INPATIENT PSYCHIATRIC FACILITY ALL-CAUSE UNPLANNED READMISSION MEASURE VERSION 1.0

Final Technical Report

Prepared for the Centers for Medicare & Medicaid Services

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GLOSSARY OF TERMS

Term	Definition
Case mix	The spectrum of patient-specific readmission risk factors, such as illnesses of index admissions at a given hospital.
Comorbid risk variable	A variable indicating presence of comorbid conditions, i.e., conditions that occur concomitantly with the principal cause of hospital admissions. In general, comorbid conditions were measured from secondary diagnoses of the index admissions and principal and secondary diagnoses of inpatient and outpatient visits within twelve months prior to the index admission. Diagnoses in claims as coded in International Classification of Diseases Version 9 – Clinical Modification (ICD-9-CM) were grouped using the Centers for Medicare and Medicaid Services Condition Categories (CC) and psychiatry expert input.
Expected readmission rate	The 30-day readmission rate of an IPF estimated from its performance and case mix. The expected readmission rate is estimated from the hierarchical regression model, including the hospital-specific intercept and risk variables.
Index admission	Any eligible admission to an inpatient psychiatric facility during the measurement period to which 30-day unplanned admissions are attributed. Index admissions define the measure denominator.
IPF-specific intercept	The IPF-specific effect on readmission, considering its observed readmission rate, its case mix, and its number of index admissions. Under the assumption that the risk adjustment model achieved full balance of case mix, the IPF-specific intercept is a measure of hospital performance.
National observed readmission rate	The 30-day incidence of readmissions, estimated as all index admissions with unplanned 30-day readmission divided by all index admissions.
Observed readmission rate	The crude 30-day readmission rate for a given IPF.
Readmission	An admission to an inpatient psychiatric or acute care hospital within 30-days of discharge from an eligible inpatient psychiatric admission (index admission). Readmission defines the measure numerator. Readmissions to inpatient psychiatric facilities can become index admissions.
Planned readmission	An intentional readmission within 30 days from discharge from an eligible inpatient psychiatric admission (index admission) that was scheduled as part of the plan of care. Planned readmissions are not included in the measure numerator. Planned readmissions to inpatient psychiatric facilities can become index admissions.

Term	Definition
Predicted readmission rate	The 30-day readmission rate of an IPF estimated from its case mix using a logistic regression risk adjustment model
Risk variable	A variable that has been created for use in measure risk adjustment.
Principal discharge diagnosis	Principal cause of hospital admission. Principal discharge diagnoses of the index admission in the measure development and testing data set as coded with ICD-9-CM.
Principal discharge risk variable	A variable in the risk adjustment model that has been created to represent the principal discharge diagnosis of the index admission. Discharge diagnoses are grouped using the Agency for Healthcare Research and Quality (AHRQ) Clinical Classification Software (CCS) and psychiatry expert input.
Psychiatric admission	Hospitalization with a principal discharge diagnosis in the Clinical Classification Software Groups 650 (adjustment disorder) to 670 (miscellaneous mental disorders)

LIST OF ACRONYMS AND ABBREVIATIONS

ADD	Attention deficit disorder
AMA	Against medical advice
AMI	Acute Myocardial Infarction
AHRQ	Agency for Healthcare Research and Quality
CC	Condition Categories; developed by the Centers for Medicare and Medicaid Services for grouping of diagnoses on inpatient and outpatient claims coded in ICD-9-CM
CCS	Clinical Classification Software; developed by AHRQ for grouping of principal discharge diagnoses coded in ICD-9-CM
CMHS	Center for Mental Health Services
CMS	Centers for Medicare & Medicaid Services
HCC	Hierarchical Condition Categories
CI	Confidence interval
CNS	Central Nervous System
COPD	Chronic obstructive pulmonary disease
CPAP/IPPB	Continuous positive airway pressure/intermittent positive pressure breathing
CPT	Clinical Procedure Terminology
CY	Calendar Year
Dx	Diagnosis
E&M	Evaluation & Management procedure codes
ECT	Electroconvulsive therapy
ED	Emergency department
FFS	Fee-for-service
HCPCS	Healthcare common procedure coding system
HIV/AIDS	Human immunodeficiency virus/acquired immunodeficiency syndrome
Hx	History
ICC	Intra-class correlation coefficient
ICD-9-CM	Internal Classification of Diseases Version 9 – Clinical Modification
ICM	Intensive case management
Infx	Infection
IPF	Inpatient psychiatric facility
IPFQR	Inpatient Psychiatric Facility Quality Reporting
IPPS	Inpatient prospective payment system
LL	Lower limit
NEC	Not elsewhere classified
NOS	Not otherwise specified
NQF	National Quality Forum
PCP	Primary care physician
POA	Present on admission
PTSD	Posttraumatic stress disorder
RSRR	Risk-standardized readmission rates
SAMHSA	Mental Health Services Administration
SD	Standard deviation
SNF	Skilled nursing facility
SRR	Standardized risk ratio

TB	Tuberculosis
TEP	Technical expert panel
TMS	Transcranial magnetic stimulation
UL	Upper limit

EXECUTIVE SUMMARY

Background

Readmission to acute care settings following discharge from inpatient psychiatric facilities (IPF) is both costly to Medicare and undesirable for patients. Our analysis of Medicare claims data for calendar years 2012 and 2013 showed that among the 716,174 inpatient psychiatric facility (IPF) admissions for Medicare beneficiaries, more than 20% resulted in a readmission to an IPF or a short-stay acute care hospital within 30 days of discharge. Readmission to an IPF or a short-stay acute care hospital after discharge from an IPF is an undesirable outcome because it represents deterioration in a patient's mental and/or physical health status severe enough to require a return to an acute level of care. Additionally, another hospitalization exposes patients to risks of healthcare-acquired complications. While not all readmissions are preventable, there is evidence that improvements to the quality of care for patients in the IPF setting can reduce readmission rates, which, in turn, would reduce costs to Medicare and the burden to patients and their caregivers. Therefore, the Centers for Medicare & Medicaid Services (CMS) has a contract with Health Services Advisory Group, Inc. (HSAG) to develop a measure that evaluates readmission rates following IPF stays and promotes facility-level quality improvement.

Measure Overview

The goal of the project was to develop a measure that reflects the quality of care provided to patients at IPFs by providing a reliable comparison between an individual IPF readmission rate and a national readmission rate. This incentive for quality improvement could lead to a reduction in the national rates and a reduction in the variation in rates across facilities. Therefore, we developed a facility-level measure that estimates an unplanned, 30-day, risk-standardized readmission rate for adult Medicare fee-for-service (FFS) patients with a principal discharge diagnosis of a psychiatric disorder or dementia/Alzheimer's disease. This measure was informed by both empirical analyses using Medicare claims data and input from measure development experts and key stakeholders to ensure the validity of the measure methodology.

In addition, where applicable, this measure aligns with the measure specifications for the CMS Hospital-Wide All-Cause Unplanned Readmission Measure (NQF #1789).[1] For risk adjustment, we employed a similar approach to adjusting for principal discharge diagnoses and comorbidities as the CMS Hospital-Wide Readmission measure. However, we conducted additional analyses to refine the ICD-9-CM risk variable groupings using Medicare Part A and Part B claims data with the goal of increasing the sensitivity and specificity of risk variables in this patient population. We have also conducted a literature review to identify and define additional risk variables that are associated with the readmission outcome in the IPF patient population.

We selected risk factors using empirical data and expert input followed by a formal statistical elimination process to optimize the validity of the risk adjustment model. Risk model testing procedures used common standards and found high validity of all model performance parameters. Additionally, we conducted several sensitivity analyses to ensure that the cohort, the incidence period of the outcome, and the risk factors were adequately specified to produce the most reliable and valid facility-level measure results.

The final model has a c-statistic of 0.66 and good predictive ability. Risk-standardized readmission rates (RSRR) range from 11.0% to 35.4%. The intra-class correlation coefficient of estimated IPF RSRRs was 0.78 indicating good reliability. The measure identified 8.3% of hospitals as better than the national average (indicated by significantly lower RSRRs) and 13.4% as worse than the national average.

Conclusion

We developed a measure of risk-standardized all-cause unplanned readmission rates for inpatient psychiatric facilities. Its ability to discriminate between facilities above and below the national readmission rate provides an assessment of facility-level quality for patients and their caregivers. We envision the addition of this measure to the suite of measures for IPFs will help to create a comprehensive picture of the quality of care patients receive at those facilities.

1. INTRODUCTION

Readmission to acute care settings following discharge from inpatient psychiatric facilities (IPF) is both costly to Medicare and undesirable for patients. Our analysis of Medicare claims data for calendar years 2012 and 2013 showed that among the 716,174 IPF admissions for Medicare beneficiaries, more than 20% resulted in readmission to an IPF or a short-stay acute care hospital within 30 days of discharge. Estimates of Medicare payments to IPFs in 2012 indicated that the average payment per discharge was nearly $10,000.[2] While not all readmissions are preventable, there is evidence that improvements to the quality of care for patients in the IPF setting can reduce readmission rates which, in turn, would reduce costs to Medicare and the burden to patients and their caregivers.

The Centers for Medicare & Medicaid Services (CMS) contracted with Health Services Advisory Group, Inc. (HSAG) to develop a facility-level readmission measure to provide an important indicator of the quality of care patients receive in the IPF setting. The measure will help CMS achieve the goal set out by the National Quality Strategy to "promote effective communication and coordination of care" for patients treated in these facilities. This measure would also complement the portfolio of risk-adjusted readmission measures currently in CMS quality reporting programs by evaluating facilities that are not currently included in those measures. This measure helps build toward the goal of shared accountability for patient outcomes and promotes coordination across different care settings and providers. In this technical report, we provide detail on the development, risk adjustment, and testing of the IPF readmission measure.

1.1 IPF Readmission as a Measure of Quality

Readmission to an IPF or a short-stay acute care hospital after discharge from an IPF is an undesirable outcome because it represents deterioration in a patient's mental and/or physical health status that requires a return to an acute level of care. Additionally, another hospitalization exposes patients to risks of healthcare-acquired complications. Not all inpatient admissions are avoidable. They can result from disease progression, the limits of medical science in effective treatment, and the quality of outpatient and community support. However, research has shown that processes and interventions can reduce readmissions in the IPF setting. Specifically, studies have demonstrated that improvements in the following areas can reduce readmissions:

- Connecting patients with severe mental illness to intensive case management (ICM) may help prevent readmissions. A systematic review of ICM for those with severe mental illness found that compared to standard care, ICM reduced the average number of days in the hospital by 0.86 days per month.[3]
- "Attending to stability of condition" at discharge was found to modestly prevent early readmission by a systematic review of literature on 30-90 day readmissions.[4] Administering effective, evidence-based treatments for psychiatric conditions (e.g., the Veterans Affairs/Department of Defense guideline for management of bipolar disorder)[5] is a pre-requisite to stabilizing patients experiencing an acute episode of a psychiatric disorder and preventing readmissions after discharge.
- Connecting patients to services they will need post-discharge can help prevent readmission. In a study of 30-day behavioral health readmissions using a multistate Medicaid database, a 1% increase in the percent of patients receiving follow-up within

seven days of discharge was associated with a 5% reduction in the probability of being readmitted.[6]

- Transitional interventions such as pre- and post-discharge patient education, structured needs assessments, medication reconciliation/education, transition managers, and inpatient/outpatient provider communication have been effective to reduce early psychiatric readmissions. A systematic review of such interventions observed reductions of 13.6% to 37.0%.[7] The time period for counting readmissions varied across studies from 3-24 months post-discharge.
- Similarly, discharge planning in mental health was effective at reducing readmissions. In a systematic review, a meta-analysis of pooled data for 11 studies with a mean follow-up of 3.83 months demonstrated a 34% reduction in risk of readmission.[8]

These studies demonstrate that readmissions can be mitigated by IPFs and that variation in risk-adjusted readmission rates is in part a reflection of the quality of care provided at those facilities. This measure assesses an outcome that reflects the quality of multiple care processes in IPFs and will help focus attention and efforts for improvement.

1.2 Overall Approach

This facility-level measure estimates an unplanned, 30-day, risk-standardized readmission rate for adult Medicare fee-for-service (FFS) patients with a principal discharge diagnosis of a psychiatric disorder or dementia/Alzheimer's disease. We developed the measure specifications using Medicare claims and enrollment data in alignment with the methods used to develop the CMS hospital-wide readmission measure for short-stay acute care hospitals (NQF #1789). The measure complies with accepted standards for outcome measure development set forth in the CMS Measures Management System guidance,[9] National Qualify Forum (NQF),[10] and the guidance articulated in the American Heart Association scientific statement, "Standards for statistical models used for public reporting of health outcomes".[11] These standards include transparency in measure development and testing as well as adequate risk adjustment to account for differences in case mix.

Throughout the measure development process, we sought input from CMS, quality measurement experts, and key stakeholders. We convened a technical expert panel (TEP), representing experts and key stakeholders related to inpatient psychiatric care, to provide input and feedback on the development of the measure. We also established a readmission work group at the University of Florida with relevant expertise in psychiatry, psychology, IPF management, epidemiology and measurement, health economics, health services research, statistics, and claims coding and processing. Additionally, members from the Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation participated in the work group. They shared insights gained from experience in readmission measure development and shared their perspective on the best way to apply what they learned to the development of an all-cause readmission measure for the IPF setting.

2. METHODS

This section describes the specifications for the IPF readmission measure. Specifically, it provides a description of the type of data used to calculate the measure, definitions of the target population and outcome, the methods used to risk adjust and calculate measure results, and, finally, the approach to testing the reliability and validity of various aspects of the measure.

2.1 Data Sources

We developed this measure using data from administrative claims. These data are readily available and have minimal provider burden for data collection compared to electronic health record extracted data and chart abstraction. Specifically, this measure is calculated using information from the following three sources: the Medicare Denominator file, Medicare FFS Part A records, and Medicare FFS Part B records. The Medicare Denominator file contains patient demographic, enrollment, and vital status information for all beneficiaries enrolled during the calendar year. Part A data contain final action claims submitted by institutional providers for reimbursement of inpatient and outpatient services provided to beneficiaries. Institutional providers include acute care and critical access hospitals, inpatient psychiatric facilities, home health agencies, and skilled nursing facilities. Part B data contain final action claims submitted by non-institutional providers including physicians, physician assistants, clinical social workers, nurse practitioners, and other providers, such as clinical laboratories and ambulance providers. For this measure, claims for services such as laboratory tests, medical supplies, or other ambulatory services were not used. This ensures that diagnoses result from an encounter with a provider trained to establish diagnoses and not a claim for a diagnostic test.

We utilized the following information from the Medicare FFS Parts A and B datasets:

- Diagnosis and procedure codes
- Dates of service
- Reimbursement amounts
- Provider
- Beneficiary demographics

2.2 Target Population

This measure was developed for admissions to freestanding IPFs or IPF units within a hospital for adult Medicare FFS patients who were enrolled in Medicare Parts A and B. We determined that a 24-month measurement period would be required to provide an adequate facility-level sample size. Therefore, we built an analytical dataset that included index admissions for the 24-month period between January 1, 2012 and December 31, 2013 for measure development.

2.2.1 Inclusion Criteria

The admission to which the readmission outcome is attributed is referred to as an index admission. Eligible index admissions include those for which patients are:

- Admitted to an IPF. This measure is limited to index admissions to IPFs identified in Medicare Part A administrative claims. These admissions account for approximately two-

thirds of all admissions for principal psychiatric disorders. The remaining admissions with principal psychiatric disorders are to short-stay acute care hospitals without IPF units.

- Discharged with a principal diagnosis that indicates psychiatric illness. Consistent with the CMS Hospital-Wide Readmission Measure, we grouped principal discharge diagnosis ICD-9-CM codes to form clinically coherent condition groups. We used the Clinical Classifications Software (CCS) groupings developed by the Agency for Healthcare Research and Quality (AHRQ).[12] We chose the AHRQ software because it was developed on the Nationwide Inpatient Sample within the Healthcare Cost and Utilization Project and is widely used in health service research, epidemiology, and quality measurement.

  The AHRQ software identifies 15 psychiatric clinical condition groups (650-670). Accordingly, we define admission for psychiatric causes as any index admission with a principal discharge diagnosis that is included in CCS 650-670 (Table 1).

Table 1. Principal discharge diagnosis clinical categories designating psychiatric illness for measure cohort

Diagnosis CCS	Description	Count	Percent Admissions n=790,644
650	Adjustment Disorders	6,460	0.8
651	Anxiety Disorders	9,371	1.2
652	Attention-deficit, conduct, and disruptive behavior disorders	1,119	0.1
653	Delirium, dementia, and amnestic and other cognitive disorders	109,993	13.9
654	Developmental disorders	438	0.1
655	Disorders usually diagnosed in infancy, childhood, or adolescence	474	0.1
656	Impulse control disorders, NEC	3,082	0.4
657	Mood disorders	335,028	42.4
658	Personality disorders	1,611	0.2
659	Schizophrenia and other psychotic disorders	266,535	33.7
660	Alcohol-related disorders	21,600	2.7
661	Substance-related disorders	23,276	2.9
662	Suicide and intentional self-inflicted injury	291	0.0
663	Screening and history of mental health and substance abuse codes	287	0.0
670	Miscellaneous disorders	2,421	0.3

IPFs are expected to admit patients who need inpatient care for a psychiatric principal diagnosis.[13] However, a small number of claims (8,658 or 1.1%) had discharge diagnoses that are not in the psychiatric condition categories of CCS 650-670. These admissions could represent coding errors or, more likely, cases where the admission was initiated for

psychiatric reasons but during the course of care it became clear that a non-psychiatric illness was the primary diagnosis. Therefore, these admissions are not included in the measure cohort because either they are not typical of inpatient psychiatric facility admissions or they could represent unreliable data. The top 10 principal discharge diagnosis clinical categories of the non-psychiatric index admissions are listed in Table 2.

Table 2. Top 10 non-psychiatric principal discharge diagnosis clinical categories of index admissions

Primary CCS	CCS Description	Count	Percent of Excluded	Cumulative Percent
111	Other and ill-defined cerebrovascular disease	1,860	21.5	21.5
85	Coma; stupor; and brain damage	814	9.4	30.9
95	Other nervous system disorders	738	8.5	39.4
159	Urinary tract infections	485	5.6	45.0
81	Other hereditary and degenerative nervous system conditions	438	5.1	50.1
241	Poisoning by psychotropic agents	397	4.6	54.7
259	Residual codes; unclassified	375	4.3	59.0
113	Late effects of cerebrovascular disease	368	4.3	63.2
242	Poisoning by other medications and drugs	361	4.2	67.4
79	Parkinson`s disease	311	3.6	71.0

- Discharged alive. Only patients discharged alive are at risk for readmission. Vital status is determined from the discharge status field of the index admission.

- Age 18 or older at admission. The measure is not limited to adults over 65 years of age like many other CMS readmission measures. Many patients with severe mental illness qualify for Medicare due to disability and approximately 65% of index admissions were less than 65 years old at the day of admission. Patients under age 18 are excluded from the measure because the number of pediatric patients was too small to develop a meaningful measure and valid risk adjustment model with Medicare billing records. Age on admission is calculated from the admission date and the beneficiary date of birth obtained from the Medicare Denominator file.

- Enrolled in Medicare Parts A and B during the 12 months prior to, the month of, and at least one month after the index admission. The enrollment period prior to the index admission is necessary to ascertain information on health history and comorbidities for risk adjustment. The one-month follow-up period thereafter is required to fully assess readmissions. Because index admissions are confined to IPFs, which may not capture medical comorbidities comprehensively in their billing record coding, we decided to include both Medicare Part A and Part B claims to obtain information on health history and comorbidity. On average, about 42% of diagnoses would have been missed if only Part A had been considered (Appendix A).

Patient admissions are included regardless of Medicaid eligibility, which is present for approximately 58% of all IPF admissions. Because Medicare serves as the primary payer for all services necessary to define the measure cohort, outcome, and risk factors, Medicaid claims data are not needed to calculate the measure results.

2.2.2 Exclusion Criteria

The goal of this measure is to assess all psychiatric admissions treated by IPFs rather than focusing on the outcomes of patients with a specific psychiatric condition. Thus, the only exclusion criteria we applied were those that improved validity and reduced bias in measure results. Index admissions are excluded if any of the following apply:

- Discharge against medical advice. Consistent with CMS inpatient readmission measures, admissions where patients leave against medical advice (AMA) are excluded because the facility may have limited opportunity to complete treatment and prepare for discharge. However, given that providers have a responsibility to discourage patients with mental illness and potentially impaired decision-making capabilities from leaving AMA and readmission rates for patients who left AMA were higher than those who did not (28.7% versus 20.9%), we were concerned about potentially excluding a particularly vulnerable sub-population of patients from the measure cohort. The work group agreed that if AMA admissions were to be included in the cohort, the measure would need to be risk adjusted for patients who were admitted involuntarily because these patients leave AMA more frequently and are not evenly distributed across facilities. At the time of measure development, information on involuntary admission was inadequately captured in claims data. Therefore, index admissions where the patient leaves AMA are excluded from this version of the measure to ensure that results were unbiased with regard to AMA discharges.

