

## ACO #8 – Risk Standardized All Condition Readmission

### Measure Information Form (MIF)

#### Data Source

- ◆ Medicare Inpatient Claims
- ◆ Medicare beneficiary enrollment data

#### Measure Set ID

- ◆ ACO #8

#### Version Number and effective date

- ◆ Version 2.0, effective 1/1/14

#### CMS approval date

- ◆ 5/22/2014

#### NQF ID

- ◆ #1789, adapted for quality measurement in Accountable Care Organizations

#### Date Endorsed

- ◆ N/A

#### Care Setting

- ◆ Hospital

#### Unit of Measurement

- ◆ Accountable Care Organization (ACO)

#### Measurement Duration

- ◆ Calendar Year

#### Measurement Period

- ◆ Calendar Year

#### Measure Type

- ◆ Outcome

#### Measure Scoring

- ◆ Risk-standardized readmission rate (RSRR)

#### Payer source

- ◆ Medicare Fee-for-Service

#### Improvement notation

- ◆ Lower RSRR scores are better

## Measure steward

- ◆ Centers for Medicare and Medicaid Services

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- ◆ This ACO risk standardized all condition readmission quality measure is adapted from a hospital risk standardized all condition readmission quality measure developed for CMS by Yale in 2011 and updated by Yale in 2014 (Horwitz et al., 2014).

## Measure description

- ◆ Risk-adjusted percentage of Accountable Care Organization (ACO) assigned beneficiaries who were hospitalized who were readmitted to a hospital within 30 days following discharge from the hospital for the index admission.

## Rationale

Readmission following an acute care hospitalization is a costly and often preventable event. During 2003 and 2004, almost one-fifth of Medicare beneficiaries – more than 2.3 million patients – were readmitted within 30 days of discharge (Jencks et al., 2009). A Commonwealth Fund report estimated that if national readmission rates were lowered to the levels achieved by the top performing regions, Medicare would save \$1.9 billion annually.

Hospital readmission is also disruptive to patients and caregivers, and puts patients at additional risk of hospital-acquired infections and complications (Horwitz et al., 2011). Some readmissions are unavoidable, but readmissions may also result from poor quality of care, inadequate coordination of care, or lack of effective discharge planning and transitional care.

Since studies have shown readmissions within 30 days to often be related to quality of care, coordination of care, or other factors within the control of health care providers, interventions have been able to reduce 30-day readmission rates for a variety of medical conditions, and high readmission rates and institutional variations in readmission rates indicate an opportunity for improvement, it is important to consider an all-condition 30-day readmission rate as a quality measure (Horwitz et al., 2011).

This ACO risk standardized all condition readmission quality measure is adapted from a hospital risk standardized all condition readmission quality measure previously developed for CMS by Yale (Horwitz et al., 2011). This version of the measure is based on the measure updates developed for CMS by Yale in 2014 (Horwitz et al., 2014).

## Clinical Recommendation Statement

Randomized controlled trials have shown that improvement in health care can directly reduce readmission rates, including the following interventions: quality of care during the initial admission; improvement in communication with patients, caregivers and clinicians; patient education; predischARGE assessment; and coordination of care after discharge. (Naylor et al., 1994; 1999; Krumholz et al., 2002; van Walraven et al., 2002; Conley et al., 2003; Coleman et al., 2004; Phillips et al., 2004; Jovicic et al., 2006; Garasen et al., 2007; Mistiaen et al., 2007; Courtney et al., 2009; Jack et al., 2009; Koehler et al., 2009; Weiss et al., 2010; Stauffer et al., 2011; Voss et al., 2011). Successful randomized trials have reduced 30-day readmission rates by as much as 20-40% (Horwitz et al., 2011).

Widespread application of these clinical trial interventions to medical practice settings has also been encouraging (Horwitz et al., 2011). Since 2008, 14 Medicare Quality Improvement Organizations (QIOs) have been funded to focus on care transitions, implementing lessons learned from these clinical trials. Several of these interventions have been notably successful in reducing readmissions within 30 days. (CFMC, 2010).

