Evaluation of Potential Prevalent Comorbidity Adjustments: Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)

TEP Summary Report

September 9&10, 2015

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Evaluation of Potential Prevalent Comorbidity Adjustments: Standardized Hospitalization Ratio and the Standardized Mortality Ratio, Technical Expert Panel Summary

The Centers for Medicare & Medicaid Services (CMS) have contracted with the University of Michigan Kidney Epidemiology and Cost Center (UM-KECC) to evaluate the potential of including prevalent comorbidities in the Standardized Hospitalization Ratio (SHR) and Standardized Mortality Ratio (SMR) risk-adjustment models. The motivation for this project originated in public comments that expressed interest in adding more recent measures of patient health status to the risk-adjustment models; these currently adjust for comorbidities at incidence. This work was a component of a larger project to reevaluate the SHR and SMR measures, and for submission for re-endorsement by the National Quality Forum (NQF).

Technical Expert Panel Objectives

The technical expert panel was charged with evaluating the potential of including prevalent comorbidities in the SHR and SMR risk-adjustment models. Specific objectives included:

- Review of the comorbidity adjustment in the current NQF-endorsed SHR and SMR measures;
- Consideration of which, if any, prevalent comorbidities are appropriate to include in each measure.

Technical Expert Panel Meeting

The Technical Expert Panel (TEP) met in Baltimore, Maryland on September 9 & 10, 2015.

The following individuals participated in this TEP:

Name, Credentials, and Professional Role	Organizational Affiliation, and City, State	Conflict of Interest Disclosure
Caroline Steward, APRN, CCRN, CNN **Advanced Practice Nurse (Hemodialysis)**	Capital Health System Trenton, NJ	None provided
Roberta Wager, MSN, RN **Renal Care Coordinator** **Member of Forum of ESRD Networks Beneficiary Council**	Fresenius Medical Care Forum of ESRD Networks Boerne, TX	None provided
Mark Mitsnefes, MD, MS **Professor of Pediatrics** **Program Director**	Cincinnati Children's Hospital Medical Center and University of Cincinnati Cincinnati, OH	None provided

Name, Credentials, and Professional Role	Organizational Affiliation, and City, State	Conflict of Interest Disclosure
Dana Miskulin, MD, MS **Staff Nephrologist** **Associate Professor of Medicine**	Tufts Medical Center Boston, MA Outcomes Monitoring Program, Dialysis Clinic Inc. Nashville, TN	Receives salary support from DCI
Jennifer Flythe, MD, MPH **Research Fellow** **Assistant Professor of Medicine**	University of North Carolina at Chapel Hill Chapel Hill, NC	Speaking honorarium from DCI.
Eduardo Lacson Jr, MD, MPH **Nephrologist**	American Society of Nephrology Lexington, MA	None provided
Lorien Dalrymple, MD, MPH **Associate Professor**	University of California, Davis Division of Nephrology Sacramento, CA	Receives research support from DCI. Husband is a physician partner at Kaiser Permanente and shareholder at TPMG. Engaged in research related to SMR and SHR.
David Gilbertson, PhD **Co-director** **Director of Epidemiology and Biostatistics**	Chronic Disease Research Group Minneapolis, MN	CDRG receives research support from: NIH, HRSA, Amgen, DaVita, NxStage, Questcor, Keryx, Amag, Akebia, Fresenius, ZS Pharma, and Peer Kidney Care Initiative.
Danielle Ward **Member of Forum of ESRD Networks Beneficiary Council Board Member**	Forum of ESRD Networks Network 6 Wake Forest, NC	None provided

Contractor Staff	Organizational Affiliation, and City, State	Conflict of Interest Disclosure
Jack Wheeler, PhD	Professor Emeritus, Health Management and Policy; University of Michigan Kidney Epidemiology and Cost Center	None
Yi Li, PhD	Director, University of Michigan Kidney Epidemiology and Cost Center; Professor of Biostatistics	None
Joseph Messana, MD	Collegiate Professor of Nephrology and Professor of Internal Medicine; University of Michigan Kidney Epidemiology and Cost Center	None
Claudia Dahlerus, PhD, MA	Principal Scientist, University of Michigan Kidney Epidemiology and Cost Center	None
Kevin He, PhD	Research Assistant Professor, Biostatistics; University of Michigan Kidney Epidemiology and Cost Center	None
Sarah Bell, MPH	Research Analyst, University of Michigan Kidney Epidemiology and Cost Center	None
Amy Jiao, MA, MPP	Research Analyst, University of Michigan Kidney Epidemiology and Cost Center	None
Casey Parrotte, BA	Lead Project Manager, University of Michigan Kidney Epidemiology and Cost Center	None

At the in person meeting, the following additional conflict of interest disclosures were provided:

Jennifer Flythe, MD, MPH: Two research grants from the Renal Research Institute (not yet executed).

1. Introduction

This report summarizes the discussions and recommendations of the *Evaluation of Potential Prevalent Comorbidity Adjustments: Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)* TEP meeting convened on September 9 & 10 in Baltimore, Maryland. The TEP discussion was informed by a preparatory review of relevant literature as part of an environmental scan conducted by UM-KECC. Potential measure elements were evaluated using the criteria for clinical performance measures adopted by NQF and CMS. These criteria include each measure's importance, scientific acceptability, feasibility, and usability.

2. Overview of Topics for Discussion

The NQF Measure Evaluation Criteria, as outlined in the *CMS MMS Blueprint*, require that a risk-adjustment methodology be based on patient factors that influence the measured outcome (but not factors related to disparities in care or the quality of care) and are present at start of care[1]. Therefore, two conditions need be met for the inclusion of a comorbidity as a risk-adjuster: (1) the comorbidity must be substantially related to the outcome being measured, and (2) the comorbidity should not reflect the quality of care furnished by the provider/facility being evaluated. The TEP was asked to consider the following questions:

1. Which comorbidities should be included as adjustors for SHR and SMR, based on their statistical and clinical relationships to the outcomes?
2. Which comorbidities should be excluded based on the likelihood that they may result from facility care?
3. Which data sources should we use to identify prevalent comorbidities?
    a. Do the sources of data available to identify prevalent comorbidities introduce bias into the models?
    b. If so, are there steps that can be taken to address this problem?
4. How do we specify the length of time over which a prevalent comorbidity is measured?
    a. Does the timing of prevalent comorbidity reporting introduce bias into the models?
5. What are the unintended consequences for the use of proposed prevalent comorbidities in the models?
    a. What can be done to mitigate the unintended consequences?
6. Given currently available data, which prevalent comorbidities are definite choices for inclusion or exclusion as measure adjustments? Which important measures of patient health status are missing from currently available data?

[1] A Blueprint for the CMS Measures Management System, v. 11. July 2014.

3. Preliminary Activities

3.1 Environmental Scan and Literature Review

Prior to the in-person TEP meeting, UM-KECC presented the TEP members and CMS with a summary of the existing published literature related to comorbidity adjustment, including information on the use of the Hierarchical Condition Categories (HCC) and the Charlson Comorbidity Index (CCI) as sources of comorbidity adjustors.

UM-KECC also provided the TEP with a summary of NQF-endorsed standardized measures, some of which adjust for prevalent comorbidities. This summary included the specifications for the two NQF-endorsed CMS measures the TEP was charged to review (*NQF #0369: Standardized Mortality Ratio and NQF #1463: Standardized Hospitalization Ratio*), as well as the specifications for a number of other measures of hospitalization and mortality in other care settings.

3.2 TEP Charter

In preparation, *The Evaluation of Potential Prevalent Comorbidity Adjustments: Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR) TEP Charter* was distributed to the TEP members for review; the Charter was approved by the nine TEP members before the in-person meeting.

3.3 Pre-TEP Teleconference Call

A pre-TEP conference call was held on August 5, 2015; it focused on the introduction of TEP members, the role of the TEP, and an overview of the measure development process.