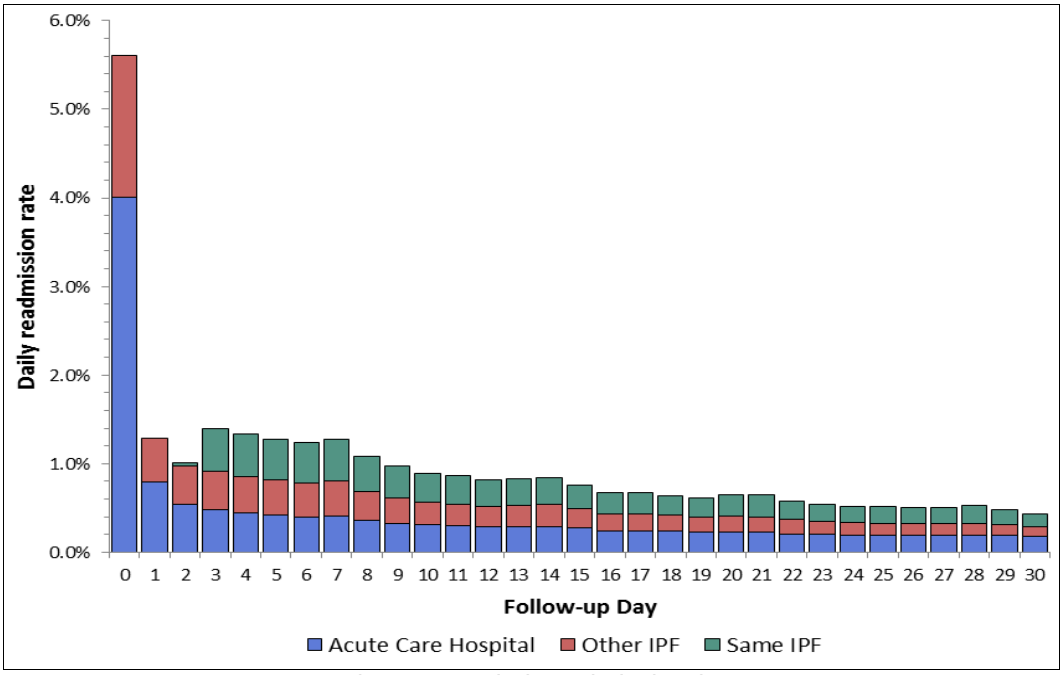
- Unreliable data. Index admissions with unreliable demographic and death information are excluded from the measure. Unreliable demographic information is defined as age greater than 115 years or missing gender. Unreliable death information is defined as:

    - An admission with a discharge status of ‘dead’ but the person has subsequent admissions;
    - The death date is prior to the admission date; or
    - The death date is within the admission and discharge dates for an admission but the discharge status is not ‘dead’.

- Transfers. Consistent with CMS inpatient readmission measures, admissions that end in a transfer to another inpatient facility are excluded. The hospital that discharges a patient to home or a non-acute care setting is accountable for any subsequent readmission. Transfers are defined as a discharge from an IPF (Hospital A) and an admission to another hospital (Hospital B) on the same or next day (Day 0 or Day 1) or a discharge from an IPF (Hospital A) that occurs after admission to another hospital (Hospital B). In these scenarios, the admissions to Hospital A were excluded from the measure cohort and the admissions to Hospital B that met all other eligibility criteria were included as the index admission in the measure cohort.

- Interrupted stays. Index admissions that are part of episodes of care known as *interrupted stays* are excluded from the measure. An interrupted stay, as defined by CMS reimbursement policy, is a readmission to any IPF before midnight on the third consecutive day following discharge from an IPF. The interrupted stay billing procedure requires one claim if a patient is readmitted to the same IPF within 3 days (Day 0, 1, 2), whereas two claims would be submitted if the patient is readmitted to a different IPF or an acute care facility during this time frame. As a result of this billing policy, very few readmissions to the same IPF appear in the claims data on Days 0, 1, or 2 (Figure 1).

Figure 1. Distribution of readmissions per follow-up day by admitting IPF type



(n=716,714 index admissions)

Admissions with a second admission on Days 0 and 1 post-discharge are already excluded from the measure cohort as transfers. As a result, the interrupted stay policy has implications only for index admissions with readmissions that occur on Day 2 post-discharge. Inclusion of index admissions with readmissions on Day 2 in the measure cohort could create bias because readmissions to different IPFs or acute care hospitals are visible in claims data, while readmissions to the same IPF are not. The readmission locations could be related to the availability of local resources or other parameters related to IPF performance. Therefore, all index admissions with a readmission on Day 2 were excluded from the measure cohort. Like transfers, readmissions to different IPFs on Day 2 that meet all other eligibility criteria are included as the index admission in the measure cohort.

2.2.3 Multiple Admissions

A patient may have multiple index admissions included in the measure cohort during a single measurement period if each admission meets all of the eligibility criteria. This means that a

readmission can also be eligible as an index admission, which is aligned with the CMS Hospital-Wide Readmission Measure. The measure work group and TEP concurred that the inclusion of all admissions enhances the measure's focus on quality because patients who are readmitted repeatedly are particularly important targets for quality improvement. Restriction to the first readmission only would mask important opportunities to prevent repeated readmissions for this particularly vulnerable group of patients. During the two-year measurement period, nearly one third of patients were admitted more than once and nearly one in twenty patients were admitted five or more times, which emphasizes the importance of capturing multiple admissions in the IPF population (Table 3).

Table 3. Number of IPF stays per patient in the measure cohort, Jan. 1, 2012 – Dec. 31, 2013

Number of Admissions	Number of Beneficiaries	Percent of Beneficiaries	Cumulative Frequency	Cumulative Percent
1	292,101	68.4	292,101	68.4
2	72,959	17.1	365,060	85.4
3	28,778	6.7	393,838	92.2
4	13,745	3.2	407,583	95.4
5	7,434	1.7	415,017	97.1
6	4,202	1.0	419,219	98.1
7	2,712	0.6	421,931	98.7
8	1,697	0.4	423,628	99.1
9	1,092	0.3	424,720	99.4
10	724	0.2	425,444	99.6
11 +	1,829	0.4	427,273	100.0

2.2.4 Final Measure Cohort

The final measure cohort consisted of 716,174 index admissions, representing 427,273 adult Medicare beneficiaries. Table 4 summarizes the selection of the measure population.

Table 4. Selection of the measure population

Index File Creation Step	Total
Adult IPF admissions with admission and discharge between January 1, 2012 – December 31, 2013, discharged alive with a psychiatric principal discharge diagnosis, and enrolled in FFS Part A and B in the 12 months prior to admission, the month of admission, and at least 1 month post-discharge	781,986
• Unreliable data	58
• Transfers and Interrupted Stays	56,644
• AMA	9,110
Cohort (index admissions)	716,174

2.3. Outcome Definition

The measure estimates the incidence of unplanned, all-cause readmissions to IPFs or short-stay acute care hospitals following discharge from an eligible IPF index admission. We defined readmission as any admission that occurs on or between Days 3 and 30 post-discharge, except

those considered planned. For measure development, readmissions were identified in calendar years 2012 and 2013 and in January 2014 to capture readmissions within 30 days of December 2013 admissions.

2.3.1 All-Cause Readmission

Several considerations went into the decision to develop an all-cause readmission measure rather than a measure that focuses on readmissions for mental illness or for the same principal discharge diagnosis as the index admission. Those considerations are listed below.

1. Our approach is consistent with CMS publicly reported, all-cause readmission measures, including the hospital-wide readmission measure for acute care hospitals. Any readmission is undesirable for patients, regardless of cause. Readmissions for medical (i.e., non-psychiatric) reasons represent about one quarter of all readmissions in this measure (Table 5).
2. Determination of the relationship between the principal discharge diagnosis of the index admission and the principal discharge diagnosis of the readmission is complex because even similar clinical presentations might be captured with slightly different principal diagnosis codes. For example, a patient discharged with bipolar disorder from the index admission may be readmitted because of a suicide attempt. Furthermore, hospital-acquired complications may manifest in a range of clinical diagnoses that can be unrelated to the principal or secondary diagnoses of the index admission. Two examples of complications include preventable adverse drug events or nosocomial infections.
3. While the current standard of care does not require IPFs to have general medical care available on site, it does require that adequate transfer agreements be in place to ensure adequate availability of medical care at another facility. Mental disorders create barriers to medical care, resulting in under-diagnosis and under-treatment of medical issues. Thus, IPF admissions offer opportunities to initiate or optimize proper medical care for these patients.
4. Complex interplays between psychiatric and medical illness may complicate the designation of the principal discharge diagnosis, resulting in arbitrary distinction of medical versus psychiatric readmissions. Readmissions from various, related causes are best captured in an all-cause readmission measure.
5. A focus on all-cause readmissions offers the IPF an opportunity to implement a broader range of quality improvement initiatives with promise for greater impact than measures that focus on a specific cause of readmission.

Table 5. Distribution of psychiatric and medical readmissions

Readmission Type	Count (Readmission Rate) n=716,174 index admissions
All	149,475 (20.9%)
Psychiatric readmission (principal discharge diagnosis category CCS 650-670)	113,716 (15.9%)
Medical readmission (principal discharge diagnosis category not within CCS 650-670)	35,759 (5.0%)

Table 6 shows that the top five principal discharge diagnosis categories among readmissions are for psychiatric disorders and account for almost three-fourths of readmissions. The next five most frequent principal discharge diagnosis categories among readmissions are for medical diagnoses. The largest category, septicemia, accounts for less than 2% of readmissions.

Table 6. Top 10 principal discharge diagnoses clinical categories at readmission

CCS	CCS Description	Frequency	Percent n=149,475 readmissions	Cumulative Frequency	Cumulative Percent
659	Schizophrenia and other psychotic disorders	49,672	33.2	49,672	33.2
657	Mood disorders	43,160	28.9	92,832	62.1
653	Delirium, dementia, and amnestic and other cognitive disorders	8,486	5.7	101,318	67.8
660	Alcohol-related disorders	5,059	3.4	106,377	71.2
661	Substance-related disorders	4,049	2.7	110,426	73.9
2	Septicemia (except in labor)	2,406	1.6	112,832	75.5
122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)	1,961	1.3	114,793	76.8
242	Poisoning by other medications and drugs	1,620	1.1	116,413	77.9
241	Poisoning by psychotropic agents	1,595	1.1	118,008	78.9
159	Urinary tract infections	1,580	1.1	119,588	80.0
	Other	29,887	20.0	149,475	100.0

2.3.2 Planned Readmissions

Planned readmissions are hospitalizations that occur within 30 days of an inpatient admission but are appropriately scheduled as part of a patient's treatment plan. These readmissions are not considered in this measure. In alignment with other CMS inpatient readmission measures, this measure does not consider any readmissions that occur subsequent to a planned readmission even if they occur within 30 days of discharge from the index admission. However, the planned readmission can become an index admission if it meets all other eligibility criteria. This ensures that readmissions are attributed to the most proximal admission which has the most influence over the readmission outcome.

For purposes of harmonization, we adopted the CMS Planned Readmission Algorithm, Version 3.0 for use in this measure (Appendix B).[1] This algorithm has been extensively tested and validated in the hospital setting. In brief, the planned readmission algorithm follows two principles to identify planned readmissions:

- Select procedures and diagnoses such as transplant surgery, maintenance chemotherapy/radiotherapy/immunotherapy, rehabilitation, and forceps delivery, are considered always planned (summarized in Table B.1 and Table B.2).
- Some procedures, such as colorectal resection or aortic resection, are considered either planned or unplanned depending on the accompanying principal discharge diagnosis

(Table B.3). Specifically, a procedure is considered planned if it does not coincide with a principal discharge diagnosis of an acute illness or complication (Table B.4).

We reviewed the planned readmission algorithm with the measure work group to ensure full applicability to IPFs and treatment of patients with mental illness. The work group agreed with the general algorithm but highlighted one procedure, electroconvulsive therapy (ECT) (ICD-9-CM 94.26 and 94.27), for further discussion because it was identified as the only potentially planned procedure that specifically treats psychiatric conditions. Of 153,684 readmissions, we found 2,445 (1.4%) with ECT procedures. These procedures accounted for 41.8% of all 5,855 potentially planned procedures. The majority of the ECT procedures (>94%) were associated with principal discharge diagnoses of mood disorders (CCS 657) and schizophrenia (CCS 659), which are not considered acute complications by the planned readmission algorithm. Accordingly, ECT procedures with these diagnoses are considered planned. A total of 130 of 2,445 (5.3%) readmissions with ECT procedures were associated with an acute diagnosis and, therefore, would be considered unplanned, according to the existing algorithm. The full list of principal discharge diagnoses associated with ECT readmissions is listed in Table 7.

Table 7. Principal discharge diagnosis categories associated with readmissions with ECT

CCS	Description	Count	Percent	Acute
657	Mood disorders	1,768	72.3	
659	Schizophrenia and other psychotic disorders	541	22.1	
653	Delirium, dementia, and amnestic and other cognitive disorders	59	2.4	X
660	Alcohol-related disorders	14	0.6	X
661	Substance-related disorders	13	0.5	X
651	Anxiety disorders	12	0.6	X
241	Poisoning by psychotropic agents	4	0.2	X
658	Personality disorders	4	0.2	X
670	Miscellaneous disorders	4	0.2	X
131	Respiratory failure; insufficiency; arrest (adult)	3	0.1	X
211	Other connective tissue disease	2	0.2	
242	Poisoning by other medications and drugs	2	0.2	X
108	Congestive heart failure; nonhypertensive	1	0.0	
122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)	1	0.0	X
145	Intestinal obstruction without hernia	1	0.0	X
159	Urinary tract infections	1	0.0	X
197	Skin and subcutaneous tissue infections	1	0.0	X
236	Open wounds of extremities	1	0.0	
237	Complication of device; implant or graft	1	0.0	X
238	Complications of surgical procedures or medical care	1	0.0	X
244	Other injuries and conditions due to external causes	1	0.0	X
50	Diabetes mellitus with complications	1	0.0	
55	Fluid and electrolyte disorders	1	0.0	X
63	Diseases of white blood cells	1	0.0	X
64	Other hematologic conditions	1	0.0	

CCS	Description	Count	Percent	Acute
654	Developmental disorders	1	0.0	
656	Impulse control disorders, NEC	1	0.0	X
662	Suicide and intentional self-inflicted injury	1	0.0	X
83	Epilepsy; convulsions	1	0.0	X
85	Coma; stupor; and brain damage	1	0.0	X
99	Hypertension with complications and secondary hypertension	1	0.0	X

The work group agreed with the designation of acute complications that would render an ECT procedure unplanned. Regarding ECT readmissions for mood disorders and schizophrenia, the work group discussed two possible pathways: readmissions that were indeed planned to administer ECT or readmissions that were actually unplanned and caused by schizophrenia or mood disorder severity. To investigate which pathway most likely leads to these readmissions, we looked into the number of readmissions where ECT was provided during a prior admission. More than 35% of ECT procedures occurred in follow-up to ECT that was administered on the index admission. Similarly, of 2,637 index admissions with ECT treatment that resulted in a readmission, 968 (36.7%) received ECT on readmission. This aligned with the work group's opinion that planned admissions to facilitate ECT administration are not uncommon. Therefore, we decided with work group and TEP input to adopt the Planned Readmission Algorithm, Version 3.0, with no changes to the classification of ECT procedures. In other words, readmissions for ECT will only be included in the outcome if they are accompanied by an acute diagnosis. Otherwise, they will be considered planned.

Because the measure population is mostly composed of patients with acute mental illness, who are rarely treated with services that require planned readmissions, the impact of planned readmissions on the overall measure numerator was minimal. Only 2.7% of readmissions were excluded because they were considered planned (Table 8).

Table 8. Distribution of planned readmissions by type

	Count	Readmission Rate	Percent of Readmissions	Percent of Planned Readmissions
Index Admissions	716,174			
All Readmissions	153,684	21.5%		
Unplanned Readmissions - included in numerator	149,475	20.9%		
Potentially planned and with acute diagnosis – unplanned	1,702	0.2%	1.1%	
Planned readmissions – excluded from numerator	4,209	0.6%	2.7%	
Always planned procedure	30	0.0%	0.0%	0.7%
Always planned diagnosis	26	0.0%	0.0%	0.6%
Potentially planned and with no acute diagnosis	4,153	0.6%	2.7%	98.7%

2.3.3 Readmission Incidence Period

For the IPF readmission measure, we determined that the incidence period would include Days 3–30 following discharge from an eligible index admission. As previously discussed, the incidence period begins on Day 3 following hospital discharge because of limitations differentiating readmissions from transfers and interrupted stays in claims data.

We examined readmission rates for various time periods as provided in Table 9. Consistent with the literature, this patient population has an increasing readmission rate the longer the time interval from discharge with about half of all index admissions being readmitted within 6 months.

Table 9. Readmission rate distributions by varying incidence periods

Incidence Period (days)	Denominator	All Readmissions		Psychiatric		Non-Psychiatric	
		Readmits	Rate (%)	Readmits	Rate (%)	Readmits	Rate (%)
7	716,174	45,275	6.3	10	5.0	9,717	1.4
15	716,174	94,397	13.2	73,012	10.2	21,385	3.0
30	716,174	153,684	21.5	116,220	16.2	37,464	5.2
60	699,798	222,634	31.8	167,824	24.0	60,231	8.6
90	689,327	266,718	38.7	200,844	29.1	76,877	11.2
180	661,327	335,505	50.7	255,373	38.6	108,352	16.4

Even though the risk of readmission continues to rise beyond 30 days after discharge, we selected the 30-day time frame as being most appropriate for the following reasons:

- A 30-day incidence period is consistent with readmission measures that have been endorsed by NQF and are publicly reported in the CMS Inpatient Quality Reporting Programs. Measure specifications should be harmonized unless the evidence supports modification.
- Literature supports the connection between readmissions during the 30-day time frame and the quality of care provided during the index hospitalization.[14-20] Studies on risk factors for 30-day readmissions show independent associations between certain aspects of IPF care and readmission rates, stressing 30-day unplanned readmission as an indicator of poor service quality.[21-23] These findings are consistent with other studies by organizations such as the Mental Health Services Administration (SAMHSA) and its Center for Mental Health Services (CMHS) which found 30-day hospital readmission to be a quality indicator.[24]
- Thirty days is the current standard for the amount of time that care received within a facility and during the discharge and transition process can influence readmissions. Efforts to improve 30-day readmission rates in a wide range of patient populations have been studied extensively and several interventions such as improvements in pre-discharge care and a focused effort on comprehensive discharge planning have been shown to reduce 30-day readmission rates.[14-19,25-33]
- The measure work group concurred that the 30-day time period captures complications that may be attributable to IPF care.

More stability in psychiatric conditions and management in the outpatient setting with fewer readmissions in any time period is desirable; therefore, we conducted a sensitivity analysis to explore the impact on IPF readmission rates for a longer time period of 90 days after discharge. We computed risk standardized 90-day readmission rates for IPFs as presented in Appendix D1. The 90-day readmission rates resulted in substantial changes in the classification of IPFs in all categories—better than, not different than, or worse than the national rate. The sensitivity analysis cannot indicate which rate is a more valid reflection of IPF quality of care but does suggest that the measures with different time frames are potentially measuring different constructs. Given these results and the rationale presented above, we are confident that the 30-day time period is most appropriate.

2.4 Risk Model Development

Because the clinical and demographic characteristics of patients are expected to differ across IPFs and these characteristics might affect readmission risk, the case mix needs to be balanced to allow fair comparisons of readmission rates across hospitals. The goal of risk adjustment is to ensure that the residual variation among facility rates solely reflects differences in performance. Thus, risk adjustment is critical for measure validity. To develop the risk model, we utilized a 12-month look back-period from the index admission to ascertain readmission risk factors. Therefore, we used Medicare Parts A and B data from calendar years 2011 through 2013. This section discusses the process for identifying and developing the risk factors for consideration, the empirical approach to selecting model variables, and additional considerations for finalizing the risk model for this measure.

2.4.1 Identification and Development of Candidate Risk Variables

We considered four types of risk factor variables:

- Patient demographic factors
  - Age and gender designations in claims data
- Principal discharge diagnosis of the IPF index admission
  - Discharge diagnoses using modified AHRQ CCS categories
- Comorbidity risk variables
  - Secondary diagnoses of the index admission and primary or secondary diagnoses of inpatient and outpatient encounters during the 12-month look-back period using modified CMS Hierarchical Condition Categories (CC) groupings. We chose these groupings because they were developed by CMS specifically for risk adjustment and are used in other readmission measures to capture comorbidities.
- Other risk factor variables identified from literature review
  - Proxies for the severity of medical or psychiatric illness, functional status, and patient cooperation/compliance that can be identified in inpatient or outpatient claims during the index admission or 12-month look-back period. At the time of measure development, NQF and CMS policy regarding the inclusion of sociodemographic factors in the risk adjustment models of quality measures had not been finalized. Therefore, those variables were not considered for this version of the measure.

Before evaluating each of the variables in the risk model, we carefully assessed the best way to define each type of variable. When available, we utilized existing ICD-9-CM grouping categories and explored empirically how best to modify them to capture the risk of readmission in this population and create a more parsimonious set of variables. In some instances, we reassigned ICD-9-CM codes to different groupings and in other instances we combined groupings that were clinically similar and carried similar risk. The following subsections describe in more detail how we defined each type of risk variable.