ACOs will have incentives under the Medicare Shared Savings Program and Pioneer Model to manage the range of medical care, coordination of care, and other factors affecting readmission rates for their assigned beneficiaries. By taking responsibility for all aspects of the medical care of their assigned beneficiaries, ACOs will be able to assess the range of

possible interventions affecting readmissions and then select the interventions appropriate for each population of patients included in among their assigned beneficiaries.

## References

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### Release Notes / Summary of Changes

- ◆ Updated the measure to reflect the most recent version of the hospital risk standardized all condition readmission quality measure, developed for CMS by Yale, and updated in 2014 (Horwitz et al., 2014).
- ◆ Re-specified the measures by adding the CMS planned readmission algorithm version 3.0.
- ◆ Integrated updated version of the AHRQ CCS software
- ◆ Updated CC map to reflect annual ICD-9-CM CC map update
- ◆ Removed procedure CCS 61 from the list of procedures qualifying an admission for the surgery cohort.

### Technical Specifications

- ◆ Target Population  
ACO assigned or aligned Medicare beneficiaries

### Denominator

- ◆ Denominator Statement  
All hospitalizations not related to medical treatment of cancer, primary psychiatric disease, or rehabilitation care, fitting of prostheses, and adjustment devices for ACO assigned beneficiaries at non-Federal, short-stay acute-care or critical access hospitals, where the beneficiary was age 65 or older, was continuously enrolled in fee-for-service Medicare Part A for at least one month after discharge, was not discharged to another acute care hospital, was not discharged against medical advice, and was alive upon discharge and for 30 days post-discharge.
- ◆ Denominator Details  
The ICD-9 diagnosis and procedure codes of the index admission are aggregated into clinically coherent groups of conditions/procedures (condition categories or procedure categories) by using the Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications System (CCS). Each admission is assigned to one of five mutually exclusive specialty cohorts: medicine, surgery/gynecology, cardiorespiratory, cardiovascular, and neurology. The cohorts reflect how care for patients is organized within hospitals. To assign admissions to cohorts, admissions are first screened for the presence of an eligible surgical procedure category. Admissions with an eligible surgical procedure category are assigned to the surgical cohort, regardless of the diagnosis code of the admission. All remaining admissions are assigned to cohorts based on the discharge condition category of the principal diagnosis.

Rationale: Conditions typically cared for by the same team of clinicians are expected to experience similar added (or reduced) levels of readmission risk. The surgery/gynecology cohort includes admissions likely cared for by surgical or gynecological teams. These admissions are identified using AHRQ procedure categories. The cardiorespiratory cohort includes several condition categories with very high readmission rates such as pneumonia, chronic obstructive pulmonary disease, and heart failure. These admissions are combined into a single cohort because they are often clinically indistinguishable and patients are often simultaneously treated for several of these diagnoses. The cardiovascular cohort includes condition categories such as acute myocardial infarction that in large hospitals might be cared for by a separate cardiac or cardiovascular team. The neurology cohort includes neurologic condition categories such as stroke that in large hospitals might be cared for by a separate neurology team. The medicine cohort includes all non-surgical patients who were not assigned to any of the other cohorts. For further details, and list of CCS' by category see Horwitz et al. (2014).

In order to define the eligible admissions, the ICD-9 codes of the index admission are first aggregated into clinically coherent conditions by using the Agency for Healthcare Research and Quality's Clinical Classifications Software (CCS). There are a total of 285 mutually exclusive AHRQ condition categories, most of which are single, homogenous diseases such as pneumonia or acute myocardial infarction. Some are aggregates of conditions, such as "other bacterial infections." Mental health and substance abuse categories are included. In addition, AHRQ provides 231 mutually exclusive procedure categories to group procedures a patient might have had during hospitalization.