4. In-person TEP Meeting

4.1 Introductions and Background

Roles and Responsibilities

UM-KECC staff began the meeting by reviewing the roles of the TEP and of the measure developer. UM-KECC's role is to facilitate the TEP, and to ensure that the TEP's opinions on the subject matter are recorded and transcribed accurately in a TEP summary report. Following the TEP, UM-KECC will distribute a draft report for TEP review and confirmation that the discussion was accurately captured. Once this report has been finalized, CMS will take into consideration the TEP's recommendations for future policy decisions. It is important to note that the recommendations of the TEP may not necessarily be implemented into CMS policy. It does not represent a failure if CMS decisions do not reflect the TEP's advice or recommendations. The primary objective is that the TEP opinions are recorded accurately, presented transparently, and understood. CMS explained that if they choose not to follow TEP recommendations, this decision will be based on a compelling rationale which will be shared with both the TEP and the general public.

One TEP member asked if the measures being developed will be used in the ESRD Quality Incentive Program (QIP). CMS explained that the ultimate use of the measures in CMS programs has not yet been determined; there are a number of programs in which they may be implemented, including Dialysis Facility Compare, the Dialysis Facility Reports, and the ERSD QIP. It is CMS' goal to first develop the best possible quality measures, and then determine implementation after the measure specifications are finalized.

NQF Risk-adjustment Criteria

The group briefly reviewed the NQF criteria for risk adjustment, which specify that:

- risk adjustment should be based on patient factors that influence the measured outcome and are present at the start of care,
- measures should not be adjusted for factors related to disparities in care or the quality of care,
- risk adjustment factors must be substantially related to the outcome being measured, and
- risk adjustment factors should not reflect quality of care by the provider/facility being evaluated.

UM-KECC noted that these last two points are central to the TEP's deliberations, and that educational information would be presented regarding how to determine the relationship of comorbidities to the SMR and SHR. This material is included in report Section 4.3.

Questions for the TEP to Consider

As presented in Section 2, the group reviewed the list of questions under consideration for panel deliberations. These questions helped structure TEP discussions, and included:

1. Which comorbidities should be included as adjustors for SHR and SMR, based on their statistical and clinical relationships to the outcomes?
2. Which comorbidities should be excluded based on the likelihood that they may result from facility care?
3. Which data sources should we use to identify prevalent comorbidities?
    a. Do the sources of data available to identify prevalent comorbidities introduce bias into the models?
    b. If so, are there steps that can be taken to address this problem?
4. How do we specify the length of time over which a prevalent comorbidity is measured?
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5. What are the unintended consequences for the use of proposed prevalent comorbidities in the models?
    a. What can be done to mitigate the unintended consequences?
6. Given currently available data, which prevalent comorbidities are definite choices for inclusion or exclusion as measure adjustments? Which important measures of patient health status are missing from currently available data?

Current Adjustments in the SHR and SMR

UM-KECC reviewed the current adjustments in the SHR and SMR models:

Standardized Hospitalization Ratio (NQF #1463)

Numerator	Number of inpatient hospital admissions among eligible patients at the facility during the reporting period.
Denominator	Number of hospital admissions that would be expected among eligible patients at the facility during the reporting period, given the national death rates for patients with the same characteristics as those at the facility.
Adjustments	Patient age, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status, comorbidities at incidence (2728), BMI at incidence, and calendar year
C-Statistic (predictive power)	0.60
Patients	Medicare only

Standardized Mortality Ratio (NQF #0369)

Numerator	Number of deaths among eligible patients at the facility during the time period.
Denominator	Number of deaths that would be expected among eligible dialysis patients at the facility during the time period, given the national death rates for patients with the same characteristics as those at the facility.
Adjustments	Patient age, race, ethnicity, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status, comorbidities at incidence (2728), BMI at incidence, calendar year, and age-adjusted population death rates by state and race
C-Statistic (predictive power)	0.68
Patients	Medicare and non-Medicare

A TEP member asked if there was a common baseline interpretation of a C-statistic. UM-KECC explained that a C-statistic is used to evaluate the predictive power of a statistical model. For example, if one chose a pair of patients from a data set, only one of whom was hospitalized, a C-statistic of 0.6 indicates that 60% of the time the model will successfully to identify which person was hospitalized.

It was noted that there is no statistical definition of a "good" C-statistic. Values for this measure range from 0.5 to 1.0. A value of 0.5 indicates that the model is no better than chance, and a value of 1.0 indicates that the model perfectly identifies those within a group and those not. Models with a C-statistic of 0.50-0.60 are typically considered to be weakly predictive, moderately predictive when the *c*= 0.60-0.80, and strongly predictive when *c* exceeds 0.8[2]. Within the context of other similar outcome measures, C-statistic values frequently fall within the 0.65-0.7 range.

4.2 Approaches to Classifying Comorbidities

UM-KECC explained that they considered three approaches to classifying comorbid conditions in preparation for this TEP meeting: the CMS ESRD Hierarchical Condition Categories (HCC), the Charlson Comorbidity Index (CCI), and the AHRQ Clinical Classification Software (CCS). Both CMS HCCs and the CCI have wide acceptability as methods for comorbidity risk adjustment. UM-KECC presented analyses applying the CMS HCC Grouper and the CCI to classify comorbidities.

CMS ESRD Hierarchical Condition Categories

Overview

UM-KECC presented an overview of the CMS ESRD Hierarchical Condition Categories (HCCs). They described how the CMS HCCs were developed to determine capitated payment to Medicare Advantage Plans based on patient risk profiles; ICD-9 codes were aggregated into approximately 805 diagnostic groups, and then into 189 Condition Category (CC) groups. Diseases within a CC are related clinically and by cost.

One TEP member asked about the applicability of HCCs to ESRD patients, as the HCCs were developed for use with the general Medicare population. UM-KECC explained that CMS has derived a subset list of 87 ESRD HCCs that were identified as being most predictive of cost for ESRD beneficiaries; the FY2014 ESRD HCCs were used in UM-KECC's analyses. For these analyses, a patient was considered to have a particular HCC if there was a claim with one of the listed ICD-9 codes during the prior 12 months. Patients were required to have had Medicare coverage for at least six of the prior 12 months to attribute the HCC. Medicare coverage in this case is defined as being Medicare eligible. Patients were considered Medicare eligible during a given month if he/she had at least $900 of Medicare-paid dialysis claims or at least one Medicare-paid inpatient claim during that month. The following two months were then also considered Medicare eligible. A sensitivity analysis was performed to indicate the percent of patients with one versus two claims classifying any specific HCC. Provider-assigned lab or diagnostic codes were excluded from this

[2] Hosmer DW, Lemeshow S. Applied Logistic Regression. New York, NY: John Wiley & Sons; 1989.
Hosmer DW, Lemeshow S. Applied Logistic Regression (2nd Edition). New York, NY: John Wiley & Sons; 2000.

analysis; diagnosis codes assigned to such procedures reflect investigation to rule out or identify the presence of a diagnosis, rather than evidence of the existence of a diagnosis.

Based upon 2010 data, UM-KECC presented a list of the top 20 ESRD HCCs most frequently reported in Medicare claims. No distinction was made between inpatient and outpatient claims. It was noted that a lower HCC number indicates greater disease severity and impact on ESRD costs.

Diabetes was the most common HCC in 2010—56.8% of ESRD patients received this code on at least one claim. One TEP member noted that although the list of ESRD HCCs have been determined to be most predictive of cost for ESRD, the ESRD HCC numbers (indicating disease severity) are the same as the complete HCC list, suggesting a similar impact on predicting cost between ESRD and non-ESRD patients. However, they felt this may not directly capture the potentially different cost burden for ESRD patients compared to general Medicare patients with the same HCC.

TEP members requested a list of ICD-9 codes associated with each HCC, for clarity on which individual diagnoses were included in each of the 87 HCCs. This list was provided to them via email during the meeting.

