2974)	1.085 (0.606, 1.944)
Calculus of urinary tract (CCS 160)	4.55	-0.9416 (0.3022)	0.39 (0.216, 0.705)
Other diseases of kidney and ureters (CCS 161)	1.19	-0.3009 (0.3239)	0.74 (0.392, 1.397)
Other diseases of bladder and urethra (CCS 162)	0.82	-0.2736 (0.3286)	0.761 (0.4, 1.449)
Genitourinary symptoms and ill-defined conditions (CCS 163)	0.96	-0.4006 (0.3201)	0.67 (0.358, 1.255)
Hyperplasia of prostate (CCS 164)	4.50	-1.2116 (0.3069)	0.298 (0.163, 0.543)
Inflammatory conditions of male genital organs (CCS 165)	0.15	-1.448 (0.7668)	0.235 (0.052, 1.056)
Other male genital disorders (CCS 166)	0.35	-0.667 (0.4288)	0.513 (0.221, 1.19)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
166)			
Nonmalignant breast conditions (CCS 167)	0.12	-1.1195 (1.0411)	0.326 (0.042, 2.512)
Inflammatory diseases of female pelvic organs (CCS 168)	0.17	-0.5682 (0.5355)	0.567 (0.198, 1.618)
Prolapse of female genital organs (CCS 170)	4.53	-2.7146 (0.4352)	0.066 (0.028, 0.155)
Ovarian cyst (CCS 172)	0.22	-1.2531 (0.7635)	0.286 (0.064, 1.275)
Menopausal disorders (CCS 173)	0.22	-0.2493 (0.5011)	0.779 (0.292, 2.081)
Other female genital disorders (CCS 175)	0.57	-1.1265 (0.4978)	0.324 (0.122, 0.86)
Skin and subcutaneous tissue infections (CCS 197)	1.32	-0.2806 (0.3116)	0.755 (0.41, 1.391)
Chronic ulcer of skin (CCS 199)	0.90	0.4414 (0.296)	1.555 (0.871, 2.778)
Other skin disorders (CCS 200)	0.06	--	--
Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease) (CCS 201)	0.47	0.2947 (0.3304)	1.343 (0.703, 2.566)
Osteoarthritis (CCS 203)	4.02	-1.7405 (0.363)	0.175 (0.086, 0.357)
Other non-traumatic joint disorders (CCS 204)	0.49	-1.4996 (0.6481)	0.223 (0.063, 0.795)
Spondylosis; intervertebral disc disorders; other back problems (CCS 205)	1.50	-1.6285 (0.4549)	0.196 (0.08, 0.479)
Pathological fracture (CCS 207)	0.03	--	--
Acquired foot deformities (CCS 208)	0.21	-1.001 (0.764)	0.367 (0.082, 1.643)
Other acquired deformities (CCS 209)	0.32	-1.6621 (0.7642)	0.19 (0.042, 0.848)
Other connective tissue disease (CCS 211)	2.30	-0.7668 (0.3225)	0.465 (0.247, 0.874)
Other bone disease and musculoskeletal deformities (CCS 212)	0.19	-0.859 (0.6493)	0.424 (0.119, 1.513)
Cardiac and circulatory congenital anomalies (CCS 213)	0.07	-1.1891 (1.0548)	0.304 (0.039, 2.407)
Genitourinary congenital anomalies (CCS 215)	0.12	-1.4076 (1.037)	0.245 (0.032, 1.868)
Other congenital anomalies (CCS 217)	0.08	-0.7056 (1.0477)	0.494 (0.063, 3.849)
Joint disorders and dislocations; trauma-related (CCS 225)	0.21	-1.2258 (0.7643)	0.293 (0.066, 1.313)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Fracture of neck of femur (hip) (CCS 226)	0.22	0.6485 (0.3373)	1.913 (0.988, 3.706)
Skull and face fractures (CCS 228)	0.54	-0.3332 (0.3509)	0.717 (0.36, 1.426)
Fracture of upper limb (CCS 229)	0.96	-0.5173 (0.3484)	0.596 (0.301, 1.18)