Admissions are eligible for inclusion in the measure if:

1. Patient is enrolled in Medicare FFS  
Rationale: Claims data are consistently available only for Medicare FFS and VA beneficiaries
2. Patient is aged 65 years or older  
Rationale: Medicare patients younger than 65 usually qualify for the program due to severe disability. They are not included in the measure because Medicare patients younger than 65 are considered to be too clinically distinct from Medicare patients 65 and over.
3. Patient was discharged from non-federal acute care hospitals  
Rationale: Data from federal hospitals were not available during the development of this measure.
4. Patient did not die in the hospital  
Rationale: Only patients who are discharged alive are eligible for readmission.
5. Patient is not transferred to another acute care facility upon discharge.  
Rationale: Readmission is attributed to the hospital that discharged the patient to the non-acute care setting. Transferred patients are still included in the measure cohort, but the initial admitting hospital is not accountable for the outcome.
6. Patient is enrolled in Part A for the 12 months prior to and including the date of the index admission  
Rationale: The 12-month prior enrollment ensures a full year of administrative data for risk adjustment.

Note that a readmission within 30 days will also be eligible as an index admission, if they meet all other eligibility criteria. This allows the measure to capture repeated readmissions for the same patient, whether at the same hospital or another.

Note: The measures consider multiple contiguous hospitalizations as a single acute episode of care. Admissions to a hospital within one day of discharge from another hospital are considered transfers, whether or not the first institution indicates intent to transfer the patient in the discharge disposition code. Readmissions for transferred patients are attributed to the hospital that ultimately discharges the patient to a non-acute care setting.

If a patient is readmitted to the same hospital on the same day of discharge for the same diagnosis as the index admission, the measure considers the patient to have had one single continuous admission. However, a diagnosis of the readmission that differs from the index admission is considered a readmission.

◆ Denominator Exclusions

Excluded from the measure are all admissions for which full data are not available or for which 30-day readmission by itself cannot reasonably be considered a signal of quality of care.

Exclusions:

1. Admissions for patients without 30 days of post-discharge data  
Rationale: This is necessary in order to identify the outcome (readmission) in the dataset.
2. Admissions for patients lacking a complete enrollment history for the 12 months prior to admission  
Rationale: This is necessary to capture historical data for risk adjustment.
3. Admissions for patients discharged against medical advice (AMA)  
Rationale: Hospital had limited opportunity to implement high quality care.
4. Admissions for patients to a PPS-exempt cancer hospital  
Rationale: These hospitals care for a unique population of patients that is challenging to compare to other hospitals.
5. Admissions for patients with medical treatment of cancer  
Rationale: These admissions have a very different mortality and readmission profile than the rest of the Medicare population, and outcomes for these admissions do not correlate well with outcomes for other admissions. (Patients with cancer who are admitted for other diagnoses or for surgical treatment of their cancer remain in the measure).
6. Admissions for primary psychiatric disease  
Rationale: Patients admitted for psychiatric treatment are typically cared for in separate psychiatric or rehabilitation centers which are not comparable to acute care hospitals.
7. Admissions for rehabilitation care  
Rationale: These admissions are not for acute care or to acute care hospitals.

◆ Denominator Exceptions and Exclusions Details

Denominator exclusions are identified based on variables contained in the Medicare Standard Analytic File (SAF) or Enrollment Database (EDB). For Medicare FFS patients:

1. Lack of enrollment in Medicare FFS for 30 days post-discharge is identified by patient enrollment status in Part A FFS claims using CMS' EDB; the enrollment indicators must be appropriately marked for the month(s) which falls within 30 days of hospital discharge date.
2. Lack of continuous enrollment in Medicare FFS for 12 months prior to index hospital stay is determined by patient enrollment status in Part A FFS using CMS' EDB; the enrollment indicators must be appropriately marked for each of the 12 months prior to the index hospital stay
3. Discharges AMA are identified using the discharge disposition indicator within the SAF.
4. PPS-exempt cancer hospitals are identified by their Medicare provider ID.
5. Table 1 indicates all cancer discharge condition categories excluded from the measure.
6. Table 2 indicates all psychiatric discharge condition categories excluded from the measure.
7. Admissions for rehabilitation care are identified by principal diagnosis codes (ICD-9 codes) included in CCS 254

In addition, in-hospital deaths are identified using the discharge disposition vital status indicator in the SAF and transfers to other acute care facilities are identified in the claims when a patient is discharged from an acute care hospital and admitted to another acute care hospital on the same day or next day.