2.4.1.1 Principal discharge diagnosis risk variables

Because the measure cohort includes an array of psychiatric disorders and certain psychiatric diagnoses are expected to carry a greater risk of readmission, we include principal discharge diagnoses as risk variables. The CCS categories were not developed for use in risk adjustment so we carefully considered the most appropriate way to cluster these diagnosis codes based on clinical presentation, frequency, and readmission risk. We modified the 15 established CCS categories that summarize mental illness categories (650 – 670) as follows. We combined several CCS categories with small frequency and similar readmission risk into two new categories (652/654/655 and 670/663). We also created subcategories for mood disorders (CCS 657.1 and CCS 657.2) to capture differences in clinical presentation as well as readmission risk among patients with bipolar versus depressive disorders. The new subcategory for depressive disorders was then combined with suicide attempt/self-injury (CCS 662) because of similar readmission risk. The category for schizophrenia was also split into subcategories to distinguish schizo-affective disorders from psychosis (CCS 659.1 and CCS 659.2). The final groupings are a mutually exclusive categorization of ICD-9-CM codes into 13 unique modified CCS categories (Appendix C, Table C.1).

2.4.1.2 Candidate comorbidity risk variables

We derived comorbidity risk variables from three types of source data: the secondary diagnoses of the index admission, principal and secondary diagnoses of hospitalizations in the 12 months preceding the index admission, and principal and secondary diagnoses of emergency department claims or outpatient claims that had evaluation and management (E&M) procedure codes indicating services provided by physicians or qualified health care professionals. This assures that diagnosis codes are only considered when assigned to services provided by practitioners with the training to establish diagnoses. To improve specificity and eliminate diagnoses that may have been assigned during diagnostic work up without later confirmation, a minimum of two outpatient claims with a diagnosis in the same condition category were required for inclusion as a risk variable. Special attention was given to secondary diagnoses of the index admission because these may reflect either comorbidities that existed prior to the hospitalization or complications that developed during admission that may reflect quality of hospital care and thus potential performance deficits.

Psychiatric Comorbidities
We extracted all ICD-9-CM codes that represent mental illness in the CCS (Table 1) and CC categories 48-66. This mapping exercise resulted in a total of 676 unique ICD-9-CM codes that are grouped into a mental illness category by at least one of the classification algorithms. We then determined differences between the grouping approaches and reviewed frequencies and

readmission rates for individual categories as well as individual ICD-9-CM codes. Due to the length of this crosswalk, it was not appended to this report but can be furnished upon request.

We modified the 19 CC categories designating psychiatric illness as follows. We collapsed alcohol/drug psychosis (CC 51), alcohol/drug dependence (CC 52) and alcohol/drug abuse without dependence (CC 53) into a single risk factor because of concerns about the level of clinical specificity when distinguishing between these categories and because of similar readmission rates. We excluded tobacco use disorder (ICD-9-CM 305.1) from CC 53 because readmission rates were distinctly lower. We split schizophrenia (CC 54) into schizo-affective disorders (CC 54.1) and psychosis (CC 54.2) to align with the categorization for the principal discharge diagnosis risk variables. Likewise, we split major depressive, bipolar, and paranoid disorders (CC 55) into bipolar (CC 55.1) and depressive disorders (CC 55.2) because the former exhibits higher readmission rates. We re-categorized paranoid disorders (ICD-9-CM 297x) under psychosis (CC 54.2) to align with the approach used by the comparable CCS grouping. Likewise, reactive and unspecified psychosis (CC 56) was re-categorized under psychosis (CC 54.2) because of similar readmission rates. Depression (CC 58) was grouped together with the newly created depression category (CC 55.2) except for adjustment reaction with prolonged depression (ICD-9-CM 309.1), which was grouped under adjustment reaction (CC 60.1).

We separated post-traumatic stress disorder (CC 60.2) from anxiety disorders (CC 59) because of higher readmission rates. Several other ICD-9-CM codes that were originally grouped under CC 59 (e.g., bulimia, anorexia, somatization disorder) were grouped under other psychiatric disorders (CC 60.3) because of lower readmission rates. Likewise, several ICD-9-CM codes formerly under other psychiatric disorders (CC 60) were re-categorized into adjustment reaction (CC 60.1) and anxiety (CC 59) based on their readmission rates and to align with the comparable CCS groupings.

We combined the categories for severe, moderate, and mild mental retardation (CC 61 to 64) because of concerns regarding the specificity of coding and similar readmission rates. Finally, we re-categorized several non-psychiatric diagnoses that implied alcohol or drug dependence (e.g., ICD-9-CM 648.31, 965.00 opium poisoning, or 779.5 drug withdrawal syndrome newborn) under drug/alcohol disorders (CC 51-53) to align with the comparable CCS groupings. The final set of CC groupings that designate psychiatric illness as comorbidities includes 14 unique modified CC categories (Table C.2).

Based on measure work group discussions and comparisons with previously developed readmission measures, we identified two categories, delirium (CC 48) and alcohol/drug psychosis (CC 51) as potentially related to hospital complications rather than preexisting comorbidities if occurring during the index admission. For example, possible clinical scenarios that could result in psychosis included iatrogenic causes of delirium or failure to properly address drug withdrawal issues. Review of present on admission (POA) designation suggested that the majority (76.2% for delirium and 72.5% for alcohol/drug psychosis) were comorbidities. Only a fraction (2.4% and 4.1%, respectively) was flagged as not present on admission, while the remainder either lacked or had an unclear POA designation. Based on these findings, we decided to exclude these codes as comorbidity risk variables only if the POA flag for that secondary diagnosis code was set to “no” during the index admission.

In an effort to further capture mental disorder severity, we explored whether history of hospitalizations for the most prevalent psychiatric principal diagnoses was more strongly associated with readmissions than general presence of these disorders during the index admission. We did find elevated readmission rates for alcohol/substance use disorders, schizo-affective disorder, bipolar disorder, psychosis and depression. However, because previous admissions could reflect the same performance deficit as the readmission that is targeted in this measure, these variables were eliminated from further consideration.

Non-psychiatric comorbidities
The evaluation of non-psychiatric comorbidities included two decision points: addressing which medical comorbidities should be considered and how selected comorbidities could be further collapsed for statistical efficiency in the final risk model. For medical comorbidity selection, we reviewed frequencies and readmission rates of all non-psychiatric CC categories. We also reviewed the CC categories that had been selected in the acute care short-stay hospital-wide readmission measure and obtained additional input from clinical experts. This process resulted in 86 non-psychiatric candidate CCs. Seventy-five CCs were eliminated from further consideration because they had either low prevalence or showed no appreciable association with readmissions in univariate analysis. Examples of discarded CCs include hypertension and urinary tract infection, which were frequently identified as comorbidities but were not associated with elevated readmission rates. Other examples are major congenital cardiac defects and cystic fibrosis, which had elevated readmission rates but extremely small prevalence, precluding statistically precise estimation of associations with readmission.

To decrease the total degrees of freedom that would need to be considered in the final risk adjustment model, we further collapsed CCs. Considerations in identifying higher-level groupings included the clinical etiology and pathophysiology, frequency and readmission rate estimates, the hierarchical groupings employed by the CC classifications, and groupings that were implemented in the previously developed short-stay acute care hospital-wide readmission measure. The original assignment of ICD-9-CM codes to specific CCs was maintained for all non-psychiatric CCs. For consistency, we also maintained the designation of potential hospital-acquired complications if occurring during the index admission that was used for the short-stay acute care all-cause readmission measure. Those diagnoses are only included in the respective comorbidity variable if they appear in Part A or Part B data preceding the index admission. Table C.2 summarizes the candidate non-psychiatric comorbidity categories, whether they were considered a complication if present in the secondary diagnosis of the index admission, and the final groupings in high-level categories.

2.4.1.3 Other candidate risk variables

To identify any additional risk variables that may be applicable to IPFs, we conducted a systematic literature review of studies aimed at explaining or exploring readmission risk in psychiatric populations. In addition to the expected psychiatric disorders and other non-psychiatric medical diagnoses, the studies we reviewed employed several risk factor concepts aimed at capturing psychiatric disorder complexity, frailty, and patient cooperation/compliance. Additionally, the literature review supported the inclusion of gender in the risk adjustment model for this patient population because it does play an important clinical role in psychiatric disorders.

Male gender is associated with greater disorder severity and is independently associated with greater readmission risk and therefore was considered as one of the demographic variables in model development.[29,34-38 38]

We reviewed each non-demographic variable for feasibility and arrived at a set of 19 potential risk factors that were further explored for inclusion in this risk model. Table 10 lists the candidate risk factors along with the number of studies in our literature review that examined the variable and the rationale for inclusion in those studies.

Table 10. Other candidate risk factor concepts identified in the literature

Risk Factor	Definition	# Studies Including Variable	Proposed Rationale
Admitted due to forensic or legal status	Admission source on the index admission is Court/law enforcement	16	Proxy for cooperation/ compliance
History of discharge AMA	Presence of at least 1 inpatient claim with discharge status of AMA within the 12 months prior to admission	5	Proxy for lack of cooperation/compliance
History of suicidal attempt, ideation, intentional self-harm	Presence of at least 1 inpatient, outpatient, or ED claim with a principal or secondary diagnosis of E950x-E959 or V6284 in the 12 months prior to index admission	6	Proxy for psychiatric disorder severity; independent cause for admission
History of Aggression	Presence of ICD-9-CM 301.7, 312.x, or 313.81 in: secondary diagnosis on index admission; principal or secondary diagnosis on admission within 12 months prior to index admission; or at least 2 emergency department (ED) or outpatient E&M claims in the previous 12 months.	3	Proxy for lack of cooperation/compliance; independent cause of admission
Count of psychiatric comorbidities	Number of unique psychiatric disorders identified from comorbidity risk factor definitions including: 51-53 Drug/Alcohol disorders, 54/56 Schizo-affective/ Psychosis, 55 Bipolar/Depression, 57 Personality disorders, 60.1 Adjustment disorder, 60.2 PTSD, 60.3 Other psych disorders, 61-65 intellectual disability, 66 ADD	6	Proxy for psychiatric disorder complexity / severity
History of somatoform disorders	Principal or secondary diagnosis ICD9-CM 300.8x on claims within 12 months before index admission or secondary diagnosis of the index admission	1	Proxy for psychiatric disorder complexity / severity
History of ECT/TMS	Presence of at least 1 inpatient or outpatient encounter with therapeutic repetitive transcranial magnetic stimulation (TMS) or electroconvulsive therapy (ECT) within the 12 months prior to admission. (CPT codes 90867, 90868, 90870 or ICD-9-CM codes 94.26, 94.27)	3	Proxy for psychiatric disorder severity
History of wellness visits	Outpatient claims with HCPCS G0402, G0438, or G0439 in the 12 months preceding index admission	7	Proxy for cooperation / compliance

Risk Factor	Definition	# Studies Including Variable	Proposed Rationale
History of nursing home stay	Presence of at least 1 SNF claim in the 12 months prior to admission or the admission source on the index admission is SNF	10	Proxy for frailty
History of home healthcare	Presence of at least 1 home healthcare claim in the 12 months prior to admission	10	Proxy for frailty
Established relationship to PCP	Presence of at least 1 Part B claim in the 12 months prior to admission with an E&M procedure with a primary care provider (internal or family medicine)	7	Access to care
History of # of ED visits for dementia	Number of ED visits for dementia (CC 49-50) in 12 months preceding the index admission	3	Proxy for psychiatric disorder complexity / severity
History of # of ED visits for psychiatric causes	Number of ED visits for psychiatric disorders (CC 51-60) in 12 months preceding the index admission	3	Proxy for psychiatric disorder complexity / severity
History of # of ED visits for non-psychiatric causes	Number of ED visits for non-psychiatric disorders (outside 49-66) in 12 months preceding the index admission	3	Proxy for psychiatric disorder complexity / severity
History of # of admissions for dementia	Number of admissions for dementia (CC 49-50) in 12 months preceding the index admission	24	Proxy for psychiatric disorder complexity / severity
History of # of hospital days for dementia	Number of hospital days for dementia (CC 49-50) in the 12 months preceding the index admission	24	Proxy for psychiatric disorder complexity / severity
History of # of admissions for psychiatric causes	Number of admissions for psychiatric disorders (CC 51-60) in 12 months preceding the index admission	24	Proxy for psychiatric disorder complexity / severity
History of # of hospital days for psychiatric causes	Number of hospital days for psychiatric disorders (CC 51-60) in the 12 months preceding the index admission	24	Proxy for psychiatric disorder complexity / severity
History of # of admissions for non-psychiatric causes	Number of admissions for non-psychiatric disorders (outside CC 49-66) in 12 months preceding the index admission	24	Proxy for psychiatric disorder complexity / severity

Several of these variables were not advanced for inclusion in the risk adjustment models. Somatoform disorders were too rare to produce precise estimates of an association with readmission risk. Because the prevalence of wellness visits appeared underestimated, we cross-checked prevalence in the general Medicare population, which yielded only slightly larger estimates around 11%. Thus, we decided to discard this variable because of validity concerns.

A set of variables measured general access to care (history of PCP visit, nursing home stay or home healthcare) or the volume of emergency or acute care (count of emergency room visits or count of hospital stays or hospital days). Although these variables may reflect in part severity of patients' conditions, they may also capture prior quality deficits and local practice patterns, which may be counter to the intent of the measure to reduce readmissions. For example, of all index admissions with a hospital admission in the previous 12 months, 25.9% had their most recent admission preceding the index admission to the same IPF (Table 11). When previous admissions for psychiatric causes were considered, this relationship was more pronounced with 40.5% of index admissions having the most recent admission from the same facility. Therefore, we decided not to include variables that used types of care accessed or frequency of visits in the 12 months prior to the index admission as proxies for severity of illness.

Table 11. History of previous admissions or emergency room visits by location and principal discharge diagnosis

	Psychiatric		Non-psychiatric		Any cause	
	#	%	#	%	#	%
# of index admissions with >0 previous admissions	362,697		261,166		504,507	
Index IPF is the provider for most recent admission	146,778	40.47	1,468	0.56	130,463	25.86
Index IPF is part of the same hospital	9,274	2.56	66,181	25.34	54,253	10.75
Total to Same Hospital	156,052	43.03	67,649	25.90	184,716	36.61
Total to Same Hospital and within 30 days of index admission	21,299	5.87	20,103	7.70	29,392	5.83
# of index admissions with >0 previous ED	310,606		442,894		538,841	
Index IPF is the provider for most recent ED	739	0.24	67	0.02	510	0.09
Index IPF is part of the same hospital as ED	48,415	15.59	85,633	19.33	101,332	18.80
Total ED to Same Hospital	49,154	15.83	85,700	19.35	101,832	18.90
Total to Same Hospital and within 30 days of index admission	9,905	3.19	7,781	1.76	11,088	2.06

We defined the remaining variables from the literature for further analysis similar to the comorbidity risk variables. The variables for discharge AMA, suicide/self-harm, aggression, legal status for admission, and comorbidity counts are obtained from Part A and Part B claims. Discharge AMA is defined as admissions that were discharged against medical advice from an inpatient hospital at least once in the 12-month look back period. We created three variables for discharge AMA in the risk model: had an AMA discharge in the 12 months prior to the index admission, did not have an AMA discharge in the 12 months prior to the index admission, and

did not have an admission to determine AMA in the 12 months prior to the index admission. Suicide/self-harm is defined as admissions with at least one inpatient, outpatient, or emergency department visit with a principal or secondary diagnosis of suicide attempt, ideation, or intentional self-harm in the 12 months prior to the index admission. ECT is defined as admissions with at least one inpatient or outpatient visit for ECT or TMS. Aggression is defined as diagnosis for aggression during the index admission or on one inpatient or at least two outpatient claims in the 12 months prior to the index admission. Comorbidity counts are the number of psychiatric or non-psychiatric comorbidity variables per index admission. Legal status for admission was obtained from the claims for the index admission

2.4.1.4 Summary of candidate risk variables

In summary, we employed a similar approach to defining principal discharge diagnoses using AHRQ CCS categories and comorbidities using CMS CC categories as had been done in the CMS Hospital-Wide Readmission measure. However, we made several modifications to the groupings with the goal of increasing the sensitivity and specificity of risk variables. First, we mapped and manually reviewed psychiatric diagnoses clusters established with the CCS or CC approaches to arrive at an optimized set of clinically consistent groups with similar readmission rates. Second, we utilized both Part A and Part B data ascertained from a 12-month pre-index admission period to ensure comprehensive capture of comorbidities and disease severity. Third, in order to optimize specificity of comorbidity ascertainment we only included Part B claims with E&M CPT codes and required a minimum of two claims of the same CC cluster to establish presence of a given comorbidity. Finally, we conducted a systematic literature review to ascertain variables that were tested in studies aimed at explaining readmission risk. As a result, we developed several risk factors that can serve as proxy for disease severity and frailty.

Table 12 lists all risk factors that were advanced for testing in multivariate risk models along with their frequencies and the percent of index admissions with that risk factor that were followed by a readmission within 30 days of discharge. Where CCs were combined for the non-psychiatric comorbidities, we also list the component CCs of the higher level groupings.

Table 12. Frequencies and readmission rates of candidate risk variables

Risk Variable Name / Description	Index Admissions	Percent of Index Admissions n=716,174	Percent readmitted
Demographic factors			
Gender: Male	348,641	48.7	23.4
Age			
18-34	92,281	12.9	25.4
35-44	107,682	15.0	24.6
45-54	150,626	21.0	23.5
55-64	117,317	16.4	21.3
65-74	108,554	15.2	16.6
75-84	88,310	12.3	15.7
85+	51,404	7.2	14.4

Risk Variable Name / Description	Index Admissions	Percent of Index Admissions n=716,174	Percent readmitted
Principal discharge diagnosis on index admission			
CCS 650 Adjustment disorder	6,097	0.9	14.8
CCS 651 Anxiety	8,723	1.2	18.7
CCS 652/654/655 ADD/Developmental/Childhood disorders	1,854	0.3	17.2
CCS 653 Dementia	99,273	13.9	16.2
CCS 656 Impulse control disorders	2,916	0.4	18.6
CCS 657.1 Bipolar disorder	158,323	22.1	22.5
CCS 657.2/662 Depressive disorder	150,325	21.0	18.0
CCS 658 Personality disorder	1,471	0.2	27.7
CCS 659.1 Schizo-affective disorder	113,218	15.8	26.2
CCS 659.2 Psychosis	131,732	18.4	21.6
CCS 660 Alcohol disorder	19,244	2.7	21.9
CCS 661 Drug disorder	20,560	2.9	19.5
CCS 670/663 Other mental disorder	2,438	0.3	22.7
Comorbidities			
Psychiatric			
Delirium	89,490	12.5	25.4
Dementia	178,287	24.9	17.7
Senility	12,686	1.8	23.1
Drug/alcohol disorder	309,238	43.2	25.6
Schizo-affective disorder	161,083	22.5	31.1
Psychosis	249,999	34.9	26.2
Bipolar disorder	282,469	39.4	27.4
Depression	430,569	60.1	23.2
Personality disorder	134,928	18.8	29.4
Anxiety	270,409	37.8	24.0
Adjustment disorder	23,367	3.3	27.2
PTSD	77,614	10.8	26.9
Other psych disorders	109,185	15.3	27.7
Intellectual disability	38,975	5.4	25.2
Developmental disability	35,391	4.9	27.7
Non-psychiatric			
Other infection	136,275	19.0	24.9
Metastasis	3,051	0.4	24.2
Other cancer	22,304	3.1	19.8
Diabetes complications (CC15 Diabetes with renal manifestation, CC16 Diabetes with neurologic or peripheral circulatory manifestation, CC17 Diabetes with acute complications, CC18 Diabetes with ophthalmologic manifestations)	46,961	6.6	24.8

Risk Variable Name / Description	Index Admissions	Percent of Index Admissions n=716,174	Percent readmitted
Diabetes (CC19 Diabetes with no or unspecified complications, CC119 Proliferative diabetic retinopathy and vitreous hemorrhage, CC120 Diabetic and other vascular retinopathies)	187,448	26.2	22.4
Malnutrition	32,891	4.6	24.9
Hematological disorder	2,996	0.4	28.5
"Plegia"/amputation (CC67 Quadriplegia, other extensive paralysis, CC68 Paraplegia, CC69 Spinal cord disorders/injuries, CC100 Hemiplegia/hemiparesis, CC101 Diplegia (upper), monoplegia, and other paralytic syndromes, CC102 Speech, language, cognitive, perceptual deficits, CC177 Amputation status, lower limb/amputation complications, CC178 Amputation status, upper limb)	38,766	5.4	22.3
Seizures	96,201	13.4	27.6
Heart failure	71,241	10.0	23.5
Arrhythmia (CC92 Specified heart arrhythmias, CC93 Other heart rhythm and conduction disorders)	104,344	14.6	23.5
Asthma	100,030	14.0	27.0
Dialysis	3,001	0.4	33.0
Sepsis	19,287	2.7	25.7
Endocrine disease (CC22 Other significant endocrine and metabolic disorders, CC23 Disorders of fluid/electrolyte/acid-base balance)	223,401	31.2	25.0
Anemia	186,380	26.0	25.2
Cardio-respiratory failure	45,616	6.4	25.7
AMI (CC81 Acute myocardial infarction, CC 82 Unstable angina and other acute ischemic heart disease)	13,693	1.9	27.2
Renal failure	96,235	13.4	23.5
Pancreatic disease	14,750	2.1	29.5
Urinary tract disorder	59,668	8.3	24.0
Coagulation defects	40,913	5.7	26.5
Peptic ulcer	40,834	5.7	27.1
Infection (CC1 HIV/AIDS, CC3 Central nervous system infection, CC4 Tuberculosis, CC5 Opportunistic infections, CC37 Bone/joint/muscle infection, CC152 Cellulitis, local skin infection)	78,977	11.0	27.2
Liver disease (CC25 End-stage liver disease, CC26 Cirrhosis of liver, CC27 Chronic hepatitis, CC28 Acute liver	67,685	9.5	29.8