Review of analyses

UM-KECC next reviewed their statistical methodology for identifying a subset of comorbidities, based on the HCC's ability to predict the response variables of hospitalization and mortality. This method selected 70 of the 87 HCCs. Using 2010 claims data UM-KECC then re-fit the SMR model to predict events in calendar year 2011 with the HCCs that were found to be predictive of mortality. Of the 70 HCC categories included in the SMR model, 49 were statistically significant. The resulting C-statistic for this model was incrementally better than that of the original model, a change from 0.68 to 0.72. The group reviewed the estimated coefficients for each of the HCCs, along with their associated p-values.

A TEP member inquired about the source of the claims for the CKD-related HCCs, specifically whether the analysis included pre-dialysis claims. UM-KECC responded that pre-dialysis claims may be included; there was 12-month observation period for claims, and those claims were used to predict survival in the following year. Another TEP member commented that it does not make sense to include the CKD or AKI HCCs in the model, since all of the patients in the model had either CKD or AKI. UM-KECC clarified that not all patients in this initial modeling had claims for CKD or AKI. Further, there was no screening of comorbidities at this stage; the intention of the initial analyses was to be broadly inclusive, in order to frame the discussion of which HCCs should or should not be included as potential risk adjustors.

Another TEP member noted that 70 HCCs were identified using 2013 data, yet only 49 remained statistically significant in 2011. Their expectation was that HCCs predictive in one year would likely be predictive in subsequent years. UM-KECC noted that as they had analyzed a different, independent dataset, it was not unexpected that variables reached different levels of significance. The TEP member noted that it would be interesting to examine additional years of data to compare changes in variable significance across years.

One TEP member noted that an assumption inherent to this analysis is that the coding and billing practices and processing were similar in 2011 and 2013. Another participant explained that in 2013 more HCC codes were added, possibly explaining a spike in certain comorbid conditions. Members believed that

it may be worthwhile to investigate whether there were systematic changes in those two years, possibly by assessing the proportion of each HCC code that was present in the entire 2011 and 2013 datasets.

UM-KECC illustrated the impact of adding prevalent comorbidities by comparing the facility flagging rates ('better than expected'; 'as expected'; 'worse than expected') of the current SMR to the SMR with the prevalent comorbidities added. In this analysis, 60 facilities moved from 'worse than expected' to 'as expected', and 40 moved from 'as expected' to 'worse than expected' (the total number of facilities in the analysis was 5,263). The Kappa statistic between the sets of flagging results was 0.7299, indicating that the methods were in good agreement.

UM-KECC presented the results of a similar analysis for the SHR. The analytic process was the same as for the SMR, and resulted in 65 statistically significant HCCs in the SHR model, with the C-statistic increasing to 0.60 from 0.66. A change in flagging rates for the SHR was also seen when HCCs were included; 68 facilities moved from 'worse than expected' to 'as expected' in the new model with prevalent comorbidities, while 59 facilities declined from 'as expected' to 'worse than expected'.

Charlson Comorbidity Index

Overview

UM-KECC provided an overview of the Charlson Comorbidity Index (CCI) as an alternative diagnosis classification system. Developed in 1987 by Charlson and colleagues, the CCI is a weighted index based on the presence and severity of 19 comorbidities. The CCI was originally created for use in the general medical population, and based on small cohort of approximately 550 patients admitted to a New York hospital. It was later validated in a 10-year longitudinal cohort study of 694 women with breast cancer at New Haven Yale hospital, and was shown to be longitudinally predictive of mortality. The CCI was applied to an ESRD population in a 2000 study by Beddhu et al., to predict mortality, hospitalization, and cost. It performed well in clinical outcomes and costs estimation, however, the measure did not account for comorbidities that could be a result of care.

Review of Analyses

For discussion, UM-KECC presented preliminary analyses that applied the CCI weighting and scoring method to the SHR and SMR. Similar to Beddhu et al.'s findings, results did not account for comorbidities that could be a result of facility care. 2012 data were then used to fit a Cox regression model to generate relative risks (RR) for all comorbidities from Medicare claims. Weights were assigned as follows, based on the original CCI weighting methodology developed by Charlson et al. (1987):

Conditions with:

- RR < 1.2—dropped from analyses
- RR > 1.2 < 1.5—assigned weight of 1
- RR > 1.5 < 2.5—assigned weight of 2
- RR > 2.5 < 3.5—assigned weight of 3.

No conditions had RR >3.5.

UM-KECC used these weights to calculate the CCI then re-fit the model with the index, using 2011 data. The TEP members reviewed the results of assigning weights to comorbidities based on their relative risk. For the SMR, most conditions were weighted 1 or 0. Only cancer and moderate or severe liver disease were assigned a weight of 2. One TEP member questioned the choice of severity indicator for liver disease and cancer; UM-KECC explained that the severity weightings were in some cases influenced by the standardized condition definition of the ICD-9 diagnosis code. Severity weightings were thus not applied to some diagnoses, such as dementia. Patients with <6 months of Medicare coverage were included in the model in a separate category, as similar to the HCC analyses. Comorbidities at ESRD incidence, as indicated on the Medical Evidence Form (2728), were also included in the model as separate indicators.

UM-KECC reviewed changes in facility flagging rates when incorporating the CCI. 48 facilities moved from 'as expected' to 'worse than expected', and 40 facilities moved from 'worse than expected' to 'as expected'. The Kappa statistic was 0.7825, which demonstrated good agreement between the models with and without the CCI.

UM-KECC next presented results for the SHR analyses. In the SHR analysis, all comorbidity grouping weights were assigned as either 0 or 1. A TEP member asked if the weights incorporated the 2728 comorbidities; UM-KECC explained that they do not. They noted that for the SHR, approximately 30% of patients in the denominator had less than six months of Medicare coverage. For SMR, this was approximately 40%.

UM-KECC then reviewed the changes in facility flagging rates when the model was adjusted using the CCI. For the SMR, 48 facilities changed from 'worse than expected' to 'as expected', and 40 facilities declined from 'as expected' to 'worse than expected'. One TEP member asked if UM-KECC had information about the facilities that changed categories, particularly if they were the same facilities as had changed in the HCC model. For SMR, 40 of the facilities that changed from 'worse' to 'as expected' also changed in the HCC model. 28 facilities that changed from 'as expected' to 'worse than expected' also changed in the HCC model. A similar result was true for the SHR.

Using the CCI, the C-statistic for SMR was 0.71, as compared to 0.72 for the HCCs. For SHR, the C-statistic for the CCI model was 0.65, as compared to .66 for the HCCs.

	Hierarchical Condition Categories	**Charlson Comorbidity Index**	**Current SMR & SHR Models**
Standardized Mortality Ratio	0.72	0.71	0.68
Standardized Hospitalization Ratio	0.66	0.65	0.60

4.3 Facility Influence on Comorbidities

Review of HCC Comorbidity Exercise

After reviewing the HCC and CCI risk adjustment strategies, the group moved to discussion of facility influence on comorbidities. UM-KECC conducted an exercise in which UM-KECC nephrologists and TEP members were asked to assign a rating to each of the 70 HCC categories, based on the extent to which they believed the comorbidity could be a result of facility care.

For this exercise, each participant was asked to rate the previously discussed HCCs on a 1-5 scale; scores were anchored with a rating of 1 indicating that the comorbidity was "Very likely not a result of care", and 5 indicating that the comorbidity was "Very likely a result of facility care". UM-KECC explained that the intention of the exercise was to stimulate discussion rather than achieve consensus.

The group reviewed the results of the exercise. UM-KECC noted a wide variability the ratings. Some individuals assigned almost all 1s and 2s to many HCCs, while others chose 5s for the same conditions. When considering the total summed scores, however, there was a fair amount of consensus for the lowest tertile of comorbidities that were judged not likely the result of facility care.

In preparation for the TEP meeting discussions, UM-KECC performed preliminary analyses using results from the same rating exercise that they conducted internally prior to the meeting, rating each of the HCCs. This was conducted by four UM-KECC nephrologists. These data were used in the example as there was insufficient time to reanalyze the models with the ratings provided by the TEP members just prior to the in-person meeting.