**Table 1: Cancer discharge condition categories excluded from the measure (Medicare FFS data)**

AHRQ CCS//Description  
 CCS 42//Secondary malignancies  
 CCS 19//Cancer of bronchus; lung  
 CCS 45//Maintenance chemotherapy; radiotherapy  
 CCS 44//Neoplasms of unspecified nature or uncertain behavior

CCS 17//Cancer of pancreas  
 CCS 38//Non-Hodgkin's Lymphoma  
 CCS 39//Leukemias  
 CCS 14//Cancer of colon  
 CCS 40//Multiple myeloma  
 CCS 35//Cancer of brain and nervous system  
 CCS 16//Cancer of liver and intrahepatic bile duct  
 CCS 13//Cancer of stomach  
 CCS 29//Cancer of prostate  
 CCS 15//Cancer of rectum and anus  
 CCS 18//Cancer of other GI organs; peritoneum  
 CCS 12//Cancer of esophagus  
 CCS 11//Cancer of head and neck  
 CCS 27//Cancer of ovary  
 CCS 33//Cancer of kidney and renal pelvis  
 CCS 32//Cancer of bladder  
 CCS 24//Cancer of breast  
 CCS 43//Malignant neoplasm without specification of site  
 CCS 25//Cancer of uterus  
 CCS 36//Cancer of thyroid//879  
 CCS 21//Cancer of bone and connective tissue  
 CCS 41//Cancer; other and unspecified primary  
 CCS 20//Cancer; other respiratory and intrathoracic  
 CCS 23//Other non-epithelial cancer of skin  
 CCS 26//Cancer of cervix  
 CCS 28//Cancer of other female genital organs  
 CCS 34//Cancer of other urinary organs  
 CCS 37//Hodgkin's disease  
 CCS 22//Melanomas of skin  
 CCS 31//Cancer of other male genital organs  
 CCS 30//Cancer of testis

**Table 2: Psychiatric discharge condition categories excluded from the measure (Medicare FFS data)**

AHRQ CCS//Description  
 CCS 657//Mood disorders  
 CCS 659//Schizophrenia and other psychotic disorders  
 CCS 651//Anxiety disorders  
 CCS 670//Miscellaneous disorders  
 CCS 654//Developmental disorders  
 CCS 650//Adjustment disorders  
 CCS 658//Personality disorders  
 CCS 652//Attention-deficit, conduct, and disruptive behavior disorders  
 CCS 656//Impulse control disorders, NEC  
 CCS 655//Disorders usually diagnosed in infancy, childhood, or adolescence  
 CCS 662//Suicide and intentional self-inflicted injury

## Numerator

- ◆ Numerator Statement



Risk-adjusted readmissions at a non-Federal, short-stay, acute-care or critical access hospital, within 30 days of discharge from the index admission included in the denominator, and excluding planned readmissions.

◆ Numerator Details

The outcome for this measure is unplanned all-cause readmission within 30 days of discharge date of an eligible index admission. Because planned readmissions are not a signal of quality of care, the measure does not count planned readmissions in the outcome. The measure uses an algorithm to identify “planned readmissions” in claims data that will not count as readmissions in the measure. The algorithm is based on three main principles:

1. A few specific, limited types of care are always considered planned (transplant surgery, maintenance chemotherapy/radiotherapy/ immunotherapy, rehabilitation);
2. Otherwise, a planned readmission is defined as a non-acute readmission for a scheduled procedure; and
3. Admissions for acute illness or for complications of care are never planned.

The algorithm developed which was originally developed in 2011, and later updated in 2013, to identify planned readmissions uses a flowchart and four tables of specific procedure categories and discharge diagnosis categories to classify readmissions as planned. Readmissions are considered planned if any of the following occurs during the readmission

1. A procedure is performed that is in one of the procedure categories that are always planned regardless of diagnosis (table 3);
2. The principal diagnosis is in one of the diagnosis categories that are always planned (table 4); or
3. A procedure is performed that is in one of the potentially planned procedure categories (table 5) and the principal diagnosis is not in the list of acute discharge diagnoses (appendix A).