Risk Variable Name / Description	Index Admissions	Percent of Index Admissions n=716,174	Percent readmitted
failure/disease, CC29 Other hepatitis and liver disease)			
Heart disease (CC83 Angina pectoris/old myocardial infarction, CC84 Coronary atherosclerosis/other chronic ischemic heart disease, CC89 Hypertensive heart and renal disease or encephalopathy, CC90 Hypertensive heart disease, CC104 Vascular disease with complications, CC105 Vascular disease, CC106 Other circulatory disease)	225,466	31.5	22.4
Cerebral disease (CC95 Cerebral hemorrhage, CC96 Ischemic or unspecified stroke, CC98 Cerebral atherosclerosis and aneurysm, CC99 Cerebrovascular disease, unspecified, CC103 Cerebrovascular disease late effects, unspecified)	49,942	7.0	19.4
COPD/Fibrosis (CC108 Chronic obstructive pulmonary disease, CC109 Fibrosis of lung and other chronic lung disorders)	166,044	23.2	25.1
Skin ulcer (CC148 Decubitus ulcer of skin, CC149 Chronic ulcer of skin, except decubitus)	26,509	3.7	24.3
Lung problems (CC111 Aspiration and specified bacterial pneumonias, CC112 Pneumococcal pneumonia, empyema, lung abscess, CC113 Viral and unspecified pneumonia, pleurisy, CC114 Pleural effusion/pneumothorax, CC115 Other lung disorders)	109,241	15.3	25.8
Cancer (CC8 Lung, upper digestive tract, and other severe cancers, CC9 Lymphatic, head and neck, brain, and other major cancers, CC11 Other respiratory and heart neoplasms, CC12 Other digestive and urinary neoplasms)	17,219	2.4	22.9
Organ transplant (CC174 Major organ transplant status, CC175 Other organ transplant/replacement)	2,632	0.4	26.3
Uncompleted pregnancy (CC142 Miscarriage/abortion, CC146 Uncompleted pregnancy with complications, CC147 Uncompleted pregnancy with no or minor complications)	3,627	0.5	27.1
Injury (CC150 Extensive third-degree burn, CC151 Other third-degree and extensive burns, CC155 Major head injury, CC156 Concussion or unspecified head injury, CC160 Internal injuries, CC162 Other injuries, CC163 Poisonings and allergic reactions)	341,341	47.7	24.0

Risk Variable Name / Description	Index Admissions	Percent of Index Admissions n=716,174	Percent readmitted
Other variables			
Discharged AMA in prior 12 months	30,615	4.3	41.3
Suicide attempt /self-harm	285997	39.9	26.0
ECT/TMS in prior 12 months	13,027	1.8	22.7
Aggression	47,189	6.6	31.4
Admitted due to forensic or legal status (involuntary)	21,243	3.0	17.8
Number of psychiatric comorbidities			
0	61,657	8.6	13.6
1	137,025	19.1	14.7
2	179,689	25.1	17.1
3	155,660	21.7	21.6
4	97,368	13.6	27.2
5+	84,775	11.8	35.7

2.4.2 Risk Factor Selection

We selected candidate risk factors for the final model by considering the conceptual relationship to the outcome and empirical relationships in univariate analyses as described in the previous sections. This section describes the final risk factor selection using multivariate analysis. Because sample size and readmission rates were sufficiently large, we began with a non-parsimonious logistic regression model that included all candidate risk variables. Together with our measure work group we examined the results for plausibility of risk factor prevalence and/or descriptive statistics and consistency with previous evidence regarding their relationship with readmissions. Two variables were eliminated from further model development:

- While, the work group noted that the inability to capture involuntary admissions should be considered when interpreting readmission measure rates because patients' cooperation with treatment regimens post-discharge is expected to be lower for patients admitted involuntarily, admission legal status was removed from further model development because of concerns about the reliability of the claims variable. The work group ultimately agreed that this variable likely does not capture the full spectrum of involuntary admissions and might, therefore, result in erroneous associations.
- History of ECT/TMS was removed from further model development because of low frequency and inconsistent associations with the outcome. It showed protective effects, while the literature showed predominantly predictive effects suggesting its function as proxy for disorder severity.

All other risk variables were advanced to the second stage of variable selection. Specifically, we employed a stepwise logistic regression process with backward elimination of variables, using 100 bootstrap samples derived from the entire measure population via random selection with replacement. For each sample, we ran a logistic regression model including all candidate variables. We retained all variables in the stepwise backward elimination that showed an

association with readmission at p<0.15. Note that selection of higher p values is recommended because backward elimination models tend to select models that are smaller than desirable for predictive purposes.

Table 13 details the output of the selection process including the number of times a variable was selected, and how many times its beta estimate was positive indicating a predictive association.

Table 13. Variable selection in statistical backward elimination process of bootstrap samples

Risk Variable Name / Description	Number of Times Selected	Number of Times Estimates were Positive if Selected
Demographic Factors		
Gender: Male	100	100
Age		
18-34	100	100
35-44	100	100
45-54	100	100
55-64	100	39
65-74	100	0
75-84	100	0
85+ (reference)	---	---
Principal discharge diagnosis on index admission		
CCS 650 Adjustment disorder	100	0
CCS 651 Anxiety	100	4
CCS 652/654/655 ADD/Developmental/Childhood disorders	100	18
CCS 653 Dementia	100	100
CCS 656 Impulse control disorders	100	0
CCS 657.1 Bipolar disorder	100	100
CCS 657.2/662 Depressive disorder	100	0
CCS 658 Personality disorder	100	100
CCS 659.1 Schizo-affective disorder (reference)	---	---
CCS 659.2 Psychosis	100	100
CCS 660 Alcohol disorder	100	96
CCS 661 Drug disorder	100	0
CCS 670/663 Other mental disorder	100	66
Comorbidities		
Psychiatric		
Delirium	100	100
Dementia	26	0
Senility	59	0
Drug/alcohol disorder	100	100
Schizo-affective disorder	100	100
Psychosis	100	100

Risk Variable Name / Description	Number of Times Selected	Number of Times Estimates were Positive if Selected
Bipolar disorder	100	100
Depression	100	100
Personality disorder	100	100
Anxiety	100	100
Adjustment disorder	100	100
PTSD	100	100
Other psych disorders	100	100
Intellectual disability	100	100
Developmental disability	100	100
Non-Psychiatric		
Other infection	100	100
Metastasis	90	90
Other cancer	34	0
Diabetes complications	94	94
Diabetes	99	99
Malnutrition	74	74
Hematological disorder	97	97
“Plegia”/amputation	19	16
Seizures	100	100
Heart failure	100	100
Arrhythmia	100	100
Asthma	100	100
Dialysis	100	100
Sepsis	100	0
Endocrine disease	100	100
Anemia	100	100
Cardio-respiratory failure	100	0
AMI	100	100
Renal failure	20	11
Pancreatic disease	100	100
Urinary tract disorder	100	100
Coagulation defects	66	66
Peptic ulcer	100	100
Infection	100	100
Liver disease	100	100
Heart disease	100	100
Cerebral disease	93	0
COPD/Fibrosis	100	100
Skin ulcer	53	52
Lung problems	100	100
Cancer	20	13
Organ transplant	72	72

Risk Variable Name / Description	Number of Times Selected	Number of Times Estimates were Positive if Selected
Uncompleted pregnancy	76	76
Injury	100	100
Variables from Literature		
Discharged AMA in prior 12 months	100	100
Not discharged AMA in prior 12 months	100	1
No admissions to determine AMA (reference)	---	---
Suicide attempt / self-harm	100	100
Aggression	100	100
Count of psychiatric comorbidities	100	0

In discussion with our measure work group, we decided to retain all variables that were selected at least 70 percent of the time using the following rationale:

- As noted earlier, variables with weak associations can still contribute to the predictive performance of a model.
- Variables that are expected to be unequally distributed among facilities may be important in the model to ensure complete balance between facilities even if these variables' association with readmission risk is not strong. For example, non-psychiatric comorbidities, which are expected to be less complex among patients admitted to freestanding inpatient psychiatric facilities because IPFs cannot accept patients with complex medical needs are included.
- Several severe medical non-psychiatric comorbidities such as cardio-respiratory failure and injury produced protective effects, which appear on first glance counter-intuitive. However, while this measure includes all causes for readmission, it is largely driven by the risk for psychiatric readmissions, which contribute about three quarters of all readmissions. It is conceivable that severe non-psychiatric conditions will preclude patients from admission to psychiatric units or freestanding IPFs because of the significant level of non-psychiatric medical care that is required. This example illustrates that some medical comorbidities may have opposite effects on psychiatric versus non-psychiatric admissions, which may be summarized in an estimate of a somewhat weaker association with all-cause admissions, because both effects are combined. Because hospitals may differ in the distribution of patients with non-psychiatric comorbidities, it was important to capture some risk factors with weaker associations.

Therefore, the variables that were removed at this stage include: comorbidities of dementia, senility, other cancer, plegia/amputation, sepsis, cardio-respiratory failure, renal failure, coagulation defects, cerebral disease, skin ulcer, cancer, and count of psychiatric comorbidities. The final clinical model is presented in Table 16.

2.5 Statistical Approach to Measure Development

2.5.1 Overview

The measure is specified for a two-year reporting period using a dataset that included all index admissions from January 1, 2012 to December 31, 2013. We used the entire dataset to develop the risk model using logistic regression and validated the model with 1000 bootstrapping samples with replacement that were derived from the original development sample. We then reapplied the estimated model parameters to the original development sample to compare model performance. A similar bootstrapping approach was used to estimate measure reliability using a test-retest framework.
We report the final measure results as risk-standardized readmission rates (RSRR), which were derived from the ratio of predicted versus expected readmission rates of each IPF. We estimated confidence intervals with a bootstrapping approach and report the percent facilities above and below the national readmission rate.

Measure development and modeling included several sensitivity analyses to explore the impact of varying measure definitions and/or modeling approaches in measure results, which are summarized in Appendix D2.

2.5.2 Regression Modeling

We employed logistic regression models with logistic link function to model the risk for 30-day readmission Y_i for index admission *i* for model development and validation. Using logistic regression models for development requires significantly less computational time and allows us to evaluate risk factors and model performance without reference to the variation in readmissions across IPFs.

For the final risk adjustment model, we utilized a hierarchical approach that included an additional error term, a random effects hospital-level intercept in addition to the patient-level risk factors. The error term accounts for hospital-level correlation of readmission and thus models the assumption that performance differences among the facilities lead to systematic differences in readmission rates. The two-level specification allows reliable estimates for small-volume hospitals while accepting a certain amount of shrinkage toward the mean.

The hierarchical logistic regression model was estimated as follows. Let Y_{ij} denote the outcome (=1 if index admission *i* is readmitted, 0 otherwise) for index admission *i*. Let *M* denote the total number of hospitals and m_j the number of index admissions in hospital *j*. We model the outcome as linear association to the covariates using a logit function with dispersion:

$$\text{Logit}(\text{Prob}(Y_i=1)) = \alpha_j + \beta * Z_{ij} + \varepsilon_i \qquad (1)$$

$$\alpha_j = \mu + \omega_j \; ; \; \omega_j \sim N(0, \tau^2)$$

where $Z_{ij} = (Z_1, Z_2, \ldots Z_k)$ is a set of patient-level covariates, α is the hospital-specific intercept; μ is the adjusted average outcome over all hospitals; τ^2 is the between hospital variance

component, and $\varepsilon \sim N(0,\sigma^2)$ captures over- or under-dispersion. We fit the models using SAS version 9.3 (GLIMMIX procedure).

2.5.3 Hospital Performance Reporting

Risk-standardized readmission rates (RSRR) for each IPF were estimated from the results of the hierarchical logistic regression model as follows. The standardized risk ratio is calculated as the predicted number of readmissions over the expected number of readmissions (P/E) for each IPF. This is analogous to the observed over expected ratio (O/E) calculated using simple logistic regression. We estimated the *predicted* number of readmissions for each IPF using the sum of the estimated probability of readmission for each index admission at that IPF that was calculated from the hospital-specific intercept α (random effect) and all other risk factors. The expected number of readmissions for each hospital was then calculated using the same sum of readmission probabilities for each index admission that was calculated from the average intercept and all other risk factors.

The standardized risk ratio is then calculated as

$$SRR_j = pred_j/exp_j \qquad (2)$$

where

$$pred_j = \Sigma logit^{-1} (\alpha_j + \beta * Z_{ij}) \qquad (3)$$

$$exp_j = \Sigma logit^{-1} (\mu + \beta * Z_{ij}) \qquad (4)$$

Because the predicted number of readmissions is calculated based on the hospital's performance and its observed case mix and the expected number is calculated based on the national performance and its observed case mix, an SRR greater than 1 indicates worse quality of care compared to the national average. An SRR less than 1 indicates better quality of care.

The SRR was then used to calculate RSRR by multiplying SRR by the overall raw readmission rate for all index admissions in the cohort. We used bootstrapping to calculate 95% confidence intervals for the RSRR to characterize the uncertainty of the estimate. Specifically, we sampled the IPFs with replacement for the bootstrap sample. All index admissions are included in the bootstrap sample if a particular IPF is sampled. IPFs sampled more than once are treated as different hospitals. We ran hierarchical logistic regression as shown in Section 2.5.2 Regression Modeling on the bootstrap samples. The model results provide the set of hospital-specific intercepts and corresponding variances: $\{\alpha_j , var[\alpha_j]\}$. Since we included the same index admissions for the same IPF in each bootstrap sample, to account for the variability in the hospital random effect, we sampled the hospital-specific intercept from $\alpha_j^* \sim N(\alpha_j , var[\alpha_j])$. We then calculated SRR and RSRR where SRR is calculated as $SRR_j = \Sigma logit^{-1} (\alpha_j^* + \beta * Z_{ij}) / \Sigma logit^{-1} (\mu + \beta * Z_{ij})$. For IPFs sampled more than once in the bootstrap sample, we randomly selected one SRR and RSRR for this sample. Finally, for each IPF, we had 1000 SRR/RSRR results derived from 1000 bootstrap samples. We calculated the 2.5^{th} and 97.5^{th} percentile of RSRR estimates as the 95% confidence interval of RSRR.

2.5.4 Assessment of Risk Adjustment Model

To validate the risk adjustment model, we used bootstrapping in which 1,000 bootstrap samples were randomly drawn from the original dataset with replacement. The bootstrap samples were used as the development dataset, and the original cohort was used as the comparison dataset. This approach allows the use of the entire dataset for model development and a nearly unbiased estimate of predictive accuracy with relatively low variance compared with other validation approaches, such as data splitting and cross-validation.[39] We computed the following summary statistics to assess model performance:

- Calibration: Reflects over-fitting where a developed model with good predictive performance fails to provide valid predictions in a new dataset. Over-fitting is captured with Over-Fitting Indices (γ0, γ1), which are calculated as follows. Let *b* denote the *estimated vector* of regression coefficients. *Predicted Probabilities* are calculated from (p) = 1/(1+exp{-Xb)}, and *Z* = *Xb*. A new logistic regression model that includes only an intercept and a slope by regressing the logits on Z is fitted in the validation sample using Logit(P(Y=1|Z)) = $\gamma_0 + \gamma_1 Z$. Estimated values of γ_0 far from 0 and estimated values of γ_1 far from 1 provide evidence of over-fitting.
- Discrimination in terms of predictive ability: Reflects the ability to distinguish between high-risk subjects and low-risk subjects as measured by the range between the lowest and highest risk decile.
- Discrimination in terms of c statistic: Reflects how accurately the model is able to distinguish between an index admission that does or does not have a readmission. A c-statistic of 0.5 represents random prediction and a c-statistic of 1.0 represents perfect prediction.
- Distribution of residuals: Reflects whether the difference between observed and expected values is normally distributed and suggests similar model performance across various risk levels. The proportion of residuals below -2 and above 2 should be minimal.
- Model chi-square: Reflects model goodness of fit.

2.6 Measure Reliability and Validity Testing

2.6.1 Measure Reliability

To maximize data element reliability, we used data elements from claims data that have been shown to be reliable and have face validity in measure development, health services research, and epidemiologic studies. For example, to optimize sensitivity and specificity of comorbidity risk factors for this measure, we used established algorithms that consider outpatient claims (improved sensitivity) but require at least two claims associated with evaluation and management (E&M) procedure codes to reduce coding errors (improved specificity). We also conducted extensive descriptive analysis of all candidate risk factors and discarded variables with clinically implausible prevalence or incoherent associations with readmissions.

To test the reliability of facility-level risk-standardized readmission rates (RSRRs), we calculated the intra-class correlation coefficient (ICC) using a test-retest approach that examines the agreement between repeated measures of the same IPF for the same time period. The randomly sampled sets of admissions from a given hospital are assumed to reflect an independent set of re-measurement of readmission rates for the hospital. Good reliability is assumed if the risk-

standardized measure rates calculated from the random datasets for the same IPF are similar. Higher ICC values indicate stronger agreement, and hence, better measure reliability.

We used two test-retest approaches to generate independent samples of patients within the same IPF: a split-half sampling design and bootstrapping. For split-half sampling, we randomly sampled half of all eligible index admissions in each facility over the two-year period, resulting in two samples that cover the same two-year period but with case volume the size of a measure that would be calculated with one year of data. The ICC in the split-half sampling design was estimated using the RSRRs of the two split-half samples.

For bootstrapping, we sampled 1,000 pairs of samples from the original measure cohort with replacement (stratified sampling by IPF), resulting in 1,000 pairs of new samples within each IPF with the identical sample size as in the original measure cohort, thus maintaining the sample size of a two-year measure. The ICC in the bootstrap sampling was estimated for each pair of the bootstrap samples. With the 1,000 ICC estimates from the 1,000 pairs of bootstrap samples, we determined the distribution of estimated ICC coefficients and thus could calculate the mean and 95% CI of the ICC.

2.6.2 Measure Validity

We formally assessed measure face validity with the Technical Expert Panel convened to guide measure development and validation. We reviewed the proposed measure specifications along with all analyses that had been conducted to support the development of the measure and the risk adjustment model with the TEP and then asked them to rate on a scale from one to nine (1-Strongly disagree, 3-Disagree, 5-Neutral, 7- Agree, 9-Strongly agree) how strongly they agreed with the following statement:

> "The performance score from the readmission measure, as specified (adjusted to account for differences across facilities in the case mix of patients served), represents an accurate reflection of facility-level quality of care related to readmissions."

We categorized votes as agreement (rating 7-9); neutral (rating 4-6); and disagreement (rating 1-3). To assess the level of agreement, we identified the category of the median rating and examined the distribution of responses across the three categories to identify the level of disagreement. We identified disagreement if at least one-third of the ratings were in the agreement category and also one-third in the disagreement category. We reviewed comments to identify any themes related to the ratings.

Finally, we conducted several sensitivity analyses to explore the impact of alternate measure specifications on measure validity, measure results, and respective IPF rankings. Results of all sensitivity analysis are presented in Appendix D. Specifically, these analyses include examinations of the 30-day incidence period (Appendix D1), multinomial modeling (Appendix D2), and stratified cohorts (Appendix D3).

3. RESULTS

This section presents descriptive characteristics of the measure cohort, measure results, and assessments of the reliability and validity of the IPF readmission measure.

3.1 Cohort Characteristics

The final measure development cohort included 716,174 index admissions to 1,679 IPFs. A slightly larger proportion of admissions were for females and the predominant proportion by Whites, followed by Blacks and Hispanics (Table 14). The larger proportion of index admissions was younger than 65. About 59% of all index admissions were eligible for Medicare and Medicaid (i.e., dual eligible).

Table 14. Cohort demographics

Demographic	Count	Percent of Index (n=716,174)	Readmissions	Percent Readmissions
Gender				
Male	348,641	48.68	81,514	23.38
Female	367,533	51.32	67,961	18.49
Race/Ethnicity				
1-White	552,613	77.16	111,717	20.22
2-Black	121,783	17.00	28,677	23.55
3-Other	5,839	0.82	1,078	18.46
4-Asian	7,188	1.00	1,457	20.27
5-Hispanic	21,174	2.96	5,078	23.98
6-North American Native	5,065	0.71	967	19.09
0-Unknown	2,512	0.35	501	19.94
Age				
18 to 24	11,787	1.65	2,985	25.32
25 to 44	188,176	26.28	46,917	24.93
45 to 64	267,943	37.41	60,305	22.51
65 to 74	108,554	15.16	18,013	16.59
75 to 84	88,310	12.33	13,839	15.67
85 to 94	48,031	6.71	6,939	14.45
95+	3,373	0.47	477	14.14
Dual eligible	420,149	58.67	97431	23.19

A two-year measure as developed would result in less than 5% of IPFs with denominator size of less than 25 cases (Table 15). The mean and median length of stay for index admissions was 13 and 9 days, respectively.