The analyses included the total score for HCC groups of between and 4 and 6 when summing the four ratings. It was suggested that these comorbidities might be considered to be unlikely the result of facility care. The C-statistics for these models were higher than the original model, but lower than the model that adjusted for all 70 HCCs. The changes in facility flagging rates were similar to the original model. UM-KECC indicated that they would repeat the analyses following the in-person meeting, once a list reflecting TEP member consensus on the comorbidities has been compiled.

Presentation by David Gilbertson, PhD

On the initial TEP conference call, Dr. Gilbertson mentioned that the Center for Chronic Disease Research had conducted work relevant to the measurement of comorbidities in patient claims data. At the request of UM-KECC, he presented results from an unpublished study (as of the date of this report) he and colleagues have conducted. The study assessed how the strength of association between a baseline-identified condition and subsequent mortality varied by when the condition was measured. It also investigated methods to control for confounding. They found that for all conditions investigated, the association between a comorbid condition and subsequent mortality was stronger the closer the observation was to death. For chronic conditions specifically, claims often occur as a result of disease exacerbation and the need for active treatment of symptoms; an interval with no claims may represent a quiescent period with no need for treatment. These associations were stronger for inpatient claims than for outpatient claims.

4.4 Discussion

Throughout the discussion on the first day of the TEP meeting, the group focused on the following primary points in response to the material and analyses UM-KECC had presented that day.

Identifying Possible Comorbidity Adjustors

UM-KECC presented a number of analyses based on two primary means of adjusting for prevalent comorbidities: the CMS Hierarchical Condition Categories (HCC) and the Charlson Comorbidity Index (CCI). During the discussions of those analyses, some TEP members noted that some of the comorbidities did not exhibit face validity. For example, some conditions had negative coefficients, suggesting they have protective effects (negative effect on mortality or hospitalization). UM-KECC agreed, noting that the observed "protective" effect could be due to collinearity, i.e., their strong correlation with other conditions included in the model. One TEP member noted that face validity was evident for some of the CCI categories, such as diabetes, but there was a level of confounding when measuring these chronic conditions. It was also noted that comorbidities are being counted twice if they are present in both the 2728 and the HCCs/CCI, which can affect the interpretation of the analyses.

There was a general interest in additional sensitivity analyses related to the HCCs and the CCI. In addition, the TEP members requested descriptive statistics for the facility flagging rates analyses; those facilities that changed categories may share unifying characteristics contributing to the change. There was also a request to review and clinically condense the HCC categories prior to analyses in order to limit the number of categories to those most strongly related to the outcomes of hospitalization and mortality. Specific adjustors were discussed in more detail on Day 2 of the TEP meeting.

Patients with Less than six Months of Medicare Claims History

As UM-KECC presented the analyses performed using HCCs and the CCI, TEP members expressed concern regarding patients who had less than six months of Medicare claims history. Medicare claims are the only source of prevalent comorbidity data that UM-KECC has access to, as these data are not available from CROWNWeb. The restriction of obtaining prevalent comorbidity data only from Medicare claims was regarded as a limitation of the generalizability of the models presented.

A TEP member asked about the patient population included in the SHR and SMR analyses; UM-KECC explained the SHR model included Medicare eligible patients for the current year, including some who may not have been eligible during the prior year. Eligibility was based on the date of the hospitalization—only patients that were Medicare eligible at the time of the hospitalization were included in the measure. The SMR analyses included all Medicare and non-Medicare patients.

Another participant asked whether UM-KECC is able to gather data on non-Medicare patients. UM-KECC explained that they do not have access to claims or other comorbidity data for non-Medicare patients. Patients who are not on Medicare during the comorbidity look-back period are still included in the model as a hospitalization/death, but there was insufficient information about their prevalent comorbidities to include in the model. These patients are included in the model but are identified by a variable indication less than six months of Medicare claims. UM-KECC noted that this is a fundamental issue in using Medicare claims to determine comorbidities for the SHR and SMR models. One TEP member pointed out

that for patients who do not have at least six months of Medicare claims, the measure still adjusts for comorbidities at ESRD incidence as listed on the 2728 form. This condition applies to all analyses presented during this meeting.

Another TEP member asked whether the criteria for a Medicare claim in the past six months also required that Medicare be the primary payer on those claims. UM-KECC responded that Medicare need not be the primary payer for claims availability. If this condition were required, patient claims may not be accurately represented in the data until they had been on dialysis for over two years and had qualified as Medicare primary. UM-KECC noted, however, that nearly half of patients are Medicare eligible prior to the start of dialysis.

Data Sources

Because Medicare claims are the only data source UM-KECC can currently use to ascertain prevalent comorbidities, the TEP discussed possible recommendations for the inclusion of another data source in the future. CMS is developing a mechanism to collect testing data that could be used for that purpose, but awaiting the results of this effort would mean prevalent comorbidities could not be immediately incorporated into the SHR/SMR models. Other alternative data sources and the limitations of claims were further discussed.

Alternatives

A TEP member noted that Electronic Health Record (EHR) data may also represent a future option. The participant suggested that using EHR data for public reporting may encourage providers to collect better data. The group discussed concerns that given the current fragmented structure of health care delivery and policy, there is little incentive for hospitals to partner with dialysis facilities to provide comorbidity data. Another TEP member noted that their experience has been that from the patient perspective, the communication between providers (cardiologists, nephrologists, etc.) has been generally good because the use of EHRs. A panel member cautioned that communication practices between providers may vary by region. It was noted that patients may not communicate their comorbidities clearly when they are at the hospital, leading to incomplete information for both the hospital and the dialysis facility.

The group discussed another possible option for prospective data collection: obtaining comorbidity information directly from the patients through self-reports. Recent studies have incorporated such information, although it was noted the response rate and completeness of data varies greatly as a result of individual patient characteristics such as health status. As an example, one TEP member noted that it is already difficult to get patients to complete the 40 question ICH-CAHPS survey, so there is little confidence that collecting additional comorbidity and health status data from patients would be a feasible long-term solution. Another TEP member noted that from the patient feedback indicates that facilities do not provide sufficient education as to why the collected information is needed. The contributor noted that if the facility was clear about the purpose of the questions patients are being asked to answer, the response rate may be higher. Also, strategies such as small rewards could be used to motivate patients to participate in data collection. Another member believed that even if appropriate education was provided, self-reporting would not result in reliable data. It was acknowledged that the group generally agreed that

patient self-reported data is probably not a viable alternative, but that providers may be incentivized for better reporting as they begin to realize the importance and uses of these data.

The group also discussed the possibility of obtaining claims data from private insurance sources. One TEP member believed that even though there are weaknesses in this type of data, including such information would provide a more complete picture of the patient's health status. This alternative would benefit the SMR calculation, which currently includes both Medicare and non-Medicare patients.

Medicare Claims

As a continuation of the discussion regarding patients with less than six months of claims history, the group further reviewed the pros and cons of using Medicare claims as the source of prevalent comorbidity data. One TEP member noted that using Medicare claims as a basis for the models results in over-counting of diagnoses for some patients while under counting for those who have no claims history. Another TEP member identified some larger issues with Medicare claims, such as the effects of regional practices, ESRD vintage, age, and differential incentives that may influence reporting practice in order to ensure Medicare reimbursement. It was also noted that claims reporting is likely the least biased data source, despite its limitations.

Discussion next focused on the SMR calculation, which currently includes data for both Medicare and non-Medicare patients. The group discussed the possibility of stratifying or weighting the SMR based on whether a patient's comorbidity data is obtained from only the 2728 versus those who have also have information available from claims; an alternate approach would be to design two separate SMRs for those patients. One TEP member noted that the utility of such measures would depend on the source of information, as the result would create two different populations of patients. Another TEP member was concerned about recommending that the model differentiate between patients based on claims history via stratification or weighting, as the distinction may be difficult to interpret and possibly confusing to providers and patients.