**Table 3: Procedure Categories that Are Always Considered Planned**

AHRQ Procedure CCS//Description  
 CCS 64 // Bone marrow transplant  
 CCS 105 //Kidney transplant  
 CCS 134 // Cesarean section  
 CCS 135 //Forceps; vacuum; and breech delivery  
 CCS 176 // Other organ transplantation

**Table 4: Diagnosis Categories that Are Always Considered Planned**

AHRQ Procedure CCS//Description  
 CCS 45 // Maintenance chemotherapy  
 CCS 194 // Forceps delivery  
 CCS 196 // Normal pregnancy and/or delivery  
 CCS 254 // Rehabilitation

**Table 5: Procedure Categories that are Potentially Planned**

AHRQ Procedure CCS or ICD 9 Code//Description  
 CCS 3 // Laminectomy; excision intervertebral disc  
 CCS 5 // Insertion of catheter or spinal stimulator and injection into spinal  
 CCS 9 // Other OR therapeutic nervous system procedures  
 CCS 10 // Thyroidectomy; partial or complete  
 CCS 12 // Other therapeutic endocrine procedures  
 CCS 33 // Other OR therapeutic procedures on nose; mouth and pharynx  
 CCS 36 // Lobectomy or pneumonectomy  
 CCS 38 // Other diagnostic procedures on lung and bronchus  
 CCS 40 // Other diagnostic procedures of respiratory tract and mediastinum  
 CCS 43 // Heart valve procedures



CCS 44 // Coronary artery bypass graft (CABG)  
CCS 45 // Percutaneous transluminal coronary angioplasty (PTCA)  
CCS 47 // Diagnostic cardiac catheterization; coronary arteriography  
CCS 48 // Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator  
CCS 49 // Other OR heart procedures  
CCS 51 // Endarterectomy; vessel of head and neck  
CCS 52 // Aortic resection; replacement or anastomosis  
CCS 53 // Varicose vein stripping; lower limb  
CCS 55 // Peripheral vascular bypass  
CCS 56 // Other vascular bypass and shunt; not heart  
CCS 59 // Other OR procedures on vessels of head and neck  
CCS 62 // Other diagnostic cardiovascular procedures  
CCS 66 // Procedures on spleen  
CCS 67 // Other therapeutic procedures; hemic and lymphatic system  
CCS 74 // Gastrectomy; partial and total  
CCS 78 // Colorectal resection  
CCS 79 // Local excision of large intestine lesion (not endoscopic)  
CCS 84 // Cholecystectomy and common duct exploration  
CCS 85 // Inguinal and femoral hernia repair  
CCS 86 // Other hernia repair  
CCS 99 // Other OR gastrointestinal therapeutic procedures  
CCS 104 // Nephrectomy; partial or complete  
CCS 106 // Genitourinary incontinence procedures  
CCS 107 // Extracorporeal lithotripsy; urinary  
CCS 109 // Procedures on the urethra  
CCS 112 // Other OR therapeutic procedures of urinary tract  
CCS 113 // Transurethral resection of prostate (TURP)  
CCS 114 // Open prostatectomy  
CCS 119 // Oophorectomy; unilateral and bilateral  
CCS 120 // Other operations on ovary  
CCS 124 // Hysterectomy; abdominal and vaginal  
CCS 129 // Repair of cystocele and rectocele; obliteration of vaginal vault  
CCS 132 // Other OR therapeutic procedures; female organs  
CCS 142 // Partial excision bone  
CCS 152 // Arthroplasty knee  
CCS 153 // Hip replacement; total and partial  
CCS 154 // Arthroplasty other than hip or knee  
CCS 157 // Amputation of lower extremity  
CCS 158 // Spinal fusion  
CCS 159 // Other diagnostic procedures on musculoskeletal system  
CCS 166 // Lumpectomy; quadrantectomy of breast  
CCS 167 // Mastectomy  
CCS 169 // Debridement of wound; infection or burn  
CCS 170 // Excision of skin lesion  
CCS 172 // Skin graf  
 ICD 9 Codes : 30.1, 30.29, 30.3, 30.4, 31.74, 34.6 // Laryngectomy, revision of tracheostomy, scarification of pleura  
 (from Proc CCS 42- Other OR Rx procedures on respiratory system and mediastinum)  
 ICD 9 Code: 38.18 // Endarterectomy leg vessel (from Proc CCS 60- Embolectomy and endarterectomy of lower  
 limbs)