Table 15. Number of index admissions per IPF, Jan 1, 2012 to Dec 31, 2013

Stays per IPF	CY2012		CY2013		Total	
	Count	Percent	Count	Percent	Count	Percent
0 to 25	81	4.92	82	4.98	74	4.36
26 to 50	91	5.53	73	4.44	30	1.77
51 to 75	118	7.17	105	6.38	46	2.71
76 to 100	143	8.69	145	8.81	51	3.01
101 to 200	562	34.16	591	35.93	270	15.92
201 to 300	299	18.18	290	17.63	308	18.16
301 to 400	139	8.45	144	8.75	271	15.98
401 to 500	92	5.59	84	5.11	188	11.08
501 to 600	45	2.74	44	2.67	112	6.60
601 to 700	28	1.70	36	2.19	78	4.60
701 to 800	16	0.97	19	1.16	57	3.36
801 to 900	12	0.73	12	0.73	44	2.59
901 to 1000	9	0.55	9	0.55	39	2.30
1000+	10	0.61	11	0.67	128	7.55
Total	**1,645**		**1,645**		**1,696**	

A total of 149,475 index admissions had an unplanned readmission within the measure-specified 3-30 day incidence period. During the same time period, we observed 9,109 (1.27%) post-discharge deaths.

3.2 Model and Measure Results

The following sections summarize the results of the logistic regression model and its assessment followed by the measure results derived from the hierarchical logistic regression model and respective assessments of measure validity and reliability.

3.2.1 Risk Model Results

The final risk adjustment model includes 56 variables, including two categorical variables with three or more levels (Table 16). Younger age groups and males have a higher odds for readmission. Note that the odds ratios for principal CCS diagnoses are expressed relative to CCS 659.1 schizo-affective disorder, which had the highest readmission rates in univariate analyses. Psychiatric comorbidities show a similar pattern as respective principal diagnoses with schizo-affective disorder, bipolar disorder and personality disorder among the strongest determinants of readmission.

Table 16. Risk adjustment model parameters (simple logistic regression)

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Intercept	0.083	0.080	0.086
Demographic factors			
Gender: Male	1.225	1.209	1.240

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Age			
18-34	1.304	1.257	1.353
35-44	1.238	1.194	1.283
45-54	1.182	1.142	1.223
55-64	1.110	1.073	1.149
65-74	0.998	0.967	1.031
75-84	1.041	1.009	1.074
85+	1.000	---	---
Principal discharge diagnosis on index admission			
CCS 650 Adjustment disorder	0.704	0.653	0.759
CCS 651 Anxiety	0.878	0.828	0.931
CCS 652/654/655 ADD/Developmental/Childhood disorders	0.885	0.782	1.003
CCS 653 Dementia	1.111	1.080	1.144
CCS 656 Impulse control disorders	0.832	0.754	0.918
CCS 657.1 Bipolar disorder	0.961	0.942	0.981
CCS 657.2/662 Depressive disorder	0.894	0.873	0.915
CCS 658 Personality disorder	1.091	0.968	1.229
CCS 659.1 Schizo-affective disorder	1.000	---	---
CCS 659.2 Psychosis	1.048	1.027	1.070
CCS 660 Alcohol disorder	0.967	0.929	1.007
CCS 661 Drug disorder	0.810	0.779	0.844
CCS 670/663 Other mental disorder	0.946	0.855	1.047
Comorbidities			
Psychiatric			
Delirium	1.064	1.045	1.084
Drug/alcohol disorder	1.119	1.103	1.135
Schizo-affective disorder	1.337	1.316	1.359
Psychosis	1.161	1.145	1.178
Bipolar disorder	1.235	1.217	1.252
Depression	0.966	0.949	0.983
Personality disorder	1.191	1.173	1.211
Anxiety	1.087	1.073	1.102
Adjustment disorder	1.111	1.077	1.146
PTSD	1.039	1.019	1.059
Other psych disorders	1.111	1.092	1.130
Intellectual disability	1.018	0.991	1.045
Developmental disability	1.000	0.975	1.027
Non-psychiatric			
Other infection	1.081	1.064	1.098
Metastasis	1.119	1.027	1.220

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Diabetes complications	1.043	1.016	1.069
Diabetes	1.032	1.016	1.048
Malnutrition	1.016	0.989	1.045
Hematological disorder	1.153	1.061	1.253
Seizures	1.091	1.073	1.109
Heart failure	1.082	1.058	1.107
Arrhythmia	1.068	1.049	1.089
Asthma	1.068	1.050	1.086
Dialysis	1.373	1.263	1.493
Endocrine disease	1.073	1.057	1.089
Anemia	1.101	1.086	1.117
AMI	1.094	1.050	1.140
Pancreatic disease	1.103	1.062	1.146
Urinary tract disorder	1.045	1.023	1.067
Peptic ulcer	1.086	1.059	1.114
Infection	1.082	1.062	1.102
Liver disease	1.149	1.127	1.172
Heart disease	1.047	1.031	1.063
COPD/Fibrosis	1.092	1.076	1.108
Lung problems	1.026	1.009	1.044
Organ transplant	1.119	1.013	1.236
Uncompleted pregnancy	1.092	1.010	1.181
Injury	1.041	1.028	1.055
Variables from literature			
Discharge AMA in prior 12 months	2.239	2.173	2.307
Not discharged AMA in prior 12 months	1.453	1.429	1.478
No Admissions to Determine AMA	1.000	---	---
Suicide attempt / self-harm	1.181	1.161	1.201
Aggression	1.090	1.064	1.117

3.2.2. Assessment of Risk Adjustment

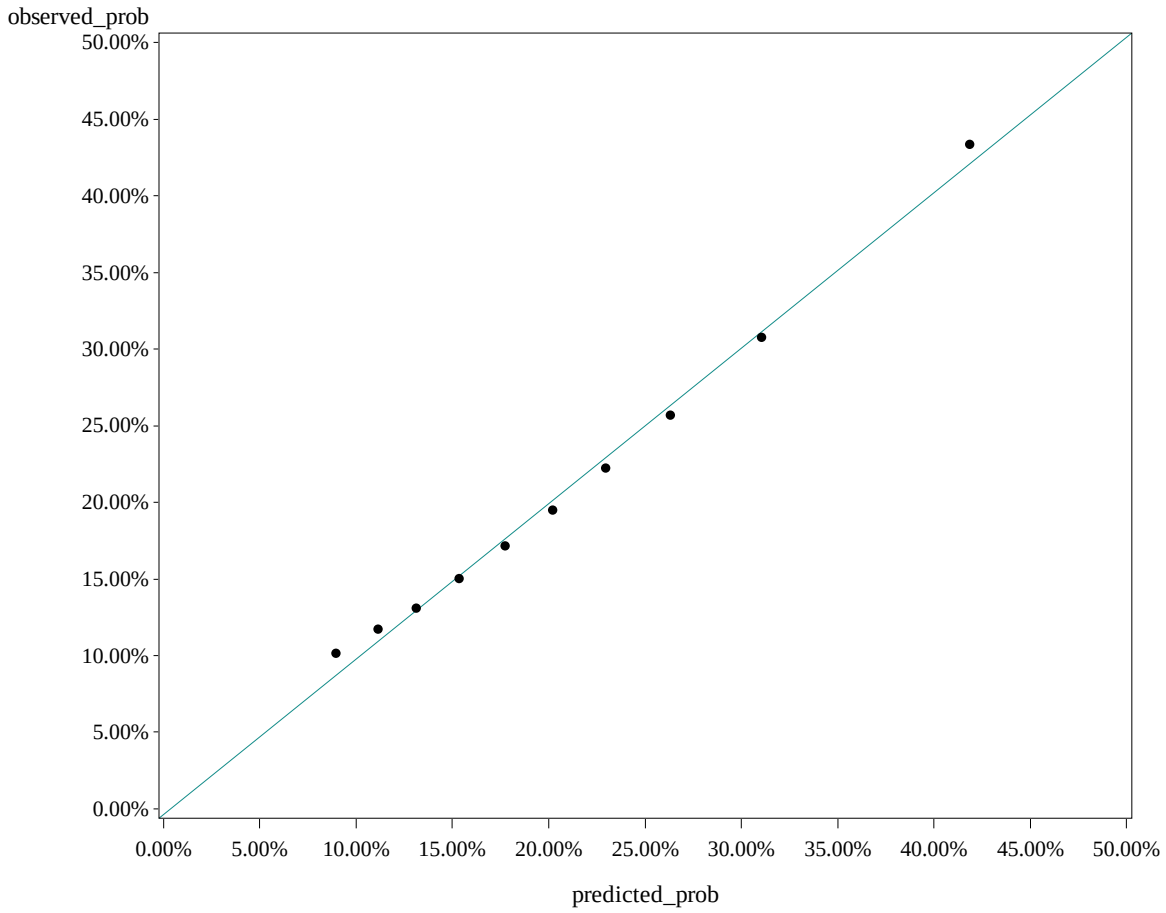
Risk adjustment model performance parameters showed excellent calibration with no indication for over-fitting (Table 17). The upper and lower decile of predicted readmission probabilities spans 33%, suggesting good discrimination. The c-statistic of 0.660 suggests moderate predictive discrimination, expressed as the model's ability to distinguish between index admissions that are and are not readmitted.

Estimated model performance parameters are fully confirmed in the validation with near-identical values, owing to the large sample size (716,174 index admissions) within and across IPFs. Statistical findings of excellent calibration are confirmed when comparing observed to predicted probabilities by risk deciles (Figure 2).

Table 17. Risk model performance

Indices		Development Model	Validation Using Bootstrapping (95% CI)
Calibration (over-fitting)	γ^0	0	0 (-0.02, 0.01)
	γ^1	1	1 (0.99, 1.01)
Predictive ability	p10	9%	8.9% (8.8, 9.1)
	p90	42%	41.9% (41.6, 42.9)
Discrimination c-statistic		0.660	0.660 (0.659, 0.660)
Distribution of residuals **<-2** **-2 to <0** **0 to <2** **>=2**		 0.0 79.1 13.4 7.5	 0 (0, 0) 79.1 (79.1, 79.1) 13.4 (13.3, 13.5) 7.5 (7.4, 7.6)
Model Wald X^2 (degrees of freedom=61)		37,858	37,917 (37,242, 38,615)

Figure 2. Risk decile calibration plot



3.2.3 Measure Results: Unadjusted and Adjusted Readmission Rates

Table 18 summarizes the parameters of the risk model including the IPF-specific random effect estimated using hierarchical logistic regression. Both the average intercept as well as the risk factor-specific odds ratios change slightly owing to the introduction of the IPF random effect.

The estimated between-hospital variance in the adjusted log-odds of readmission is 0.05425. Comparing a high-performing hospital with an estimated intercept at -1 SD and a low-performing hospital at +1 SD, the odds of readmission for the low-performing hospital would be 1.59 times higher than for the high-performing hospital. Under the assumption that case mix adjustment is complete, this estimate reflects the variation in performance across IPFs. If there were no differences between IPFs, the between-hospital variance would be 0 and the odds ratio would be 1.0.

Table 18. Risk adjustment model parameters – hierarchical logistic regression

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Intercept	0.083	0.080	0.086
Demographic factors			
Gender: Male	1.215	1.200	1.231
Age			
18-34	1.283	1.235	1.332
35-44	1.219	1.175	1.265
45-54	1.160	1.119	1.201
55-64	1.098	1.061	1.137
65-74	0.999	0.967	1.032
75-84	1.044	1.012	1.077
85+	1.000	---	---
Principal discharge diagnosis on index admission			
CCS 650 Adjustment disorder	0.721	0.668	0.778
CCS 651 Anxiety	0.875	0.825	0.928
CCS 652/654/655 ADD/Developmental/Childhood disorders	0.911	0.802	1.035
CCS 653 Dementia	1.133	1.099	1.168
CCS 656 Impulse control disorders	0.834	0.755	0.921
CCS 657.1 Bipolar disorder	0.951	0.931	0.971
CCS 657.2/662 Depressive disorder	0.884	0.864	0.905
CCS 658 Personality disorder	1.171	1.037	1.322
CCS 659.1 Schizo-affective disorder	1.000	---	---
CCS 659.2 Psychosis	1.022	1.000	1.043
CCS 660 Alcohol disorder	0.990	0.949	1.043
CCS 661 Drug disorder	0.837	0.803	0.873
CCS 670/663 Other mental disorder	0.972	0.875	1.080

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Comorbidities			
Psychiatric			
Delirium	1.077	1.058	1.097
Drug/alcohol disorder	1.120	1.104	1.137
Schizo-affective disorder	1.311	1.289	1.332
Psychosis	1.152	1.136	1.332
Bipolar disorder	1.229	1.212	1.247
Depression	0.964	0.947	0.981
Personality disorder	1.238	1.218	1.259
Anxiety	1.099	1.084	1.114
Adjustment disorder	1.125	1.090	1.161
PTSD	1.057	1.037	1.078
Other psych disorders	1.128	1.108	1.147
Intellectual disability	1.032	1.005	1.060
Developmental disability	1.007	0.980	1.033
Non-psychiatric			
Other infection	1.069	1.052	1.087
Metastasis	1.122	1.029	1.223
Diabetes complications	1.040	1.014	1.067
Diabetes	1.036	1.020	1.051
Malnutrition	1.022	0.994	1.051
Hematological disorder	1.154	1.061	1.254
Seizures	1.077	1.059	1.095
Heart failure	1.093	1.069	1.119
Arrhythmia	1.066	1.046	1.086
Asthma	1.056	1.038	1.074
Dialysis	1.382	1.269	1.503
Endocrine disease	1.080	1.064	1.096
Anemia	1.090	1.074	1.106
AMI	1.090	1.046	1.136
Pancreatic disease	1.110	1.068	1.153
Urinary tract disorder	1.046	1.024	1.068
Peptic ulcer	1.092	1.065	1.120
Infection	1.065	1.045	1.086
Liver disease	1.134	1.112	1.157
Heart disease	1.044	1.028	1.060
COPD/Fibrosis	1.084	1.068	1.101
Lung problems	1.031	1.013	1.049
Organ transplant	1.123	1.016	1.242
Uncompleted pregnancy	1.090	1.008	1.180
Injury	1.048	1.034	1.062

Risk Variable Name / Description	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Variables from literature			
Discharged AMA in prior 12 months	2.107	2.044	2.172
Not discharged AMA in prior 12 months	1.413	1.390	1.437
No Admissions to Determine AMA	1.000	---	---
Suicide attempt / self-harm	1.171	1.151	1.192
Aggression	1.091	1.064	1.118

Table 19 and Figure 3 show the distribution of observed readmission rates and RSRRs among the 1,696 IPFs. As expected, the range of readmission rates decreased with the RSRRs due to case mix adjustment and shrinkage introduced by the random effect. However, the RSRR range remains sizeable with 17.34% defining the lower and 24.95% the upper 10th percentile.

Table 19. Readmission rate distributions across IPFs – 30-day measure

	N IPFs	Mean	SD	Min	10th Percentile	Lower Quartile	Median	Upper Quartile	90th percentile	Max
Observed	1,696	19.38%	6.49%	0.00%	12.24%	15.46%	19.10%	22.86%	27.33%	46.67%
RSRR	1,696	21.00%	3.01%	10.97%	17.34%	18.99%	20.80%	22.75%	24.95%	35.41%

Figure 3. Distribution of observed readmission rate and RSRR for IPFs

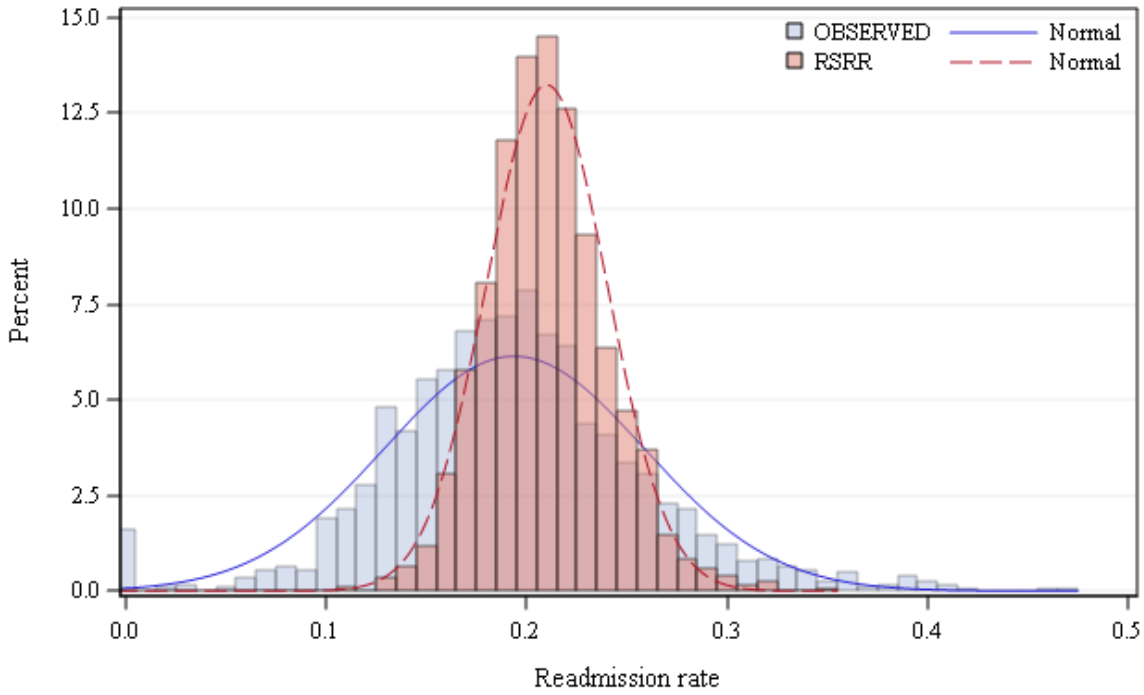


Table 20 summarizes the distribution of IPFs that are identified as performing above or below the national average, based on the overlap of each IPFs 95% confidence interval boundaries estimated during bootstrapping with the observed national readmission rate. About 8% and 13%

of IPFs are identified as performing better and worse than the national rate, respectively. Both proportions are higher than those reported in previously developed readmission measures, emphasizing the measure's discriminative validity.

Table 20. Distribution of IPFs outside the national readmission rate

	# of IPFs	Percent of IPFs
Better than national rate	140	8.3
No different than national rate	1,257	74.1
Worse than national rate	227	13.4
Fewer than 25 cases during performance period	72	4.2

3.3 Reliability and Validity Testing

3.3.1 Measure Reliability

RSRR distributions across IPFs obtained for the two randomly split-half samples that we established for test-retest reliability testing are displayed in Table 21. We estimated RSRR for each sample using the hierarchical logistic regression model and RSRR calculations previously described. The average RSRR in the two split-half samples is very similar with 21.03 and 20.93 percent. The corresponding intra-class correlation is 0.60, which is the upper limit of "moderate" according to conventional interpretation.[40]

Table 21. RSRR distributions for IPFs in split half samples

	# Index Admissions	# of IPFs (n≥25)	Mean	SD	Min	10th Percentile	Lower Quartile	Median	Upper Quartile	90th percentile	Max
Sample 1	358,087	1,594	21.03	2.71	12.62	17.73	19.20	20.89	22.72	24.50	31.02
Sample 2	358,087	1,593	20.93	2.56	13.29	17.85	19.14	20.73	22.41	24.36	30.89

The ICC obtained from the bootstrapping approach, comparing 1,000 pairs of samples of the original measurement cohort sampled with replacement yielding an identical sample size as the original measurement cohort, is 0.78 (95% CI 0.77-0.80). This is considered "substantial".

3.3.2 Measure Validity

Validity of this measure is determined by its ability to capture variation in readmission rates across IPFs that are attributable to hospital performance. Both definition of the measure and construction of the risk adjustment model is consistent with established standards for outcome measurement defined in the National Quality Forum guidance for outcomes measures,[10] the CMS Measures Management System guidance,[9] and the American Heart Association scientific statement on statistical modeling of outcomes measures.[11]

Several features of the measure methodology support validity of the measure results. First, our measure is based on diagnoses and procedures codes in billing records, which are widely used in health service research and epidemiology. Some previously developed CMS readmission and

mortality measures, which have uniformly relied on billing records, have been validated with data ascertained from medical chart abstraction of inpatient records and have generally reported comparable results. For this measure, we paid additional attention to both sensitivity and specificity in risk factor ascertainment by including diagnoses from outpatient billing records, which captured a variety of especially non-psychiatric comorbidities that were not recorded in the index admission claims. To ensure that the diagnoses assigned to outpatient encounters truly capture manifestation of a disease as opposed to diagnostic work up, we restricted outpatient claims to those with E&M procedure codes and required a minimum of two claims with diagnoses within the same CC grouping.