Acknowledging these limitations, the TEP reached a general consensus that the primary data source for prevalent comorbidities should continue to be Medicare claims, as it is the only available data source at this time. This recommendation limits SMR calculation to Medicare eligible (as defined in 4.2 Approaches to Classifying Comorbidities) patients only, creating a substantive change from the current SMR specifications. There was continued interest among the TEP members in augmenting these data in the future, perhaps through an annual update with the comorbidity status that is reported on the patient's annual care plan. There was also interest in a weighted model that includes all patients, to address the issue regarding incomplete claims history.

The TEP requested additional claims data analyses to answer some outstanding questions, including:

- Regional variation by intensity of care
- Claim frequency over time on dialysis
- Claim frequency pre- and post-dialysis
- Descriptive statistics to help in evaluating differences in facilities that are flagged by the different models

- Interaction of comorbidities with ESRD vintage
- Consideration of defining illness burden using claims for durable medical equipment (e.g. home oxygen)

UM-KECC reported that following the in-person TEP meeting, they will evaluate all the suggested analyses to determine which may best inform subsequent discussion and TEP decision making.

Look-back Period for Identification of Prevalent Comorbidities

The group also discussed the look-back period for identification of prevalent comorbidities. In the HCC analyses presented by UM-KECC, the look-back period was the calendar year prior to January 1st, 2011. Comorbidities at ESRD incidence are only assessed at one point in time, upon completion of the 2728. During review of these analyses, one TEP member noted that limiting the look-back period to 12 months does not allow for an indication of severity; it is possible that a patient has had heart failure for five years, but the model only considers their claims from the past year.

The TEP discussed a number of options for defining the look-back period, including six months, one year, and a full look-back. This issue was discussed further on Day 2.

4.5 Day 2: Recap of Day 1 Decisions

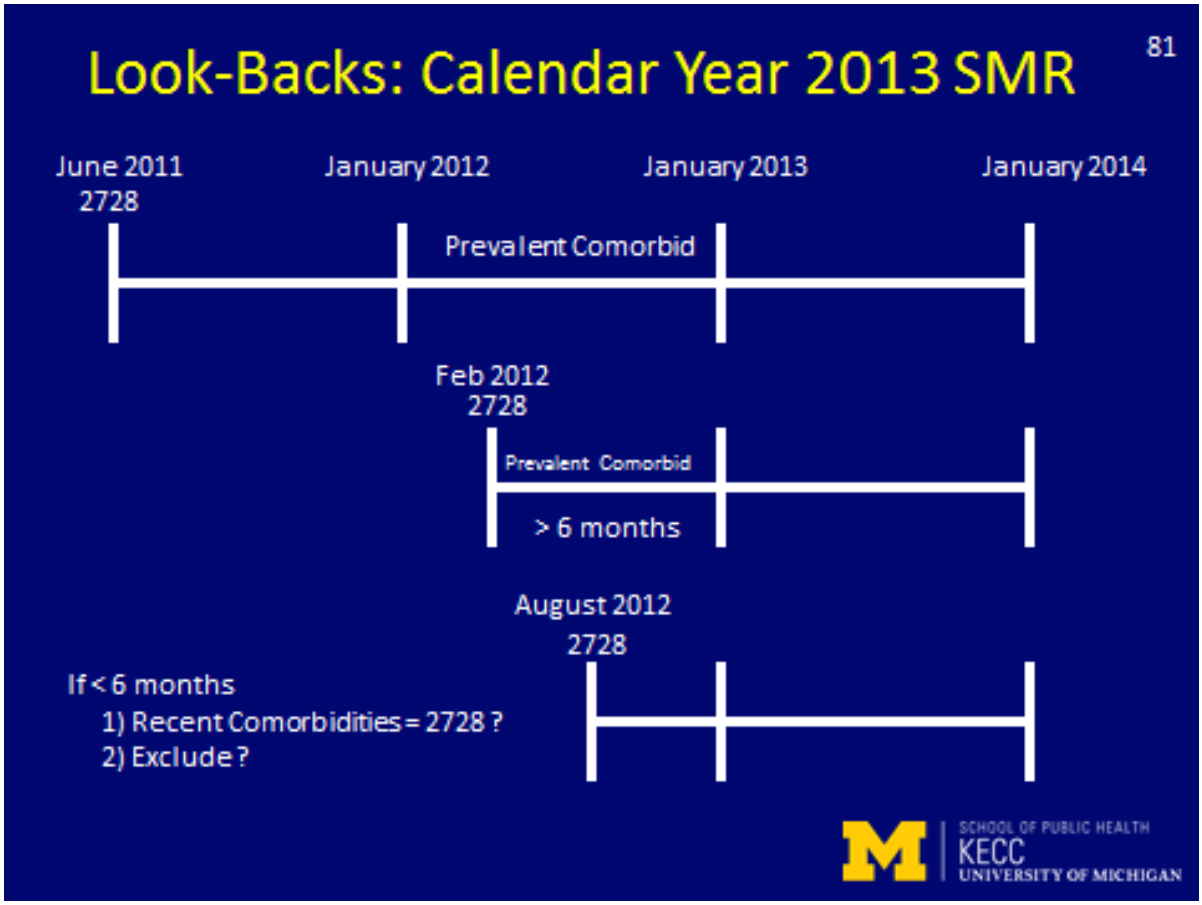
Limiting Measures to Medicare-only Patients

The second day of the TEP meeting began with a review of discussions from the previous day. It was noted that the TEP members believed that prevalent comorbidities are important in order to reflect the complexity of the case mix for patients in a facility. The decision to limit the SHR and SMR calculations to the population of Medicare patients only was reiterated; this ensures that prevalent comorbidities are claims-based, and that data for all patients are included in the measures. The TEP members acknowledged that limiting the measures to the Medicare-only population would exclude a number of patients. It was stated that in the future, prospective data collection on all patients would be beneficial to these measures. The discussion ended with the specific statement that claims are the best data source currently available, and that pursuing revisions to both the SHR and the SMR as limited to Medicare patients was the panel's preliminary recommendation.

Review of Look-back Periods

The TEP continued discussions regarding the various options for look-back periods. It was noted that carefully defining the look-back period was important to ensure that measures would include patients who have the requisite claims data. There was discussion of whether the six-month requirement should be for any six months during the calendar year, or for the last six consecutive months of available data. A TEP member noted that for most purposes, the last six months is probably the most relevant. Another TEP member noted it will be necessary to define prevalence in this context, in order to standardize the look-back period.

To help evaluate the differences of these potential look-back periods, the following slide was created to guide discussion. It details three look-back options for including prevalent comorbidities from claims data.



The top line illustrates a look-back period for a patient who had a 2728 completed in June 2011 and full claims available for 2012 and 2013. For this patient the risk adjustment for the 2013 SMR would be calculated with the incident comorbidity data from the 2728 form, with the addition of the prevalent comorbidity data from calendar year 2012. The middle line shows a look-back period for a patient who had a 2728 completed in February 2012, with full claims data for the over six-month remainder of 2012 and all of 2013. For this patient the risk adjustment for the SMR for 2013 would be calculated with the incident comorbidity data from the 2728 form, with the addition of the prevalent comorbidity data from calendar year 2012. The bottom line shows a look-back period for a patient who had a 2728 completed in August 2012, with less than six months of full claims available for the remainder of 2012 and for all of 2013. For this patient the risk adjustment for the SMR for 2013 would be calculated with the incident comorbidity data from the 2728 only and a flag indicating the patient had missing prevalent comorbidity data.

While reviewing the slide, TEP members discussed the implications for patients with transient loss of Medicare coverage, as it is uncertain if they would be included as eligible Medicare patients for the measure. Another issue was that requiring six months of claims may systematically exclude younger patients. Also, potential survival bias may be introduced by a patient who lives longer thus has a longer time frame of documented comorbidities on claims.