ICD 9 Codes: 55.03, 55.04 // Percutaneous nephrostomy with and without fragmentation (from Proc CCS 103- Nephrotomy and nephrostomy)

ICD 9 Codes: 94.26, 94.27 Electroshock therapy (from Proc CCS 218- Psychological and psychiatric evaluation and therapy)

### Stratification or Risk Adjustment

This measure uses risk adjustment and is not stratified.

For risk adjustment, hierarchical logistic regression models are used to model the log-odds of readmission within 30 days of discharge, as a function of patient-level demographic and clinical characteristics and a random ACO-level intercept. This model specification accounts for within-ACO correlation of the observed outcomes and models the assumption that underlying differences in quality among the ACOs being evaluated lead to systematic differences in outcomes. In brief, the approach simultaneously models two levels (patient and ACO) to account for the variance in patient outcomes within and between ACOs. At the patient level, each model adjusts the log-odds of readmission within 30-days of discharge for age and selected clinical covariates. The second level models the ACO-specific intercepts as following a normal distribution. The ACO intercept represents the underlying ACO specific risk of readmission, after accounting for patient risk.

A fixed, common set of variables is used in all of the models for simplicity and ease of data collection and analysis. However, a hierarchical logistic regression model is estimated for each specialty cohort separately, and the coefficients associated with each variable may vary across specialty cohorts. To group ICD-9-CM codes into comorbid risk variables, CMS Condition Category (CMS-CCs) groups are used.

This ACO-wide readmission quality measure was adapted from the hospital-wide readmission quality measure in two ways. First, the unit of analysis was changed from the hospital to the ACO. This was possible because both the hospital-wide readmission measure and the ACO-wide readmission measures have in common assessing readmission performance for a population that has patients clustered together (either in hospitals or in ACOs). The goal is to isolate the effects of beneficiary characteristics on the probability that a patient will be readmitted from the effects of being in a specific hospital or ACO. In addition, planned readmissions can be excluded for the ACO-wide readmission quality measure in the same way that they are excluded for the CMS hospital-wide readmission measure.

Second, an additional group of beneficiaries was then developed from the 2010 Medicare 5% claims file to represent a national perspective from the rest of the country for the ACO-wide readmission data analysis, since ACOs do not cover the entire country in the same way that the hospital-wide readmission measure analysis included all of the hospitals in the country. The additional group is limited to beneficiaries in the 5% file that had the basic eligibility characteristics required by the Shared Savings Program ACO patient assignment algorithm.