Fracture of lower limb (CCS 230)	0.38	-0.3639 (0.4062)	0.695 (0.313, 1.541)
Other fractures (CCS 231)	0.20	0.8013 (0.3427)	2.229 (1.139, 4.362)
Sprains and strains (CCS 232)	0.87	-1.4105 (0.4732)	0.244 (0.097, 0.617)
Open wounds of head; neck; and trunk (CCS 235)	0.31	-0.2214 (0.3782)	0.801 (0.382, 1.682)
Open wounds of extremities (CCS 236)	0.56	-0.5146 (0.3697)	0.598 (0.29, 1.234)
Complication of device; implant or graft (CCS 237)	3.89	0.3747 (0.2859)	1.455 (0.831, 2.547)
Complications of surgical procedures or medical care (CCS 238)	3.34	-0.0163 (0.2891)	0.984 (0.558, 1.735)
Superficial injury; contusion (CCS 239)	0.18	-0.6041 (0.4445)	0.547 (0.229, 1.306)
Other injuries and conditions due to external causes (CCS 244_2)	0.17	0.4203 (0.3816)	1.522 (0.721, 3.216)
Syncope (CCS 245)	0.11	-0.2096 (0.5075)	0.811 (0.3, 2.193)
Gangrene (CCS 248)	0.78	0.8487 (0.2961)	2.337 (1.308, 4.175)
Other aftercare (CCS 257)	0.20	-1.2024 (0.7664)	0.3 (0.067, 1.349)
Residual codes; unclassified (CCS 259)	0.16	-0.2213 (0.5386)	0.802 (0.279, 2.304)
Other Infectious Diseases (CC 7)	11.51	-0.2964 (0.0407)	0.743 (0.686, 0.805)
Metastatic & Severe Cancers (CC 8, 9)	1.36	0.5136 (0.0824)	1.672 (1.422, 1.965)
Protein-Calorie Malnutrition (CC 21)	5.09	0.5159 (0.0403)	1.675 (1.548, 1.813)
Disorders of Fluid/Electrolyte/Acid-Base Balance (CC 24)	19.22	0.325 (0.0354)	1.384 (1.291, 1.484)
Disorders of Lipoid Metabolism (CC 25)	57.07	-0.1954 (0.0305)	0.822 (0.775, 0.873)
Liver Failure (CC 27, 30)	0.62	0.964 (0.0953)	2.621 (2.175, 3.16)
Other GI Disorders (CC 34, 35, 37, 38)	37.81	-0.2905 (0.0312)	0.748 (0.704, 0.795)
Other Musculoskeletal and Connective Tissue Disorders (CC 44, 45)	34.96	-0.1128 (0.0312)	0.893 (0.84, 0.95)
Hematologic or Immunity	6.34	0.2301 (0.0422)	1.259 (1.159, 1.368)

Risk Variable name	% of Patients	Parameter Estimates (Standard Error)	Odds Ratio (95% Confidence Interval)
Disorders (CC 46-48)			
Dementia and Other Nonpsychotic Organic Brain Syndromes (CC 51-53)	7.73	0.3575 (0.0384)	1.43 (1.326, 1.541)
Coma/Brain Compression/Anoxic Injury and Severe Head Injury (CC 80, 166)	0.58	1.1525 (0.0877)	3.166 (2.666, 3.76)
Respiratory Failure, Respirator Dependence, Shock (CC 82-84)	5.86	0.4206 (0.0416)	1.523 (1.404, 1.652)
Congestive Heart Failure (CC 85)	14.95	0.4367 (0.0335)	1.548 (1.449, 1.653)
Hypertension and Hypertensive Heart Disease (CC 94, 95)	65.99	-0.2504 (0.0319)	0.778 (0.731, 0.829)
Pneumonia (CC 114-116)	6.13	0.4034 (0.0402)	1.497 (1.383, 1.619)
Dialysis or Severe Chronic Kidney Disease (CC 134, 136, 137)	4.09	0.4695 (0.05)	1.599 (1.45, 1.764)
Acute or Unspecified Renal Failure (135, 140)	12.54	0.14 (0.0373)	1.15 (1.069, 1.237)
Poisonings and Allergic and Inflammatory Reactions (CC 175)	3.22	-0.0169 (0.0594)	0.984 (0.875, 1.105)
Minor Symptoms, Signs, Findings (CC 179)	28.06	0.8139 (0.0313)	2.257 (2.122, 2.399)