A question was raised about using a three-month rather than a six-month cutoff for claims history. UM-KECC noted that they had only looked at a six-month cut off in current analyses, but could examine the changes in distribution of comorbidities between three and six month claims histories; the TEP was interested in this information. For this comparison using different time period cutoffs for measuring the comorbidity in a patient's claims history would need to be investigated, and the appropriateness of adjusting for such comorbidities reported on claims in the immediate acute phase of the condition should be taking into account, as the acute condition may not be relevant to how the facility has managed chronic conditions for those patients. The idea of seasonal variations in admission was also discussed. Following the TEP meeting, UM-KECC will provide analyses on the effects of different cutoffs for a minimum number of months with claims, and the lengths of time that the annual update could consider (three months, six months, or one year), the addition of the flexibility of updating data every six months rather than annually, and a review of seasonal variation.

A goal was identified about how to reflect within the measure of comorbidities, that these may change over time. One way to address this would be to consider updating the comorbidities on an annual basis. The TEP determined that the 2728 was a good starting point for observing comorbidities, and did not recommend collection of comorbidity data prior to ESRD onset. However, ESRD vintage was mentioned as an important consideration that may help capture the impact of time and subsequent observation of comorbidities.

A question was raised about how to address comorbidities for people who have been on dialysis for a very long time, and therefore have accrued a longer list of previously diagnosed prevalent comorbidities. A suggestion was to consider weighting the comorbidities based on their time proximity to the actual event of mortality. For example if a patient developed a comorbidity within one year of the event then it would be assigned a higher weight in the model. This would allow for adjustment for both incident and prevalent comorbidities, but would give greater weight to recent diagnoses which may be more indicative of condition severity. Some TEP members cautioned about including comorbid conditions that may develop near death.

Number and Type of Claims

The TEP discussed different claims types and frequencies that may serve as surrogates for comorbidity severity. It is possible to weight claims types differently in the measure. The group generally agreed that one inpatient claim or two outpatient claims for the same comorbidity could be used as a criterion for defining comorbidity prevalence. A TEP member discussed the need to examine different institutional claim types. The importance of having the same set of rules for SHR and SMR was noted, as well as that different claim types could be allowed to enter separately into the model as potential adjustors.

4.6 Discussion of Comorbidities for Risk Adjustment

The TEP began to discuss specific HCC categories for inclusion in the risk adjustment. The discussion began by reviewing the heat-mapped results of the rating exercise discussed on Day 1 (see Section 4.3). Using the HCC as the basis for comorbidity definitions, the TEP reviewed these and began to discuss which HCCs should be considered as adjustments. However, while discussing the HCC with the highest agreement

from the pre-TEP exercise (congestive heart failure), two issues were raised in determining which HCC categories should be included as adjustments. The first issue involved the definition of the HCC. A number of the TEP members were concerned that there was variation in the amount of control a facility held over which ICD-9 codes comprised the HCCs. The TEP requested that UM-KECC provide the frequency of each specific ICD-9 code, to determine which codes made the highest contribution in the attribution of an HCC to the patient. UM-KECC will follow-up with these analyses after the TEP meeting.

The second issue regarded the appropriateness of adjusting for the comorbidities, and determination of whether they result from facility care. Although the specific HCC categories and how the comorbidities are defined will continue to be reviewed following the TEP, the panel chose to examine the comorbidities that received the greatest consensus in the pre-TEP exercise. The first of these was heart failure and fluid overload; the TEP discussed patient accountability, what actionable and structural processes could allow a facility to address this issue, and provider accountability. It was noted as important to remember that it is the facility's responsibility to ensure that patients fully understand the rationale of the dietary instruction they receive, and the consequences of non-adherence. One TEP member expressed a preference to not include a comorbidity as an adjustment if there was a strong potential that it is associated with facility care. Another TEP member noted the implications of including a comorbidity in the adjustment—in the case of Heart Failure, it may suggest that the dialysis center is not responsible for fluid overload. Another TEP member noted that in their experience, while CHF could be a result of the facility's failure to recognize and adjust dry weight, most of the time it was due to patient's repeated non adherence with fluid restriction, and their refusal to extend treatment time or to come for an extra UF(s) to remove the excess fluid despite staff's urging and facilitating of the additional treatments.

TEP members were asked to vote on whether a condition should or should not be adjusted for, because it was or was not a result of facility care, for 6 conditions. The first three were HCC categories which the TEP had identified in the pre-TEP exercise as the most likely to be under a facility's control (though there was far from a consensus on this in the pre-TEP exercise). These included heart failure, septicemia, and specified heart arrhythmias. The remaining votes concerned the HCC categories which the TEP had identified as least likely to be under a facility's control. These included lymphoma and other cancer, cirrhosis of the liver, and morbid obesity. The votes for the specific categories are listed below.

1. **Heart failure is a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 3
    b. Disagree, should be adjusted for – 6

2. **Septicemia is a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 7
    b. Disagree, should be adjusted for – 2

3. **Specified heart arrhythmias are a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 1
    b. Disagree, should be adjusted for – 8

4. **Lymphoma and other cancers is a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 0
    b. Disagree, should be adjusted for – 9

5. **Cirrhosis of the liver is a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 0
    b. Disagree, should be adjusted for – 9

6. **Morbid obesity is a result of facility care and should not be adjusted for.**
    a. Agree, should not be adjusted for – 0
    b. Disagree, should be adjusted for – 9

As can be seen, there was clear consensus on the 3 conditions that the TEP did not think related to facility care and should be adjusted for, but there was no consensus on conditions that in the pre-TEP exercise some had identified as being related to facility care. There was discussion of whether 100% consensus was needed by TEP members or 2/3 consensus would be satisfactory in deciding whether a condition should be adjusted for or not, but no final decision was made on this.

Following the preliminary review of these comorbidities, it was determined the TEP would re-examine the definitions for the HCC categories in terms of specific diagnoses included. The TEP also considered whether to be more conservative in determining whether or not a facility is responsible for the condition, or to focus on what actionable information from the quality measures would most benefit patients. Since there is currently no adjustment for prevalent comorbidities, one TEP member questioned if it was appropriate to adjust for prevalent comorbidities at all, as doing so may make a measure appear more accurate than it actually is.

Following this discussion the TEP noted that their ultimate responsibility will be to create a balanced measure that does not over-adjust but also does not unfairly penalize facilities.

CMS additionally discussed possible uses for the revised measure, including the Dialysis Facility Reports, the Dialysis Facility Compare, and eventually the DFC Star Ratings and the QIP, where these measures have not been previously submitted. It was also noted that the measures would also be submitted to NQF.

A list of analyses that will be presented in follow-up TEP meetings is detailed below in Section 4.9.

4.7 Feasibility and Usability

The TEP made only preliminary recommendations and will base their final decisions on subsequent analyses to be completed following the in-person TEP meeting.

4.8 Measure-area Gaps for the ESRD Population

The TEP agreed that prospective data collection for prevalent comorbidities is a priority for the future, and that obtaining prevalent comorbidity information for non-Medicare patients would be valuable in future measure development.

4.9 In-person TEP Meeting, Conclusion and Follow-up Plan

There were a number of issues discussed at the TEP meeting that UM-KECC considered to require further examination. These included:

1. Consideration of comorbidities for risk adjustment:
    a. Apply variable selection method to individual ICD-9 codes associated with the 87 ESRD HCCs.
    b. Provide results to TEP chair and TEP for review.

2. Defining the look-back period for identifying prevalent comorbidities:
    a. Analyses comparing frequency of HCCs using different look-back periods, e.g., prior 12 months, one calendar year, two years, or multiple years.

3. Defining comorbidity prevalence:
    a. Analytical comparison of measures where comorbidity is recognized by the presence of any inpatient or outpatient claim in the prior year, with measures where comorbidity recognition requires at least one inpatient claim, or two outpatient claims separated by 30 days.

4. Defining “No Medicare Coverage”:
    a. Currently defined as patients with <6 months of Medicare coverage in the prior year. This group was composed of **233,730 of 528,327 potential patients, or 44.24%**.
    b. Analysis: the frequency of patients with HCC comorbidities based on one month, three months, six months, nine months, or 12 months of claims.
    c. SMR: the group needs to determine whether SMR will be limited to Medicare only patients, or continue to include all patients, and if so, how to account for their inclusion in the model. The current SMR is not limited to Medicare patients only
    d. One option discussed was to assign a value of zero to all the comorbidity covariates, for patients with no claims; the 2728 will be only source of comorbidity information for these patients.