### Risk Variables Common to All HWR Specialty Cohorts

CMS-CCs // Description

n/a // Mean age, years

CMS-CC 7 // Metastatic cancer/acute leukemia

CMS -CC 8, 9 // Severe Cancer

CMS -CC 10-12 // Other cancers

CMS -CC 44 // Severe hematological disorders

CMS -CC 46 // Coagulation defects and other specified hematological disorders

CMS -CC 47 // Iron deficiency or other unspecified anemias and blood disease

CMS -CC 25, 26// End-stage liver disease

CMS -CC 32 // Pancreatic disease

CMS -CC 130 // Dialysis status  
 CMS -CC 131 // Acute renal failure  
 CMS -CC 128, 174 // Transplants  
 CMS -CC 1, 3-5 // Severe Infection  
 CMS -CC 6, 111-113 // Other infectious diseases and pneumonias  
 CMS -CC 2 // Septicemia/Shock  
 CMS -CC 80 // CHF  
 CMS -CC 81-84, 89, 98, 99, 103-106 // Coronary atherosclerosis or angina, cerebrovascular disease  
 CMS -CC 92, 93 // Specified arrhythmias  
 CMS -CC 79 // Cardio-respiratory failure or cardio-respiratory shock  
 CMS -CC 108 // COPD  
 CMS -CC 109 // Fibrosis of lung or other chronic lung disorders  
 CMS -CC 21 // Protein-calorie malnutrition  
 CMS -CC 22, 23 // Disorders of fluid, electrolyte, acid-base  
 CMS -CC 38 // Rheumatoid arthritis and inflammatory connective tissue disease  
 CMS -CC 15-20, 119, 120 // Diabetes mellitus  
 CMS -CC 148, 149 // Decubitus ulcer or chronic skin ulcer  
 CMS -CC 67-69, 100-102, 177, 178 // Hemiplegia, paraplegia, paralysis, functional disability  
 CMS -CC 74 // Seizure disorders and convulsions  
 CMS -CC 77 // Respirator dependence/tracheostomy status  
 CMS -CC 51, 52 // Drug and Alcohol disorders  
 CMS -CC 54-56, 58, 60 // Psychiatric comorbidity  
 CMS -CC 158 // Hip fracture/dislocation

For further details see Horwitz et al., 2014.

### Sampling

- ◆ N/A

### Calculation Algorithm

1. Models for each specialty cohort are specified and estimated, using a separate hierarchical logistic regression model for that cohort. Each model is then used to calculate a standardized risk ratio (SRR) for each ACO which contributes index admissions to that model. These SRRs, weighted by volume, are then pooled for each ACO to create a composite ACO-wide SRR.
2. For each specialty cohort within an ACO, the numerator of the SRR (“predicted”) is the number of readmissions for patients within the specialty cohort within 30 days predicted on the basis of the ACO’s performance with its observed case mix, and the denominator (“expected”) is the number of readmissions expected for patients within the specialty cohort on the basis of the overall performance with that ACO’s case mix. This approach is analogous to a ratio of “observed” to “expected” used in other types of statistical analyses. It conceptually allows for a comparison of a particular ACO’s performance given its case-mix to an average ACO’s performance with the same case-mix. Thus, an SRR less than 1 indicates lower-than-expected readmission or better quality and an SRR greater than 1 indicates higher-than-expected readmission or worse quality.
3. These SRRs are then pooled for each ACO to create a composite ACO-wide SRR. This pooled SRR is the geometric mean of the specialty cohort SRRs, weighted by the number of admissions in the specialty cohort, and the pooled SRR is then multiplied by the overall crude readmission rate to produce the risk standardized readmission rate (RSRR) for reporting.

For further details see Horwitz et al., 2014.

## Appendix A: Acute Diagnosis Categories

Diagnosis CCS	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo
99	Hypertension with complications
100	Acute myocardial infarction (with the exception of ICD-9 codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental

Diagnosis CCS	Description
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders

Diagnosis CCS	Description
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders

**Acute ICD-9 codes within Dx CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy**

ICD-9 Code	Description
03282	Diphtheritic myocarditis
03640	Meningococcal carditis nos
03641	Meningococcal pericarditis
03642	Meningococcal endocarditis
03643	Meningococcal myocarditis
07420	Coxsackie carditis nos
07421	Coxsackie pericarditis
07422	Coxsackie endocarditis
07423	Coxsackie myocarditis
11281	Candidal endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capssulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
03282	Diphtheritic myocarditis
03640	Meningococcal carditis nos
03641	Meningococcal pericarditis
03642	Meningococcal endocarditis
03643	Meningococcal myocarditis
07420	Coxsackie carditis nos
07421	Coxsackie pericarditis
07422	Coxsackie endocarditis
07423	Coxsackie myocarditis
11281	Candidal endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capssulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
3912	Acute rheumatic myocarditis
3918	Acute rheumatic heart disease nec
3919	Acute rheumatic heart disease nos
3920	Rheumatic chorea w heart involvement