We have developed this measure in concordance with national guidelines for publicly reported outcomes measures. Importantly, we have obtained detailed input from our technical expert panel and a specifically established work group composed of experts in psychiatry, psychology, pharmacy, IPF administration, health service research, and epidemiology as well as select TEP members. This focused work group met frequently to review analyses that were specifically conducted to support decisions regarding measure specification and risk factor selection, enhancing evidence-based decision-making.

We conducted a systematic literature review and extracted all risk factors that had been used in studies aimed at explaining readmission in psychiatric patients regardless of country, focus on subpopulations, or readmission type. We reviewed each risk factor that is available in billing records and, if feasible and conceptually sound for comparisons across hospitals, advanced the variables for univariate analysis. Risk factor selection employed both clinical assessment of risk factor frequencies and plausibility of univariate associations as well as a standard statistical selection process aimed at maximizing the predictive ability of the model.

For face validity, all 17 members of the IPF TEP voted. The distribution of the votes was as follows:

Agreement (rating 7-9):	10 votes (59%)
Neutral (rating 4-6):	6 votes (35%)
Disagreement (rating 1-3):	1 vote (6%)

The median rating was 7, which indicated agreement with the face validity of the measure. Only 1 out of 17 ratings was in the opposite category, disagreement. The face validity vote indicates that the measure is viewed as valid by the TEP, which is representative of key stakeholders. Comments for neutral votes reflected either the commenter's inability to assess face validity based on their knowledge and experience or a question about the influence of factors in the post-discharge environment. However, these issues did not cause the TEP members to vote in disagreement with face validity.

Finally, we conducted several sensitivity analyses to facilitate a full understanding of the influence that key methodological decisions had on the valid and reliable performance categorization of IPFs (Appendix D).

4. SUMMARY

We developed a measure that assesses all-cause, 30-day unplanned readmission rates following discharge from IPF facilities for psychiatric disorders or dementia/Alzheimer's disease. This measure is risk adjusted for comorbidities using demographic variables and diagnosis codes from the index admission and 12-month look back period prior to the admission. Where applicable, the measure methodology is aligned with the existing hospital-wide readmission measure for short-stay acute care hospitals (NQF #1789). The c-statistic for this measure is 0.66, which is similar to or greater than that of other publicly reported CMS readmission measures.

Monitoring IPF readmission rates addresses a measurement gap for a particularly vulnerable patient population that is clinically distinct from the target populations of other readmission measures and is generally not appropriate for inclusion in those measures. Patients who suffer from chronic, degenerative psychiatric conditions or who have experienced an acute psychiatric event that requires an inpatient admission may be unable or unwilling to facilitate necessary post-discharge care on their own. Therefore, care coordination and transition planning are critically important for facilitating the recovery of these patients after they leave the IPF setting. Studies have shown that examples of effective strategies for reducing readmissions in this patient population include medication reconciliation, assigning a transition manager, and connecting patients to services they will need in the outpatient setting prior to discharge.

By developing a measure of risk-standardized all-cause unplanned readmission rates for IPFs, CMS aims to encourage quality improvement, specifically relating to stronger care transitions to outpatient settings. Its ability to discriminate between facilities above and below the national readmission rate provides an assessment of facility-level quality for patients and their caregivers. We envision the addition of this measure to the suite of measures for IPFs will help to create a comprehensive picture of the quality of care patients receive at those facilities.

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6. APPENDICES

Appendix A. Frequency of Index Admission Condition Categories by Data Source

Table A.1. Frequency of index admission condition categories by data source (n=716,174)

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC1	HIV/AIDS	2,019	0.3	2,034	0.3	5,830	0.8	9,883	1.4	20.6
CC2	Septicemia/Shock	11,349	1.6	3,946	0.6	7,709	1.1	23,004	3.2	17.2
CC3	Central Nervous System Infection	1,388	0.2	1,193	0.2	573	0.1	3,154	0.4	37.8
CC4	Tuberculosis	128	0.0	1,115	0.2	55	0.0	1,298	0.2	85.9
CC5	Opportunistic Infections	1,291	0.2	480	0.1	374	0.1	2,145	0.3	22.4
CC6	Other Infectious Diseases	50,651	7.1	98,615	13.8	24,698	3.4	173,964	24.3	56.7
CC7	Metastatic Cancer and Acute Leukemia	1,424	0.2	865	0.1	607	0.1	2,896	0.4	29.9
CC8	Lung, Upper Digestive Tract, and Other Severe Cancers	807	0.1	2,302	0.3	1,453	0.2	4,562	0.6	50.5
CC9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	1,597	0.2	3,458	0.5	1,903	0.3	6,958	1.0	49.7
CC10	Breast, Prostate, Colorectal and Other Cancers and Tumors	4,077	0.6	16,204	2.3	4,412	0.6	24,693	3.4	65.6
CC11	Other Respiratory and Heart Neoplasms	215	0.0	840	0.1	59	0.0	1,114	0.2	75.4
CC12	Other Digestive and Urinary Neoplasms	2,737	0.4	11,614	1.6	1,762	0.2	16,113	2.2	72.1
CC13	Other Neoplasms	3,603	0.5	19,573	2.7	1,358	0.2	24,534	3.4	79.8
CC14	Benign Neoplasms of Skin, Breast, Eye	1,963	0.3	30,933	4.3	821	0.1	33,717	4.7	91.7
CC15	Diabetes with Renal Manifestation	4,072	0.6	10,122	1.4	1,223	0.2	15,417	2.2	65.7
CC16	Diabetes with Neurologic or Peripheral Circulatory Manifestation	13,591	1.9	14,558	2.0	7,300	1.0	35,449	4.9	41.1
CC17	Diabetes with Acute Complications	1,436	0.2	1,816	0.3	2,340	0.3	5,592	0.8	32.5
CC18	Diabetes with Ophthalmologic Manifestation	3,531	0.5	9,702	1.4	872	0.1	14,105	2.0	68.8
CC19	Diabetes with No or Unspecified Complications	46,258	6.5	43,006	6.0	79,048	11.0	168,312	23.5	25.6
CC20	Type I Diabetes Mellitus	0	0.0	0	0.0	0	0.0	0	0.0	
CC21	Protein-Calorie Malnutrition	22,983	3.2	2,580	0.4	2,321	0.3	27,884	3.9	9.3

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC22	Other Significant Endocrine and Metabolic Disorders	20,594	2.9	7,048	1.0	3,251	0.5	30,893	4.3	22.8
CC23	Disorders of Fluid/Electrolyte/Acid-Base	115,085	16.1	25,555	3.6	52,025	7.3	192,665	26.9	13.3
CC24	Other Endocrine/Metabolic/Nutritional Disorders	196,072	27.4	69,823	9.7	101,623	14.2	367,518	51.3	19.0
CC25	End-Stage Liver Disease	3,229	0.5	1,246	0.2	1,617	0.2	6,092	0.9	20.5
CC26	Cirrhosis of Liver	7,437	1.0	2,017	0.3	3,349	0.5	12,803	1.8	15.8
CC27	Chronic Hepatitis	12,616	1.8	4,924	0.7	2,945	0.4	20,485	2.9	24.0
CC28	Acute Liver Failure/Disease	5,632	0.8	910	0.1	1,000	0.1	7,542	1.1	12.1
CC29	Other Hepatitis and Liver Disease	27,292	3.8	14,086	2.0	9,414	1.3	50,792	7.1	27.7
CC30	Gallbladder and Biliary Tract Disorders	2,713	0.4	7,061	1.0	3,398	0.5	13,172	1.8	53.6
CC31	Intestinal Obstruction/Perforation	5,354	0.7	5,777	0.8	5,747	0.8	16,878	2.4	34.2
CC32	Pancreatic Disease	5,851	0.8	3,943	0.6	5,600	0.8	15,394	2.1	25.6
CC33	Inflammatory Bowel Disease	2,399	0.3	1,762	0.2	2,047	0.3	6,208	0.9	28.4
CC34	Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	16,611	2.3	18,166	2.5	14,165	2.0	48,942	6.8	37.1
CC35	Appendicitis	289	0.0	453	0.1	474	0.1	1,216	0.2	37.3
CC36	Other Gastrointestinal Disorders	129,255	18.0	84,621	11.8	111,178	15.5	325,054	45.4	26.0
CC37	Bone/Joint/Muscle Infections/Necrosis	2,127	0.3	2,810	0.4	2,542	0.4	7,479	1.0	37.6
CC38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	9,081	1.3	10,760	1.5	5,153	0.7	24,994	3.5	43.1
CC39	Disorders of the Vertebrae and Spinal Discs	25,424	3.5	75,047	10.5	21,878	3.1	122,349	17.1	61.3
CC40	Osteoarthritis of Hip or Knee	8,427	1.2	32,126	4.5	6,630	0.9	47,183	6.6	68.1
CC41	Osteoporosis and Other Bone/Cartilage Disorders	24,935	3.5	22,284	3.1	5,299	0.7	52,518	7.3	42.4
CC42	Congenital/Developmental Skeletal and Connective Tissue Disorders	488	0.1	198	0.0	140	0.0	826	0.1	24.0
CC43	Other Musculoskeletal and Connective Tissue Disorders	65,900	9.2	198,514	27.7	143,742	20.1	408,156	57.0	48.6
CC44	Severe Hematological Disorders	1,620	0.2	934	0.1	513	0.1	3,067	0.4	30.5
CC45	Disorders of Immunity	5,444	0.8	2,228	0.3	1,730	0.2	9,402	1.3	23.7

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC46	Coagulation Defects and Other Specified Hematological Disorders	25,913	3.6	6,441	0.9	4,811	0.7	37,165	5.2	17.3
CC47	Iron Deficiency and Other/Unspecified Anemias	93,143	13.0	37,733	5.3	40,004	5.6	170,880	23.9	22.1
CC48	Delirium and Encephalopathy	36,277	5.1	53,986	7.5	26,406	3.7	116,669	16.3	46.3
CC49	Dementia	40,105	5.6	48,574	6.8	64,887	9.1	153,566	21.4	31.6
CC50	Senility, Nonpsychotic Organic Brain Syndromes/Conditions	6,113	0.9	15,322	2.1	1,459	0.2	22,894	3.2	66.9
CC51	Drug/Alcohol Psychosis	47,192	6.6	9,412	1.3	21,905	3.1	78,509	11.0	12.0
CC52	Drug/Alcohol Dependence	96,834	13.5	10,413	1.5	49,946	7.0	157,193	21.9	6.6
CC53	Drug/Alcohol Abuse, Without Dependence	194,982	27.2	16,483	2.3	57,351	8.0	268,816	37.5	6.1
CC54	Schizophrenia	35,891	5.0	57,397	8.0	172,812	24.1	266,100	37.2	21.6
CC55	Major Depressive, Bipolar, and Paranoid	73,026	10.2	110,579	15.4	226,805	31.7	410,410	57.3	26.9
CC56	Reactive and Unspecified Psychosis	26,490	3.7	106,724	14.9	38,958	5.4	172,172	24.0	62.0
CC57	Personality Disorders	83,510	11.7	6,941	1.0	7,849	1.1	98,300	13.7	7.1
CC58	Depression	77,715	10.9	110,074	15.4	60,493	8.4	248,282	34.7	44.3
CC59	Anxiety Disorders	70,492	9.8	27,100	3.8	23,093	3.2	120,685	16.9	22.5
CC60	Other Psychiatric Disorders	99,319	13.9	100,790	14.1	64,760	9.0	264,869	37.0	38.1
CC61	Profound Mental Retardation/Developmental Disability	143	0.0	80	0.0	16	0.0	239	0.0	33.5
CC62	Severe Mental Retardation/Developmental Disability	686	0.1	116	0.0	56	0.0	858	0.1	13.5
CC63	Moderate Mental Retardation/Developmental Disability	2,970	0.4	504	0.1	213	0.0	3,687	0.5	13.7
CC64	Mild/Unspecified Mental Retardation/Developmental Disability	21,076	2.9	2,279	0.3	3,091	0.4	26,446	3.7	8.6
CC65	Other Developmental Disability	5,905	0.8	869	0.1	180	0.0	6,954	1.0	12.5
CC66	Attention Deficit Disorder	14,125	2.0	3,660	0.5	2,208	0.3	19,993	2.8	18.3
CC67	Quadriplegia, Other Extensive Paralysis	468	0.1	448	0.1	145	0.0	1,061	0.1	42.2
CC68	Paraplegia	901	0.1	414	0.1	330	0.0	1,645	0.2	25.2
CC69	Spinal Cord Disorders/Injuries	2,139	0.3	3,089	0.4	552	0.1	5,780	0.8	53.4

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC70	Muscular Dystrophy	264	0.0	88	0.0	111	0.0	463	0.1	19.0
CC71	Polyneuropathy	24,867	3.5	12,584	1.8	4,327	0.6	41,778	5.8	30.1
CC72	Multiple Sclerosis	1,160	0.2	1,593	0.2	1,649	0.2	4,402	0.6	36.2
CC73	Parkinson's and Huntington's Diseases	7,461	1.0	6,848	1.0	6,206	0.9	20,515	2.9	33.4
CC74	Seizure Disorders and Convulsions	34,176	4.8	22,226	3.1	35,600	5.0	92,002	12.8	24.2
CC75	Coma, Brain Compression/Anoxic Damage	2,512	0.4	1,395	0.2	583	0.1	4,490	0.6	31.1
CC76	Mononeuropathy, Other Neurological Conditions/Injuries	54,473	7.6	39,959	5.6	19,837	2.8	114,269	16.0	35.0
CC77	Respirator Dependence/Tracheostomy Status	874	0.1	706	0.1	223	0.0	1,803	0.3	39.2
CC78	Respiratory Arrest	146	0.0	622	0.1	53	0.0	821	0.1	75.8
CC79	Cardio-Respiratory Failure and Shock	18,407	2.6	11,494	1.6	23,974	3.3	53,875	7.5	21.3
CC80	Congestive Heart Failure	25,295	3.5	20,332	2.8	25,264	3.5	70,891	9.9	28.7
CC81	Acute Myocardial Infarction	3,876	0.5	1,841	0.3	3,719	0.5	9,436	1.3	19.5
CC82	Unstable Angina and Other Acute Ischemic	3,263	0.5	12,277	1.7	3,090	0.4	18,630	2.6	65.9
CC83	Angina Pectoris/Old Myocardial Infarction	25,265	3.5	10,377	1.4	4,277	0.6	39,919	5.6	26.0
CC84	Coronary Atherosclerosis/Other Chronic Ishemic Heart Disease	46,601	6.5	24,733	3.5	35,096	4.9	106,430	14.9	23.2
CC85	Heart Infection/Inflammation, Except Rheumatic	1,052	0.1	2,038	0.3	672	0.1	3,762	0.5	54.2
CC86	Valvular and Rheumatic Heart Disease	12,358	1.7	28,207	3.9	5,768	0.8	46,333	6.5	60.9
CC87	Major Congenital Cardiac/Circulatory Defect	87	0.0	86	0.0	24	0.0	197	0.0	43.7
CC88	Other Congenital Heart/Circulatory Disease	1,133	0.2	1,544	0.2	216	0.0	2,893	0.4	53.4
CC89	Hypertensive Heart and Renal Disease or Encephalopathy	33,291	4.6	2,028	0.3	2,684	0.4	38,003	5.3	5.3
CC90	Hypertensive Heart Disease	4,079	0.6	10,038	1.4	983	0.1	15,100	2.1	66.5
CC91	Hypertension	120,944	16.9	88,777	12.4	166,458	23.2	376,179	52.5	23.6
CC92	Specified Heart Arrhythmias	14,256	2.0	22,377	3.1	24,786	3.5	61,419	8.6	36.4

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC93	Other Heart Rhythm and Conduction Disorders	27,906	3.9	58,048	8.1	17,228	2.4	103,182	14.4	56.3
CC94	Other and Unspecified Heart Disease	8,010	1.1	29,631	4.1	2,464	0.3	40,105	5.6	73.9
CC95	Cerebral Hemorrhage	638	0.1	4,279	0.6	1,388	0.2	6,305	0.9	67.9
CC96	Ischemic or Unspecified Stroke	2,039	0.3	22,066	3.1	6,233	0.9	30,338	4.2	72.7
CC97	Precerebral Arterial Occlusion and Transient Cerebral Ischemia	4,122	0.6	30,113	4.2	6,009	0.8	40,244	5.6	74.8
CC98	Cerebral Atherosclerosis and Aneurysm	10,880	1.5	16,949	2.4	2,437	0.3	30,266	4.2	56.0
CC99	Cerebrovascular Disease, Unspecified	1,570	0.2	3,457	0.5	155	0.0	5,182	0.7	66.7
CC100	Hemiplegia/Hemiparesis	7,382	1.0	2,173	0.3	1,668	0.2	11,223	1.6	19.4
CC101	Diplegia (Upper), Monoplegia, and Other Paralytic Syndromes	2,766	0.4	1,053	0.1	748	0.1	4,567	0.6	23.1
CC102	Speech, Language, Cognitive, Perceptual Deficits	6,715	0.9	4,775	0.7	1,357	0.2	12,847	1.8	37.2
CC103	Cerebrovascular Disease Late Effects, Unspecified	6,768	0.9	2,867	0.4	688	0.1	10,323	1.4	27.8
CC104	Vascular Disease with Complications	2,793	0.4	5,864	0.8	4,737	0.7	13,394	1.9	43.8
CC105	Vascular Disease	16,302	2.3	44,359	6.2	12,875	1.8	73,536	10.3	60.3
CC106	Other Circulatory Disease	34,522	4.8	30,433	4.2	15,437	2.2	80,392	11.2	37.9
CC107	Cystic Fibrosis	58	0.0	27	0.0	49	0.0	134	0.0	20.1
CC108	Chronic Obstructive Pulmonary Disease	57,149	8.0	33,011	4.6	54,877	7.7	145,037	20.3	22.8
CC109	Fibrosis of Lung and Other Chronic Lung Disorders	3,667	0.5	9,116	1.3	1,822	0.3	14,605	2.0	62.4
CC110	Asthma	42,518	5.9	18,382	2.6	20,164	2.8	81,064	11.3	22.7
CC111	Aspiration and Specified Bacterial Pneumonias	10,160	1.4	2,453	0.3	4,414	0.6	17,027	2.4	14.4
CC112	Pneumococcal Pneumonia, Empyema, Lung Abscess	1,267	0.2	1,999	0.3	628	0.1	3,894	0.5	51.3
CC113	Viral and Unspecified Pneumonia, Pleurisy	12,802	1.8	36,364	5.1	24,819	3.5	73,985	10.3	49.2
CC114	Pleural Effusion/Pneumothorax	2,639	0.4	15,309	2.1	4,001	0.6	21,949	3.1	69.7
CC115	Other Lung Disorders	14,489	2.0	96,587	13.5	14,099	2.0	125,175	17.5	77.2

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC116	Legally Blind	4,128	0.6	279	0.0	239	0.0	4,646	0.6	6.0
CC117	Major Eye Infections/Inflammations	315	0.0	1,037	0.1	170	0.0	1,522	0.2	68.1
CC118	Retinal Detachment	194	0.0	819	0.1	52	0.0	1,065	0.1	76.9
CC119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	97	0.0	1,208	0.2	17	0.0	1,322	0.2	91.4
CC120	Diabetic and Other Vascular Retinopathies	2,038	0.3	10,156	1.4	360	0.1	12,554	1.8	80.9
CC121	Retinal Disorders, Except Detachment and Vascular Retinopathies	2,180	0.3	19,032	2.7	1,561	0.2	22,773	3.2	83.6
CC122	Glaucoma	5,534	0.8	26,154	3.7	5,386	0.8	37,074	5.2	70.5
CC123	Cataract	2,359	0.3	48,701	6.8	802	0.1	51,862	7.2	93.9
CC124	Other Eye Disorders	14,385	2.0	69,955	9.8	5,681	0.8	90,021	12.6	77.7
CC125	Significant Ear, Nose, and Throat Disorders	1,449	0.2	3,143	0.4	477	0.1	5,069	0.7	62.0
CC126	Hearing Loss	10,272	1.4	15,318	2.1	1,240	0.2	26,830	3.7	57.1
CC127	Other Ear, Nose, Throat, and Mouth Disorders	40,223	5.6	124,007	17.3	26,115	3.6	190,345	26.6	65.1
CC128	Kidney Transplant Status	381	0.1	139	0.0	525	0.1	1,045	0.1	13.3
CC129	End Stage Renal Disease	0	0.0	0	0.0	0	0.0	0	0.0	
CC130	Dialysis Status	1,422	0.2	452	0.1	1,063	0.1	2,937	0.4	15.4
CC131	Renal Failure	43,775	6.1	11,434	1.6	30,278	4.2	85,487	11.9	13.4
CC132	Nephritis	3,501	0.5	537	0.1	133	0.0	4,171	0.6	12.9
CC133	Urinary Obstruction and Retention	12,693	1.8	22,392	3.1	10,255	1.4	45,340	6.3	49.4
CC134	Incontinence	16,798	2.3	13,752	1.9	2,716	0.4	33,266	4.6	41.3
CC135	Urinary Tract Infection	51,746	7.2	42,196	5.9	40,186	5.6	134,128	18.7	31.5
CC136	Other Urinary Tract Disorders	24,410	3.4	30,843	4.3	8,561	1.2	63,814	8.9	48.3
CC137	Female Infertility	51	0.0	134	0.0	5	0.0	190	0.0	70.5
CC138	Pelvic Inflammatory Disease and Other Specified Female Genital Disorders	3,061	0.4	9,016	1.3	1,790	0.2	13,867	1.9	65.0
CC139	Other Female Genital Disorders	8,367	1.2	38,833	5.4	5,091	0.7	52,291	7.3	74.3
CC140	Male Genital Disorders	21,331	3.0	17,775	2.5	9,332	1.3	48,438	6.8	36.7
CC141	Ectopic Pregnancy	37	0.0	67	0.0	14	0.0	118	0.0	56.8