It was expected that further discussions will be held over the next few months to review these analyses and inform final recommendations.

5. Post-TEP Public Comment Period

A public comment period was held by phone at the conclusion of the In-Person TEP Meeting on September 10, 2015. No comments were received.

6. Follow-up TEP Teleconference Call

Following the in-person TEP meeting, it was determined that a follow-up call was necessary to review the requested analyses. This will be scheduled to take place in December 2015.

7. Summary

The objective of the TEP was to consider current evidence to evaluate the potential of including prevalent comorbidities in the SHR and SMR risk adjustment models. Specific objectives included:

- Review of the comorbidity adjustment in the current NQF-endorsed SHR and SMR measures
- Consideration of what, if any, prevalent comorbidities would be appropriate to include in each measure.

During the in-person TEP meeting the group discussed the topics of look-back periods, data sources, measure exclusions, and possible comorbidities eligible for risk adjustment. A number of additional analyses were requested, and will be investigated prior to the follow-up TEP teleconference meeting.

8. Appendices

The following documents are appended to this report:

Appendix A: Annotated Bibliography

Appendix B: Environmental Scan

Appendix C: TEP in-person meeting slides

Appendix D: Post-TEP Conference Call Notes

Appendix E: Post-TEP Conference Call Meeting Slides

Appendix F: Identification of Prevalent Comorbidities Used as Risk Adjusters

Appendix G: Set of Prevalent Comorbidities Recommended for Inclusion as Risk-Adjusters

End Stage Renal Disease (ESRD) Quality Measure Development, Maintenance, and Support

End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR) Technical Expert Panel Annotated Bibliography

Literature Review Summary

For the literature review for this Technical Expert Panel (TEP), UM-KECC conducted a PubMed search using the following set of terms. Searches were conducted separately for each set. The time period for our search was 1999 – 2015.

1. "Hierarchical Condition Categories". This criterion was selected because the HCCs present a manageable system of classifying comorbidities. The system is manageable in the sense that there are a sufficiently small number of HCCs for use in a risk-adjustment model estimation. The search identified 23 articles, nearly all of which are included in the bibliography. The HCC grouper has been used in other measure development work, i.e., the dialysis facility SRR; the hospital wide readmission measure.
2. "prevalent comorbidity" * "risk adjustment". This criterion was selected to identify articles that used prevalent comorbidities in various applications of risk-adjustment, such as in the development of measures or in the comparison of cost or outcome across providers or provider types. We did not limit this to studies on the dialysis population. Relevance was defined by (1) demonstrated use of prevalent comorbidities using claims data or (2) application to kidney disease.
3. "2728 Form" or "Medical evidence form" after August 2014. This criterion was selected because there is considerable debate in the dialysis community about the validity of comorbidities reported on the 2728. This search supplemented a search conducted in August 2014. This search resulted in 10 articles included in the bibliography.
4. "Charlson Comorbidity Index"* "claim". This criterion was selected because the Charlson Comorbidity Index is another approach to risk-adjustment that may be appropriate for estimating the SMR and SHR for dialysis patients. The search was restricted to those papers where the Index was constructed using claims data, as opposed to medical record data. It yielded 11 articles. Several of these studies applied the CCI to the ESRD population.

5. “CHOICE” * “ESRD”. This criterion was selected because the Choices for Healthy Outcomes in Caring for ESRD (CHOICE) project is a well-known and widely study. The CHOICE project has used risk-adjustment in its analysis of effective care processes. This search yielded 4 papers.

TEP members will be asked to provide additional citations of relevance when they review this bibliography.

Annotated Bibliography

Szentkiralyi A, Völzke H, Hoffmann W, Baune B, Berger K. **The relationship between depressive symptoms and restless legs syndrome in two prospective cohort studies.** *Psychosom Med. 2013 May;75(4):359-65. doi: 10.1097/PSY.0b013e31828bbbf1. Epub 2013 Apr 10.*

Notes: Comorbidity measurement

Abstract: Cross-sectional studies suggest a strong association between depression and restless legs syndrome (RLS); however, the temporal relationship between the two disorders remains unknown. We tested whether the presence of clinically relevant depressive symptoms (CRDS) is a risk factor for subsequent RLS in the general population. The relationship between prevalent RLS and incident CRDS was also examined. Two independent, prospective cohort studies with representative, age-stratified random samples, the Dortmund Health Study (DHS; n = 1312/1122 [baseline/follow-up], median follow-up time = 2.1 years) and the Study of Health in Pomerania (SHIP; n = 4308/3300, median follow-up time = 5.0 years) were analyzed. RLS was assessed in both studies according to the RLS minimal criteria, at baseline and at follow-up. CRDS were assessed by the Center for Epidemiologic Studies-Depression scale (a score of ≥16) in DHS only at baseline and by the Munich-Composite International Diagnostic-Screener in SHIP at baseline and at follow-up. Clinically relevant depressive symptoms at baseline were associated new-onset RLS in both studies (DHS: odds ratio [OR] = 1.94, 95% confidence interval [CI] = 1.09-3.44; SHIP: OR = 2.37, 95% CI = 1.65-3.40) after adjustment for age, sex, education, body mass index, smoking, physical activity, and the presence of various comorbidities. RLS at baseline was an independent risk factor of incident CRDS in SHIP (OR = 1.82, 95% CI = 1.10-3.00). The presence of CRDS may be a risk factor for subsequent RLS. The relationship between the two disorders might be bidirectional because RLS also predicts incident depressive symptoms.

Weiner D, Tighiouart H, Stark P, Amin M, MacLeod B, Griffith J, Salem, Deeb N, Levey A, Sarnak M**. Kidney disease as a risk factor for recurrent cardiovascular disease and mortality.** Am J Kidney Dis. 2004 Aug;44(2):198-206.

Notes: Comorbidity adjustment

Abstract: Chronic kidney disease (CKD) is highly prevalent in the United States and is an independent risk factor for adverse cardiovascular disease (CVD) and all-cause mortality outcomes in patients with acute coronary syndromes. Few studies have evaluated the effect of CKD on cardiovascular events in a diverse community-based population with underlying CVD. Data for subjects with preexisting CVD were pooled from 4 publicly available, community-based, longitudinal studies: Atherosclerosis Risk in Communities, Cardiovascular Health Study, Framingham Heart Study, and Framingham Offspring Study. CKD was defined as an estimated glomerular filtration rate less than 60 mL/min/1.73 m2 (<1 mL/s/1.73 m2). The primary study outcome was a composite of myocardial infarction (MI), fatal coronary heart disease (CHD), stroke, and all-cause mortality. The secondary outcome included only MI and fatal CHD. A total of 4,278 subjects satisfied inclusion criteria, and 759 subjects (17.7%) had CKD. Mean follow-up was 86 months. The primary and secondary outcomes were observed in 1,703 (39.8%) and 857

subjects (20.0%), respectively. Incidence rates for the primary and secondary outcomes were greater in persons with CKD compared with those without CKD (62.5% versus 34.9% and 30.6% versus 17.8%, respectively). Adjusted hazard ratios for the primary and secondary outcomes were 1.35 (95% confidence interval [CI], 1.21 to 1.52) and 1.32 (95% CI, 1.12 to 1.55), respectively. The presence of CKD in a community-based population with preexisting CVD is associated with an increased risk for recurrent CVD outcomes. This increased risk persists after adjustment for traditional CVD risk factors.

Bradley CJ(1), Dahman B, Bataki PM, Koroukian S. **Incremental value of using Medicaid claim files to study comorbid conditions and treatments in dually eligible beneficiaries.** Med Care. 2010 Jan;48(1):79-84.