ICD 9 Code	Description
3980	Rheumatic myocarditis
39890	Rheumatic heart disease nos
39899	Rheumatic heart disease nec
4200	Acute pericarditis in other disease
42090	Acute pericarditis nos
42091	Acute idiopath pericarditis
42099	Acute pericarditis nec
4210	Acute/subacute bacterial endocarditis
4211	Acute endocarditis in other diseases
4219	Acute/subacute endocarditis nos
4220	Acute myocarditis in other diseases
42290	Acute myocarditis nos
42291	Idiopathic myocarditis
42292	Septic myocarditis
42293	Toxic myocarditis
42299	Acute myocarditis nec
4230	Hemopericardium
4231	Adhesive pericarditis
4232	Constrictive pericarditis
4233	Cardiac tamponade
4290	Myocarditis nos

**Acute ICD-9 codes within Dx CCS 105: Conduction disorders**

ICD-9 Code	Description
4260	Atrioventricular
42610	Atrioventricular block nos
42611	Atrioventricular block-1st degree
42612	Atrioventricular block-mobitz ii
42613	Atrioventricular block-2nd degree nec
4262	Left bundle branch hemiblock
4263	Left bundle branch block nec
4264	Right bundle branch block
42650	Bundle branch block nos
42651	Right bundle branch block/left posterior fascicular block
42652	Right bundle branch block/left ant fascicular block
42653	Bilateral bundle branch block nec
42654	Trifascicular block
4266	Other heart block
4267	Anomalous atrioventricular excitation
42681	Lown-ganong-levine syndrome
42682	Long qt syndrome
4269	Conduction disorder nos

**Acute ICD-9 codes within Dx CCS 106: Dysrhythmia**

ICD-9 Code	Description
4272	Paroxysmal tachycardia nos
7850	Tachycardia nos
42789	Cardiac dysrhythmias nec
4279	Cardiac dysrhythmia nos



ICD-9 Code	Description
42769	Premature beats nec

**Acute ICD-9 codes within Dx CCS 108: Congestive heart failure; nonhypertensive**

ICD-9 Code	Description
39891	Rheumatic heart failure
4280	Congestive heart failure
4281	Left heart failure
42820	Unspecified systolic heart failure
42821	Acute systolic heart failure
42823	Acute on chronic systolic heart failure
42830	Unspecified diastolic heart failure
42831	Acute diastolic heart failure
42833	Acute on chronic diastolic heart failure
42840	Unspec combined syst & dias heart failure
42841	Acute combined systolic & diastolic heart failure
42843	Acute on chronic combined systolic & diastolic heart failure
4289	Heart failure nos

**Acute ICD-9 codes within Dx CCS 149: Biliary tract disease**

ICD-9 Code	Description
5740	Calculus of gallbladder with acute cholecystitis
57400	Calculus of gallbladder with acute cholecystitis without mention of obstruction
57401	Calculus of gallbladder with acute cholecystitis with obstruction
5743	Calculus of bile duct with acute cholecystitis
57430	Calculus of bile duct with acute cholecystitis without mention of obstruction
57431	Calculus of bile duct with acute cholecystitis with obstruction
5746	Calculus of gallbladder and bile duct with acute cholecystitis
57460	Calculus of gallbladder and bile duct with acute cholecystitis without mention of obstruction
57461	Calculus of gallbladder and bile duct with acute cholecystitis with obstruction
5748	Calculus of gallbladder and bile duct with acute and chronic cholecystitis
57480	Calculus of gallbladder and bile duct with acute and chronic cholecystitis without mention of obstruction
57481	Calculus of gallbladder and bile duct with acute and chronic cholecystitis with obstruction
5750	Acute cholecystitis
57512	Acute and chronic cholecystitis
5761	Cholangitis

**Acute ICD-9 codes with Dx CCS 152: Pancreatic disorders**

ICD-9 Code	Description
5770	Acute pancreatitis