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC142	Miscarriage/Abortion	87	0.0	481	0.1	92	0.0	660	0.1	72.9
CC143	Completed Pregnancy With Major Complications	242	0.0	99	0.0	69	0.0	410	0.1	24.1
CC144	Completed Pregnancy With Complications	1,147	0.2	124	0.0	732	0.1	2,003	0.3	6.2
CC145	Completed Pregnancy Without Complications (Normal Delivery)	1,258	0.2	69	0.0	672	0.1	1,999	0.3	3.5
CC146	Uncompleted Pregnancy With Complications	533	0.1	862	0.1	768	0.1	2,163	0.3	39.9
CC147	Uncompleted Pregnancy With No or Minor Complications	442	0.1	2,040	0.3	1,068	0.1	3,550	0.5	57.5
CC148	Decubitus Ulcer of Skin	5,571	0.8	4,322	0.6	1,981	0.3	11,874	1.7	36.4
CC149	Chronic Ulcer of Skin, Except Decubitus	4,861	0.7	11,210	1.6	3,775	0.5	19,846	2.8	56.5
CC150	Extensive Third-Degree Burns	23	0.0	16	0.0	6	0.0	45	0.0	35.6
CC151	Other Third-Degree and Extensive Burns	231	0.0	269	0.0	233	0.0	733	0.1	36.7
CC152	Cellulitis, Local Skin Infection	13,762	1.9	45,544	6.4	19,832	2.8	79,138	11.1	57.6
CC153	Other Dermatological Disorders	29,310	4.1	109,122	15.2	16,976	2.4	155,408	21.7	70.2
CC154	Severe Head Injury	47	0.0	166	0.0	15	0.0	228	0.0	72.8
CC155	Major Head Injury	4,723	0.7	6,609	0.9	4,394	0.6	15,726	2.2	42.0
CC156	Concussion or Unspecified Head Injury	2,022	0.3	59,212	8.3	2,730	0.4	63,964	8.9	92.6
CC157	Vertebral Fractures	2,176	0.3	6,634	0.9	3,409	0.5	12,219	1.7	54.3
CC158	Hip Fracture/Dislocation	1,630	0.2	3,442	0.5	6,615	0.9	11,687	1.6	29.5
CC159	Major Fracture, Except of Skull, Vertebrae, or Hip	1,478	0.2	8,965	1.3	4,156	0.6	14,599	2.0	61.4
CC160	Internal Injuries	2,185	0.3	2,055	0.3	1,257	0.2	5,497	0.8	37.4
CC161	Traumatic Amputation	96	0.0	545	0.1	18	0.0	659	0.1	82.7
CC162	Other Injuries	39,737	5.5	158,925	22.2	56,040	7.8	254,702	35.6	62.4
CC163	Poisonings and Allergic Reactions	64,793	9.0	34,996	4.9	47,366	6.6	147,155	20.5	23.8
CC164	Major Complications of Medical Care and Trauma	8,418	1.2	8,607	1.2	4,061	0.6	21,086	2.9	40.8
CC165	Other Complications of Medical Care	12,926	1.8	6,016	0.8	3,045	0.4	21,987	3.1	27.4
CC166	Major Symptoms, Abnormalities	27,703	3.9	270,322	37.7	121,975	17.0	420,000	58.6	64.4

CC	Description	Part A Only		Part B Only		Parts A and B		Part A or Part B		Percent Missing if Part B Not Used
		n	%	n	%	n	%	n	%	
CC167	Minor Symptoms, Signs, Findings	100,231	14.0	180,833	25.2	261,232	36.5	542,296	75.7	33.3
CC168	Extremely Low Birthweight Neonates	0	0.0	0	0.0	0	0.0	0	0.0	
CC169	Very Low Birthweight Neonates	0	0.0	0	0.0	0	0.0	0	0.0	
CC170	Serious Perinatal Problem Affecting Newborn	0	0.0	0	0.0	0	0.0	0	0.0	
CC171	Other Perinatal Problems Affecting Newborn	0	0.0	0	0.0	0	0.0	0	0.0	
CC172	Normal, Single Birth	0	0.0	0	0.0	0	0.0	0	0.0	
CC173	Major Organ Transplant	0	0.0	0	0.0	0	0.0	0	0.0	
CC174	Major Organ Transplant Status	358	0.0	89	0.0	245	0.0	692	0.1	12.9
CC175	Other Organ Transplant/Replacement	1,048	0.1	501	0.1	48	0.0	1,597	0.2	31.4
CC176	Artificial Openings for Feeding or Elimination	3,520	0.5	1,391	0.2	1,475	0.2	6,386	0.9	21.8
CC177	Amputation Status, Lower Limb/Amputation Complications	3,710	0.5	269	0.0	698	0.1	4,677	0.7	5.8
CC178	Amputation Status, Upper Limb	1,048	0.1	11	0.0	5	0.0	1,064	0.1	1.0
CC179	Post-Surgical States/Aftercare/Elective	122,824	17.2	74,356	10.4	51,758	7.2	248,938	34.8	29.9
CC180	Radiation Therapy	21	0.0	215	0.0	1	0.0	237	0.0	90.7
CC181	Chemotherapy	144	0.0	528	0.1	30	0.0	702	0.1	75.2
CC182	Rehabilitation	1,297	0.2	4,586	0.6	78	0.0	5,961	0.8	76.9
CC183	Screening/Observation/Special Exams	48,065	6.7	142,917	20.0	18,285	2.6	209,267	29.2	68.3
CC184	History of Disease	295,983	41.3	9,503	1.3	11,894	1.7	317,380	44.3	3.0
CC185	Oxygen	0	0.0	0	0.0	0	0.0	0	0.0	
CC186	CPAP/IPPB/Nebulizers	0	0.0	0	0.0	0	0.0	0	0.0	
CC187	Patient Lifts, Power Operated Vehicles, Beds	0	0.0	0	0.0	0	0.0	0	0.0	
CC188	Wheelchairs, Commodes	0	0.0	0	0.0	0	0.0	0	0.0	
CC189	Walkers	0	0.0	0	0.0	0	0.0	0	0.0	

Appendix B. Planned Readmission Algorithm

Table B.1. Procedure categories that are always planned

Procedure CCS	Description
64	Bone marrow transplant
105	Kidney transplant
134	Cesarean section
Re135	Forceps; vacuum; and breech delivery
176	Other organ transplantation

Table B.2. Diagnosis categories that are always planned

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

Table B.3. Potentially planned procedure categories

Procedure CCS	Description
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
47	Diagnostic cardiac catheterization; coronary arteriography
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
62	Other diagnostic cardiovascular procedures
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures

Procedure CCS	Description
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
169	Debridement of wound; infection or burn
170	Excision of skin lesion
172	Skin graft
ICD-9 codes	**Description**
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)
38.18	Endarterectomy leg vessel (from Proc CCS 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from Proc CCS 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from Proc CCS 218- Psychological and psychiatric evaluation and therapy)

Table B.4. Acute principal discharge 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)

Diagnosis CCS	Description
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
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

Diagnosis CCS	Description
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
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
ICD-9 Codes	**Description**
Acute ICD-9 codes within Dx CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
032.82	Diphtheritic myocarditis
036.40	Meningococcal carditis nos
036.41	Meningococcal pericarditis
036.42	Meningococcal endocarditis
036.43	Meningococcal myocarditis
074.20	Coxsackie carditis nos
074.21	Coxsackie pericarditis
074.22	Coxsackie endocarditis
074.23	Coxsackie myocarditis
112.81	Candidal endocarditis
115.03	Histoplasma capsulatum pericarditis
115.04	Histoplasma capsulatum endocarditis
115.13	Histoplasma duboisii pericarditis
115.14	Histoplasma duboisii endocarditis

Diagnosis CCS	Description
115.93	Histoplasmosis pericarditis
115.94	Histoplasmosis endocarditis
130.3	Toxoplasma myocarditis
391.0	Acute rheumatic pericarditis
391.1	Acute rheumatic endocarditis
391.2	Acute rheumatic myocarditis
391.8	Acute rheumatic heart disease nec
391.9	Acute rheumatic heart disease nos
392.0	Rheumatic chorea with heart involvement
398.0	Rheumatic myocarditis
398.90	Rheumatic heart disease nos
398.99	Rheumatic heart disease nec
420.0	Acute pericarditis in other disease
420.90	Acute pericarditis nos
420.91	Acute idiopath pericarditis
420.99	Acute pericarditis nec
421.0	Acute/subacute bacterial endocarditis
421.1	Acute endocarditis in other diseases
421.9	Acute/subacute endocarditis nos
422.0	Acute myocarditis in other diseases
422.90	Acute myocarditis nos
422.91	Idiopathic myocarditis
422.92	Septic myocarditis
422.93	Toxic myocarditis
422.99	Acute myocarditis nec
423.0	Hemopericardium
423.1	Adhesive pericarditis
423.2	Constrictive pericarditis
423.3	Cardiac tamponade
429.0	Myocarditis nos
Acute ICD-9 Codes within Dx CCS 105: Conduction Disorders	
426.0	Atrioventricular
426.10	Atrioventricular block nos
426.11	Atrioventricular block-1st degree
426.12	Atrioventricular block-mobitz ii
426.13	Atrioventricular block-2nd degree nec
426.2	Left bundle branch hemiblock
426.3	Left bundle branch block nec
426.4	Right bundle branch block
426.50	Bundle branch block nos
426.51	Right bundle branch block/left posterior fascicular block
426.52	Right bundle branch block/left ant fascicular block
426.53	Bilateral bundle branch block nec
426.54	Trifascicular block
426.6	Other heart block
426.7	Anomalous atrioventricular excitation
426.81	Lown-ganong-levine syndrome
426.82	Long qt syndrome
426.9	Conduction disorder nos
Acute ICD-9 Codes within Dx CCS 106: Dysrhythmia	
427.2	Paroxysmal tachycardia nos
785.0	Tachycardia nos

Diagnosis CCS	Description
427.89	Cardiac dysrhythmias nec
427.9	Cardiac dysrhythmia nos
427.69	Premature beats nec
Acute ICD-9 Codes Within Dx CCS 108: Congestive Heart Failure; Nonhypertensive	
398.91	Rheumatic heart failure
428.0	Congestive heart failure
428.1	Left heart failure
428.20	Unspecified systolic heart failure
428.21	Acute systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Unspecified diastolic heart failure
428.31	Acute diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Unspecified combined systolic & diastolic heart failure
428.41	Acute combined systolic & diastolic heart failure
428.43	Acute on chronic combined
428.9	Heart failure, unspecified
Acute ICD-9 Codes Within Dx CCS 149: Biliary Tract Disease	
574.0	Calculus of gallbladder with acute cholecystitis
574.00	Calculus of gallbladder with acute cholecystitis without mention of obstruction
574.01	Calculus of gallbladder with acute cholecystitis with obstruction
574.3	Calculus of bile duct with acute cholecystitis
574.30	Calculus of bile duct with acute cholecystitis without mention of obstruction
574.31	Calculus of bile duct with acute cholecystitis with obstruction
574.6	Calculus of gallbladder and bile duct with acute cholecystitis
574.60	Calculus of gallbladder and bile duct with acute cholecystitis without mention of obstruction
574.61	Calculus of gallbladder and bile duct with acute cholecystitis with obstruction
574.8	Calculus of gallbladder and bile duct with acute and chronic cholecystitis
574.80	Calculus of gallbladder and bile duct with acute and chronic cholecystitis without mention of obstruction
574.81	Calculus of gallbladder and bile duct with acute and chronic cholecystitis with obstruction
575.0	Acute cholecystitis
575.12	Acute and chronic cholecystitis
576.1	Cholangitis
Acute ICD-9 Codes Within Dx CCS 152: Pancreatic Disorders	
577.0	Acute pancreatitis

Appendix C. Modified Groupings of ICD-9-CM Codes for Risk Adjustment of the IPF Readmission Measure

Table C.1. Modified AHRQ CCS groupings for principal discharge diagnosis risk variables

Modified CCS	Modified CCS Label	AHRQ CCS	AHRQ CCS Description
650	Adjustment Disorder	650	Adjustment Disorders
651	Anxiety	651	Anxiety Disorders
652/654/ 655	ADD/Developmental/Childhood Disorders	652	Attention-Deficit, Conduct, and Disruptive Behavior Disorders
		654	Developmental Disorders
		655	Disorders Usually Diagnosed in Infancy, Childhood, or Adolescence
653	Dementia	653	Delirium, Dementia, and Amnestic and Other Cognitive Disorders
656	Impulse Control Disorders	656	Impulse Control Disorders, NEC
657.1	Bipolar Disorder	657	Mood Disorders
657.2/ 662	Depressive Disorder	657	Mood Disorders
		662	Suicide and Intentional Self-Inflicted Injury
658	Personality Disorder	658	Personality Disorders
659.1	Schizo-Affective	659	Schizophrenia and Other Psychotic Disorders
659.2	Psychosis	659	Schizophrenia and Other Psychotic Disorders
660	Alcohol Disorders	660	Alcohol-Related Disorders
661	Drug Disorders	661	Substance-Related Disorders
670/ 663	Other Mental Disorders	670	Miscellaneous Disorders
		663	Screening and History of Mental Health and Substance Abuse Codes

Table C.2. Modified CMS CC groupings for comorbidity risk variables

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
1	Other Infection	6	Other Infectious Diseases	X
2	Metastasis	7	Metastatic Cancer and Acute	
3	Other Cancer	10	Breast, Prostate, Colorectal and Other Cancers and Tumors	
4	Diabetes Complications	15	Diabetes with Renal Manifestation	
		16	Diabetes with Neurologic or Peripheral Circulatory Manifestation	
		17	Diabetes with Acute Complications	X
		18	Diabetes with Ophthalmologic Manifestations	
5	Diabetes	19	Diabetes with No or Unspecified Complications	
		119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	
		120	Diabetic and Other Vascular Retinopathies	
6	Malnutrition	21	Protein-Calorie Malnutrition	
7	Hematological Disorder	44	Severe Hematological Disorders	

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
8	Plegia/Amputation	67	Quadriplegia, Other Extensive Paralysis	
		68	Paraplegia	
		69	Spinal Cord Disorders/Injuries	
		100	Hemiplegia/Hemiparesis	X
		101	Diplegia (Upper), Monoplegia, and Other Paralytic Syndromes	X
		102	Speech, Language, Cognitive, Perceptual Deficits	X
		177	Amputation Status, Lower Limb/Amputation Complications	X
		178	Amputation Status, Upper Limb	X
9	Seizures	74	Seizure Disorders and Convulsions	
10	Heart Failure	80	Congestive Heart Failure	X
11	Arrhythmia	92	Specified Heart Arrhythmias	X
		93	Other Heart Rhythm and Conduction Disorders	X
12	Asthma	110	Asthma	
13	Dialysis	130	Dialysis Status	X
14	Sepsis	2	Septicemia/Shock	X
15	Endocrine Disease	22	Other Significant Endocrine and Metabolic Disorders	
		23	Disorders of Fluid/Electrolyte/Acid-Base Balance	X
16	Anemia	47	Iron Deficiency and Other/Unspecified Anemias and Blood Disease	
17	Cardio-Respiratory Failure	79	Cardio-Respiratory Failure	X
18	AMI	81	Acute Myocardial Infarction	X
		82	Unstable Angina and Other Acute Ischemic Heart Disease	X
19	Renal Failure	131	Renal Failure	X
20	Pancreatic Disease	32	Pancreatic Disease	
21	Urinary Tract Disorder	136	Other Urinary Tract Disorders	
22	Coagulation Defects	46	Coagulation Defects and Other Specified Hematological Disorders	X
23	Peptic Ulcer	34	Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	X
24	Infection	1	HIV/AIDS	
		3	Central Nervous System Infection	
		4	Tuberculosis	
		5	Opportunistic Infections	
		37	Bone/Joint/Muscle Infection	
		152	Cellulitis, Local Skin Infection	X
25	Liver Disease	25	End-Stage Liver Disease	
		26	Cirrhosis of Liver	
		27	Chronic Hepatitis	
		28	Acute Liver Failure/Disease	X
		29	Other Hepatitis and Liver Disease	
26	Heart Disease	83	Angina Pectoris/Old Myocardial Infarction	

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
26	Heart Disease, cont.	84	Coronary Atherosclerosis/Other Chronic Ischemic Heart Disease	
		89	Hypertensive Heart and Renal Disease or Encephalopathy	
		90	Hypertensive Heart Disease	
		104	Vascular Disease with Complications	X
		105	Vascular Disease	X
		106	Other Circulatory Disease	X
27	Cerebral Disease	95	Cerebral Hemorrhage	X
		96	Ischemic or Unspecified Stroke	X
		98	Cerebral Atherosclerosis and Aneurysm	
		99	Cerebrovascular Disease, Unspecified	
		103	Cerebrovascular Disease Late Effects, Unspecified	
28	COPD/Fibrosis	108	Chronic Obstructive Pulmonary Disease	
		109	Fibrosis of Lung and Other Chronic Lung Disorders	
29	Skin Ulcer	148	Decubitus Ulcer of Skin	X
		149	Chronic Ulcer of Skin, Except Decubitus	
30	Lung Problems	111	Aspiration and Specified Bacterial Pneumonias	X
		112	Pneumococcal Pneumonia, Empyema, Lung Abscess	X
		113	Viral and Unspecified Pneumonia, Pleurisy	X
		114	Pleural Effusion/Pneumothorax	X
		115	Other Lung Disorders	X
31	Cancer	8	Lung, Upper Digestive Tract, and Other Severe Cancers	
		9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	
		11	Other Respiratory and Heart Neoplasms	
		12	Other Digestive and Urinary Neoplasms	
32	Organ Transplant	174	Major Organ Transplant Status	X
		175	Other Organ Transplant/Replacement	X
33	Uncompleted Pregnancy	142	Miscarriage/Abortion	
		146	Uncompleted Pregnancy With Complications (ICD-9-CM 648.40, 648.43)	
		147	Uncompleted Pregnancy With No or Minor Complications	
34	Injury	150	Extensive Third-Degree Burn	
		151	Other Third-Degree and Extensive Burns	
		155	Major Head Injury	X
		156	Concussion or Unspecified Head Injury	X
		160	Internal Injuries	
		162	Other Injuries	X
		163	Poisonings and Allergic Reactions	X

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
48	Delirium	48	Delirium and Encephalopathy	Complication if not Present on admission
49	Dementia	49	Dementia	
50	Senility	50	Senility, Nonpsychotic Organic Brain Syndromes/Conditions	
51-53	Drug/Alcohol Disorders	51	Drug/Alcohol Psychosis	Complication if not present on admission
		52	Drug/Alcohol Dependence	
		53	Drug/Alcohol Abuse, Without Dependence (except ICD-9-CM 305.1)	
		144	Completed Pregnancy with Complications (ICD-9-CM 648.31-648.32, 648.34)	
		145	Completed Pregnancy without Complication (ICD-9-CM 655.51)	
		146	Uncompleted Pregnancy with Complications (ICD-9-CM 648.30, 648.33)	
		147	Uncompleted Pregnancy with No or Minor Complications (ICD-9-CM 655.50, 655.53)	
		163	Poisonings and Allergic Reactions (ICD-9-CM 980.0, 965.00-956.02, 965.09)	
		170	Serious Perinatal Problem Affecting Newborn (ICD-9-CM 760.71-760.73, 760.75, 779.5)	
		183	Screening/Observation/Special Exams (ICD-9-CM v654.2)	
54.1	Schizo-affective	54	Schizophrenia (ICD-9-CM 295.70-295.75)	
54.2/56	Psychosis	54	Schizophrenia (ICD-9-CM 295.00-295.05, 295.10-295.15, 295.20-295.25, 295.30-295.35, 295.40-295.45, 295.50-295.55, 295.60-295.65, 295.80-295.85, 295.90-295.95)	
		55	Major Depressive, Bipolar, and Paranoid Disorders (ICD-9-CM 297.0-297.3, 297.8-297.9)	
		56	Reactive and Unspecified Psychosis	

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
55.1	Bipolar	55	Major Depressive, Bipolar, and Paranoid Disorders (ICD-9-CM 296.00-296.06, 296.10-296.16, 296.40-296.46, 296.50-296.56, 296.60-296.66, 296.7, 296.80-296.82, 296.89, 296.90, 296.99)	
55.2	Depressive Disorder	55	Major Depressive, Bipolar, and Paranoid Disorders (ICD-9-CM 296.20-296.26, 296.30-296.36, E950.0-951.1, E951.8, E952.0-952.1, E952.8-953.1, E953.8-953.9, E954, E955.0-955.7, E955.9, E956, E957.0-957.2, E957.9-958.9, E959)	
		58	Depression (ICD-9-CM 300.4, 311)	
		167	Minor Symptoms, Signs, Findings (ICD-9-CM V62.84)	
57	Personality Disorders	57	Personality Disorders	
59	Anxiety	48	Delirium and Encephalopathy (ICD-9-CM 293.84)	
		59	Anxiety Disorders (ICD-9-CM 300.01-300.02, 300.10, 300.20-300.23, 300.29, 300.3)	
		60	Other Psychiatric Disorders (ICD-9-CM 300.00, 300.09, 300.5)	
		65	Other Developmental Disability (ICD-9-CM 313.0, 313.21, 313,22)	
60.1	Adjustment Disorder	60	Other Psychiatric Disorders (ICD-9-CM 309.0, 309.22-309.24, 309.28-309.29, 309.3-309.4, 309.82-309.83, 309.89, 309.9)	
		58	Depression (ICD-9-CM 309.1)	
60.2	PTSD	59	Anxiety Disorders (ICD-9-CM 309.81)	
60.3	Other Psychiatric Disorders	59	Anxiety Disorders (ICD-9-CM 300.11-300.13, 300.15-300.16, 300.19, 300.6-300.7, 300.81-300.82, 307.1, 307.51)	
		60	Other Psychiatric Disorders (ICD-9-CM 799.2, 799.21-799.25, 799.29, 300.89, 300.9, 308.0-308.4, 308.9, 312.8, 312.00-312.03, 312.10-312.13, 312.20-312.23, 312.4, 312.81-312.82, 312.89, 312.9, 307.0, 307.9, 307.20-307.23, 307.3, 307.6, 307.7, 309.21, 312.30-312.35, 312.39, 302.0-302.4, 302.50-302.53, 302.6, 302.70-302.76, 302.79, 302.81-302.85, 302.89, 302.9, 306.0-306.4, 306.50-306.53, 306.59, 306.6-306.9, 307.40-307.50, 307.52-307.54, 307.59, 307.80, 307.89, 316)	
61-64	Intellectual Disability	61	Profound Mental Retardation/Developmental Disability	

Modified CC	Modified CC Label	CMS CC	CMS CC Description	Comp-lication
61-64	Intellectual Disability, cont.	62	Severe Mental Retardation/Developmental Disability	
		63	Moderate Mental Retardation/Developmental Disability	
		64	Mild/Unspecified Mental Retardation/Developmental Disability	
65-66	Developmental Disability	65	Other Developmental Disability (ICD-9-CM 758.6-758.7, 758.81, 758.89, 758.9, 759.4, 759.89, 313.1, 313.3, 313.81-313.83, 315.00-315.02, 315.09, 315.1-315.2, 315.31-315.32, 315.34-315.35, 315.39, 315.4-315.5, 315.8-315.9, 313.23, 313.89, 313.9)	
		66	Attention Deficit Disorder	

Appendix D. Sensitivity Analyses

Appendix D1. Impact of Incidence Period Length

Close examination of the hazard of readmission over varying follow-up periods revealed that the risk for readmission does not taper off substantially: the longer the follow-up period the more index admissions will be readmitted, resulting in close to 50% of index admissions being readmitted within 6 months of discharge. Because of the lack of a natural cut off point of the hazard, we decided to explore the impact of larger incidence periods in measuring readmission rates. Specifically, we compared measure rates, discriminative validity and the assignment of facilities into various levels of performance using the original 30 versus a 90-day incidence period.

The risk model showed slightly higher c-statistic of 0.666, suggesting that a slightly larger proportion of readmissions can be correctly predicted with patient case mix.

For the 90-day measure, a total of 1,623 IPFs had more than 24 index admissions during the measurement period and were included in the calculation of RSRR, which is one fewer than for the 30-day measure. The overall RSRR across IPFs was higher at a mean of 37.5%, compared to 21.0% for the 30-day measure. The range between low and high performers was larger with 11.8% absolute difference between the 10th and 90th percentile, compared to 7.6% for the 30-day measure (Table D.1).

Table D.1. Readmission rate distributions across IPFs – 90-day measure

	N	Mean	SD	Min	10th percentile	Lower Quartile	Median	Upper Quartile	90th percentile	Max
Observed	1,695	35.19	9.71	0.00	24.69	29.49	34.89	40.70	46.09	100
RSRR	1,695	37.49	4.66	22.06	31.59	34.34	37.45	40.35	43.38	55.18

Table D.2 shows a comparison of the attribution of IPFs to performance categories according to the 30-day versus 90-day RSRR. This analysis found that of 227 IPFs categorized as “worse than the national rate” 44 shift to “not different than the national rate” when using a 90-day incidence period. Similarly, of 140 IPFs categorized as “better than the national rate”, 24 shifted to “not different than the national rate” when using a 90-day incidence period. Of 1,256 IPFs categorized as “no different than the national rate”, 114 shifted to the outlier categories (100 to “better than the national rate” and 14 to “worse than the national rate”) when using a 90-day incidence period.

Table D.2. Comparison of 30-Day to 90-Day facility performance categorization

30-Day Readmission Categorization (Final Model)	90-Day Readmission Categorization			
Frequency	**Better than national**	**Not different from national**	**Worse than national**	**Total**
Better than national	116	24	0	140
Not different from national	100	1,052	14	1,256
Worse than national	0	44	183	227
Total	216	1,120	287	1,623

In summary, case mix explained a slightly larger proportion of the variation in readmission rates and the designation of hospitals in performance categories changed considerably with a 90-day incidence period. This suggests that a 30-day measure cannot be easily extended into longer follow-up periods without anticipated changes in its underlying construct (i.e., to measure performance). The changes in IPF performance designation might be explained by changes in the composition of readmission types or causes or the changing influence of other factors that are unrelated to the quality of care received at the IPF. Because the strongest evidence supports an association between hospital performance and readmission for shorter (30-day) rather than longer follow-up periods, we are confident that the 30-day incidence period is most appropriate for capturing IPF quality.

Appendix D2. Multinomial Modeling to Capture Different Etiologies of Medical and Psychiatric Readmissions

The etiology of psychiatric and medical readmissions varies. Our literature review and various suggestions by the measure work group raised concerns about the use of a single outcome that includes readmissions for both psychiatric and non-psychiatric causes. Existing conventions for the use of composite endpoints in clinical trials stipulate that the individual components of a composite should have similar severity and importance to patients, similar frequency and a similar relationship to the tested intervention. Similarly, the measure of a construct of performance should include only subcomponents of (a) similar severity to facilitate interpretation, (b) similar frequency to assure comparability across institutions, and (c) similar associations with risk factors that are chosen in risk adjustment. This is particularly important if case mix between facilities varies in a way that results in differences in the risk of the outcome for subpopulations.

Using age distributions in the case mix of facilities as an example, facilities with older patients might have lower risk for psychiatric readmissions but higher risk for non-psychiatric readmissions compared to facilities with younger patients. Risk adjustment models of the composite of psychiatric and non-psychiatric admissions will average the effect of age on the outcome and thus not fully capture the likely inverse association of age with the individual subcomponents. This may reduce the predictive performance of the risk adjustment model.

Therefore, we considered psychiatric and non-psychiatric problems that may necessitate readmission separately to ensure a comprehensive approach for addressing both etiologies. Because psychiatric etiologies were expected to be dominant, we paid special attention to the sensitivity and specificity of psychiatric risk factors in distinguishing low- and high-risk groups for readmission. We tested a multinomial regression model, which models the risk for psychiatric and non-psychiatric admissions separately and allows for comprehensive capture of different associations between risk factors within the individual subcomponents. We then compared model performance between the original logistic and the multinomial regression model.

We modeled an index admission's likelihood of having (a) a readmission with a principal discharge diagnosis for psychiatric (CCS 650-670) causes, (b) a readmission for non-psychiatric causes (with principal discharge diagnosis outside of CCS 650-670), or (c) no admission. Table D.3 summarizes odds ratios derived from the multinomial regression model for each of the outcomes, psychiatric and non-psychiatric readmission, compared to the third outcome, no readmission. Of note, the associations of age with the two types of readmission are reversed, with a strong increased risk of younger age groups for psychiatric readmissions and a protective effect for non-psychiatric admissions. Compared to the reference group of index admissions older than 84 years for both comparisons, the odds ratio for the youngest age group (18-34 years) are 2.25 and 0.38, respectively. A similar protective effect for one outcome and a risk increasing effect for the other can be observed for the various comorbidities.

Table D.3. Risk adjustment model parameters – multinomial regression

Variable Level	Readmission 1=psych 2= non-psych	Odds Ratio	95% LL	95% UL
Demographic factors				
Gender (male)	1	1.250	1.232	1.268
Gender (male)	2	1.117	1.091	1.143
Age Group 18 to 34 vs. 84+	1	2.252	2.145	2.364
Age Group 18 to 34 vs. 84+	2	0.376	0.352	0.403
Age Group 35 to 44 vs. 84+	1	2.136	2.036	2.240
Age Group 35 to 44 vs. 84+	2	0.452	0.426	0.480
Age Group 45 to 54 vs. 84+	1	2.030	1.938	2.127
Age Group 45 to 54 vs. 84+	2	0.516	0.489	0.544
Age Group 55 to 64 vs. 84+	1	1.812	1.730	1.898
Age Group 55 to 64 vs. 84+	2	0.639	0.608	0.671
Age Group 65 to 74 vs. 84+	1	1.461	1.396	1.528
Age Group 65 to 74 vs. 84+	2	0.709	0.679	0.742
Age Group 75 to 84 vs. 84+	1	1.260	1.204	1.318
Age Group 75 to 84 vs. 84+	2	0.904	0.868	0.942
Principal discharge diagnosis on index admission				
CCS 650 Adjustment disorder	1	0.605	0.553	0.662
CCS 650 Adjustment disorder	2	1.118	0.988	1.265
CCS 651 Anxiety	1	0.826	0.773	0.882
CCS 651 Anxiety	2	1.178	1.056	1.313
CCS 652/654/655 ADD/Developmental/Childhood disorders	1	0.760	0.653	0.885
CCS 652/654/655 ADD/Developmental/Childhood disorders	2	1.369	1.123	1.669

Variable Level	Readmission 1=psych 2= non-psych	Odds Ratio	95% LL	95% UL
CCS 653 Dementia	1	1.079	1.041	1.117
CCS 653 Dementia	2	1.342	1.274	1.414
CCS 656 Impulse control disorders	1	0.770	0.690	0.859
CCS 656 Impulse control disorders	2	1.200	0.995	1.448
CCS 657.1 Bipolar disorder	1	0.937	0.917	0.958
CCS 657.1 Bipolar disorder	2	1.149	1.097	1.203
CCS 657.2 Depressive disorder	1	0.822	0.801	0.843
CCS 657.2 Depressive disorder	2	1.216	1.159	1.276
CCS 658 Personality disorder	1	1.049	0.921	1.194
CCS 658 Personality disorder	2	1.403	1.105	1.781
CCS 659.1 Schizo-Affective	reference			
CCS 659.2 Psychosis	1	1.050	1.027	1.073
CCS 659.2 Psychosis	2	1.098	1.047	1.152
CCS 660 Alcohol disorder	1	0.998	0.956	1.043
CCS 660 Alcohol disorder	2	0.968	0.890	1.053
CCS 661 Drug disorder	1	0.742	0.710	0.776
CCS 661 Drug disorder	2	1.242	1.148	1.343
CCS 670/663 Other mental disorder	1	0.853	0.761	0.955
CCS 670/663 Other mental disorder	2	1.598	1.331	1.920
Comorbidities				
Psychiatric				
Delirium	1	1.033	1.012	1.056
Delirium	2	1.104	1.072	1.137
Drug/alcohol disorders	1	1.133	1.115	1.151
Drug/alcohol disorders	2	1.041	1.012	1.071
Schizo-affective disorder	1	1.408	1.384	1.433
Schizo-affective disorder	2	1.002	0.966	1.038
Psychosis	1	1.227	1.207	1.246
Psychosis	2	0.987	0.961	1.014
Bipolar disorder	1	1.308	1.288	1.329
Bipolar disorder	2	1.068	1.039	1.098
Depressive disorder	1	0.942	0.923	0.961
Depressive disorder	2	0.995	0.966	1.024
Personality disorder	1	1.218	1.197	1.239
Personality disorder	2	1.114	1.079	1.150
Anxiety	1	1.087	1.071	1.103
Anxiety	2	1.107	1.080	1.134
Adjustment disorder	1	1.133	1.094	1.173
Adjustment disorder	2	1.060	1.002	1.121
PTSD	1	1.044	1.023	1.066
PTSD	2	1.076	1.035	1.119
Other psychiatric disorders	1	1.128	1.107	1.149
Other psychiatric disorders	2	1.103	1.068	1.140
Mental disability	1	1.036	1.007	1.065
Mental disability	2	0.969	0.913	1.028
Developmental Disability	1	0.991	0.964	1.019
Developmental Disability	2	1.077	1.017	1.140
Non-psychiatric				
Other infection	1	1.069	1.049	1.089
Other infection	2	1.111	1.080	1.142
Metastasis	1	0.913	0.816	1.021

Variable Level	Readmission 1=psych 2= non-psych	Odds Ratio	95% LL	95% UL
Metastasis	2	1.459	1.299	1.639
Diabetes complications	1	0.920	0.892	0.948
Diabetes complications	2	1.247	1.200	1.296
Diabetes	1	1.000	0.983	1.017
Diabetes	2	1.152	1.122	1.183
Malnutrition	1	0.939	0.908	0.972
Malnutrition	2	1.109	1.065	1.154
Hematological disorder	1	1.001	0.902	1.110
Hematological disorder	2	1.387	1.236	1.557
Seizures	1	1.059	1.040	1.079
Seizures	2	1.279	1.241	1.318
Heart failure	1	0.866	0.841	0.892
Heart failure	2	1.331	1.289	1.374
Arrhythmia	1	1.010	0.988	1.033
Arrhythmia	2	1.161	1.128	1.195
Asthma	1	1.071	1.052	1.091
Asthma	2	1.106	1.070	1.143
Dialysis	1	0.813	0.719	0.921
Dialysis	2	2.128	1.925	2.352
Endocrine disease	1	1.012	0.996	1.029
Endocrine disease	2	1.303	1.270	1.338
Anemia	1	1.048	1.031	1.066
Anemia	2	1.266	1.234	1.298
AMI	1	0.969	0.918	1.023
AMI	2	1.183	1.120	1.249
Pancreatic disease	1	1.012	0.967	1.058
Pancreatic disease	2	1.381	1.303	1.463
Urinary tract disorder	1	1.019	0.994	1.045
Urinary tract disorder	2	1.091	1.056	1.127
Peptic ulcer	1	1.007	0.977	1.038
Peptic ulcer	2	1.222	1.176	1.270
Infection	1	1.038	1.016	1.061
Infection	2	1.241	1.202	1.282
Liver disease	1	1.157	1.132	1.182
Liver disease	2	1.176	1.134	1.220
Heart disease	1	0.985	0.967	1.002
Heart disease	2	1.280	1.247	1.314
COPD/Fibrosis	1	1.041	1.023	1.058
COPD/Fibrosis	2	1.257	1.225	1.289
Lung problems	1	0.955	0.936	0.975
Lung problems	2	1.201	1.168	1.235
Organ transplant	1	1.112	0.990	1.248
Organ transplant	2	1.185	1.012	1.387
Uncompleted pregnancy	1	1.073	0.988	1.166
Uncompleted pregnancy	2	1.323	1.104	1.587
Injury	1	1.002	0.987	1.016
Injury	2	1.186	1.157	1.215
Variables from literature				
Admission history with AMA vs. no admission	1	2.387	2.309	2.467
Admission history with AMA vs. no admission	2	1.784	1.688	1.885
Admission history with no AMA vs. no admission	1	1.541	1.512	1.571

Variable Level	Readmission 1=psych 2= non-psych	Odds Ratio	95% LL	95% UL
Admission history with no AMA vs. no admission	2	1.084	1.050	1.118
Suicide attempt / ideation/ self-harm	1	1.242	1.217	1.266
Suicide attempt / ideation/ self-harm	2	1.049	1.017	1.082
Aggression	1	1.106	1.077	1.135
Aggression	2	0.993	0.946	1.043

Despite the observed reverse associations between several individual risk variables and the two outcomes, resulting in an "averaged" and often times weak association of the risk variable in the simple logistic regression approach that models the combined outcome, the performance of the two models are similar. Table D.4 shows the concordance between index admissions that were observed to be readmitted or not and index admissions whose status (readmission or not) was predicted by the original logistic regression model. The concordance is 79.33%, estimated as the sum of the index admissions that were correctly predicted as not readmitted (78.51%) and the index admissions that were correctly predicted as readmitted (0.82%).

Table D.4. Concordance between logistic regression model predicted and observed outcomes

Observed	Model Prediction		
Frequency (%)	**No readmission**	**Readmission**	**Total**
No readmission	281,125 (78.51)	2,008 (0.56)	283,133 (79.07)
Readmission	72,028 (20.11)	2,926 (0.82)	74,954 (20.93)
Total	353,153 (98.62)	4,934 (1.38)	358,087 (100.00)

The same estimation of concordance is provided for the multinomial model in Table D.5. In the logistic regression model, we summed the proportion of all correctly predicted readmissions regardless of designation of psychiatric or non-psychiatric (0.39%, 0.05%, 0.01%, 0.02%) and the proportion of index admissions that were correctly predicted to be not readmitted (78.78%). Total concordance is estimated as 79.25%, which is almost identical to the logistic regression approach.

Table D.5. Concordance between multinomial regression model predicted and observed outcomes

Observed	Model Prediction			
Frequency (%)	**No readmission**	**Psychiatric readmission**	**Non-psychiatric readmission**	**Total**
No readmission	282,109 (78.78)	957 (0.27)	67 (0.02)	283,133 (79.07)
Psychiatric readmission	55,624 (15.53)	1,411 (0.39)	29 (0.01)	57,064 (15.94)
Non-psychiatric readmission	17,661 (4.93)	170 (0.05)	59 (0.02)	17,890 (5.00)
Total	355,394 (99.25)	2,538 (0.71)	155 (0.04)	358,087 (100.00)

These analyses indicate a limited gain in risk model performance with employment of a multinomial model, which is computationally more complex and resource intensive. Therefore, we confirmed that a standard binomial regression model as used for other CMS inpatient readmission measures is valid for this measure.

Appendix D3. Examination of Age-Stratified or Dementia-Stratified Cohorts

Risk factors may have different associations with readmission risk within subgroups of index admissions. For example, the role of age as a risk factor for readmission for a patient with schizophrenia is expected to be in the opposite direction of that of a patient with Alzheimer's disease. If specific risk factors have significantly different associations with readmission risk in two subpopulations, stratified risk models might be more effective than a single model approach. Specifically, if age mediated the association between a particular risk factor and readmission risk, the estimate in the overall measure cohort would reflect an average of the risk factor's effect while separate models in separate age-stratified cohorts would allow full capture of the differences in estimates and thus, improve model prediction. Such interaction could then be addressed in separate models or through inclusion of interaction terms in the overall model.

Therefore, we explored two alternate cohort approaches using stratification to confirm the validity of our final cohort. First we divided the measure cohort based on presence of dementia or Alzheimer's disease as measured by either CCS 653 in the principal discharge diagnosis or CC 49-50 in the secondary diagnoses of the index admission. This stratification followed work group recommendations that described the etiology of hospital readmission for dementia as appreciably different from readmission for other primary psychiatric disorders. Second we stratified the cohort based on age at index admission into sub-cohorts representing age groups 18-44 years, 45-64 years and 65 and older years. We fit separate models in each stratum and compared the aggregate model performance of the 2 or 3 strata with the model that was fit in the original full cohort.

Table D.6 summarizes the performance parameters of the logistic regression models for the full or stratified cohorts. Model performance for the dementia cohort was slightly superior to the full cohort model with a c-statistic of 0.670, but this was counteracted by inferior predictive ability in the other stratum, resulting in a combined weighted c-statistic of 0.611. Likewise, c-statistics of the two younger age strata were slightly better (0.667 and 0.663), but the lower predictive ability of the model for the older age stratum outweighed the former, resulting in a combined weighted c-statistic of 0.644. In summary, both stratification approaches yielded inferior model performance. This confirmed the validity of the use of a single cohort for this measure.

Table D.6. Risk adjustment model performance parameters for the full and stratified cohorts

Statistic	Full	Dementia	No Dementia	Age 18-44	Age 45-64	Age >=65
Sample size	716,174	165,738	550,436	199,963	267,743	248,268
Readmission rates	20.9%	16.4%	22.2%	25.0%	22.5%	15.8%
% Concordant	65.7	66.8	58.7	66.5	66.0	60.0
% Discordant	33.8	32.7	40.1	33.0	33.4	38.8

Statistic	Full	Dementia	No Dementia	Age 18-44	Age 45-64	Age >=65
% Tied	0.6	0.5	1.3	0.5	0.5	1.1
% Concordance Summary	67.5	60.6		64.0		
c-statistic	0.660	0.670	0.593	0.667	0.663	0.606
c-statistic summary	0.678	0.611		0.644		