Notes: Use of Medicare claims to calculate Charlson Comorbidity Index

Abstract: *BACKGROUND*: Although investigations using Medicare claims files are ubiquitous in the health services research literature, Medicaid claims files are used less frequently. Nonetheless, Medicaid is the major payer for healthcare among low-income persons. *OBJECTIVE*: To assess the added value of Medicaid claim files for identifying comorbid conditions and cancer treatments in a dually eligible sample. *RESEARCH DESIGN*: Data were obtained from linked statewide tumor registries from 2 contiguous Midwestern states (Michigan and Ohio), Medicare and Medicaid enrollment files, and Medicare and Medicaid claims files. We estimated the prevalence of Charlson Comorbidity Index conditions by counting the number of patients with these conditions in the Medicare claims files alone. We then estimate the expected percent increase in the prevalence of comorbid conditions (along with the 95% confidence interval) that could be obtained by using both Medicare and Medicaid claim files. We followed a similar procedure to identify treatments provided to dually eligible patients.
RESULTS: Medicaid claims added very few individuals with comorbid conditions over those identified through Medicare claim files. The increase in the prevalence of comorbid conditions was between 0% and 2.5%. Likewise, Medicaid claims identified few individuals with cancer treatments who were not already identified through Medicare claim files, although variations were noted between the 2 states. *CONCLUSIONS*: This study suggests that the incremental value of Medicaid inpatient, outpatient, and carrier claims is relatively small over what can be obtained from Medicare claims data.

Poleshuck, Ellen L & Talbot, Nancy L & Moynihan, Jan A & Chapman, Benjamin P & Heffner, Kathi L. **Depressive symptoms, pain, chronic medical morbidity, and interleukin-6 among primary care patients.** Pain Med. 2013 May;14(5):686-91. doi: 10.1111/pme.12089. Epub 2013 Apr 22.

Notes: Measuring chronic comorbidities

Abstract: Pain, chronic medical morbidity, and depression are highly prevalent problems that frequently co-occur in primary care. Elevated levels of inflammatory markers are linked with all three of these conditions and may play an important role in patients' comorbidities. The current study aimed to examine if the associations among pain, chronic medical morbidity, and the inflammatory marker interleukin (IL)-6 are dependent on depression status in primary care

patients. SETTING, SUBJECTS, AND OUTCOME MEASURES: Primary care patients (N = 106) aged 40 and older were assessed for pain (36-item Medical Outcomes Study Survey Form), chronic medical morbidity (checklist of chronic health conditions), and depressive symptoms (Center for Epidemiologic Studies Depression Scale), and provided a blood sample for the measurement of serum IL-6. Among patients with elevated depressive symptoms, higher IL-6 levels were associated with both greater pain and greater chronic medical comorbidity. IL-6 was unrelated to pain or chronic medical comorbidity among patients without clinically significant depressive symptoms. In mediation analyses, chronic medical morbidity did not mediate the association between IL-6 and pain, and depression severity and pain remained independently associated after adjustment for chronic medical comorbidity. Depression may increase primary care patients' vulnerability to pain and elevated levels of inflammatory markers such as IL-6.

Krishnan M(1), Weinhandl ED(2), Jackson S(3), Gilbertson DT(3), Lacson E Jr(4). **Comorbidity Ascertainment From the ESRD Medical Evidence Report and Medicare Claims Around Dialysis Initiation: A Comparison Using US Renal Data System Data.** Am J Kidney Dis. 2015 May 23. pii: S0272-6386(15)00707-6. doi: 10.1053/j.ajkd.2015.04.015. [Epub ahead of print].

Notes: Comparison of 2728 and Claims

Abstract: BACKGROUND: The end-stage renal disease Medical Evidence Report serves as a source of comorbid condition data for risk adjustment of quality metrics. We sought to compare comorbid condition data in the Medical Evidence Report around dialysis therapy initiation with diagnosis codes in Medicare claims. STUDY DESIGN: Observational cohort study using US Renal Data System data. SETTING & PARTICIPANTS: Medicare-enrolled elderly (≥66 years) patients who initiated maintenance dialysis therapy July 1 to December 31, 2007, 2008,or 2009.INDEX TESTS: 12 comorbid conditions ascertained from claims during the 6 months before dialysis therapy initiation, the Medical Evidence Report, and claims during the 3 months after dialysis therapy initiation. REFERENCE TEST: None. RESULTS: Comorbid condition prevalence according to claims before dialysis therapy initiation generally exceeded prevalence according to the Medical Evidence Report. The κ statistics for comorbid condition designations other than diabetes ranged from 0.06 to 0.43. Discordance of designations was associated with age, race, sex, and end-stage renal disease Network. During 23,930patient-years of follow-up from 4 to 12 months after dialysis therapy initiation (8,930 deaths), designations from claims during the 3 months after initiation better discriminated risk of death than designations from the Medical Evidence Report (C statistics of 0.674 vs 0.616). Between the Medical Evidence Report and claims, standardized mortality ratios changed by >10% for more than half the dialysis facilities. LIMITATIONS: Neither the Medical Evidence Report nor diagnosis codes in claims constitute a gold standard of comorbid condition data; results may not apply to non-elderly patients or patients without Medicare coverage. CONCLUSIONS: Discordance of comorbid condition designations from the Medical Evidence Report and claims around dialysis therapy initiation was substantial and significantly associated with patient characteristics, including location. These patterns may engender bias in risk-adjusted quality metrics. In lieu of the Medical Evidence Report, claims during the 3 months after dialysis therapy initiation may constitute a useful source of comorbid condition data.

Habbous, Steven & Chu, Karen P & Harland, Luke T G & La Delfa, Anthony & Fadhel, Ehab & Sun, Bin & Xu, Wei & Wong, Amy & Howell, Doris & Ringash, Jolie & Waldron, John & O'Sullivan, Brian & Goldstein, David & Huang, Shao-Hui & Liu, Geoffrey. **Validation of a one-page patient-reported Charlson comorbidity index questionnaire for upper aerodigestive tract cancer patients.** Oral Oncol. 2013 May;49(5):407-12. doi: 10.1016/j.oraloncology.2012.11.010. Epub 2013 Jan 4.

Notes: Use of Charlson Comorbid Index and prevalent comorbidities

Abstract: Cancer patients have a wide range of comorbidities that are important confounders for biomarker and clinical studies of prognosis and outcome. Comorbidities can be captured using the Charlson Comorbidity Index (CCI) through abstraction of medical records, but patient-reported outcome (PRO) questionnaires have also been used. The objective was to validate the PRO-CCI in a head and neck cancer (HNC) population, and to assess its level of agreement with the standard (std-CCI) method of chart review. A one-page PRO-CCI was compared with the std-CCI obtained through independent abstraction in 882 HNC patients (2007-2010). Kappa statistics and associated measures (p(pos) and p(neg)) were used to assess agreement. Discrepancy for each comorbid illness was evaluated. Proportional hazard models compared the association of std-CCI and PRO-CCI with overall survival (OS). Adjustments were made and a modified PRO-CCI was re-evaluated in a new cohort of upper aerodigestive tract cancers patient. PRO-CCI was higher than the std-CCI ($p < 0.0001$). After adjustment, having at least two comorbidities according to either the std-CCI [HR 1.97 (1.38-2.80)] or the PRO-CCI [HR 1.62 (1.18-2.24)] was prognostic. Of the most prevalent comorbidities, agreement was high for most of the CCI elements (kappa 0.76-0.93), but poorest agreement for connective tissue disease (kappa = 0.29, p(pos) = 43%, p(neg) = 84%) and COPD (kappa = 0.48, p(pos) = 53%, p(neg) = 95%). When the connective tissue disease question was modified, agreement of this item improved (kappa = 0.47, p(pos) = 50%). PRO-CCI can be an easy and effective tool in prognostic and outcomes research in HNC patients.

Ashton, Carol M & Septimus, Joshua & Petersen, Nancy J & Souchek, Julianne & Menke, Terri J & Collins, Tracie C & Wray, Nelda P. **Healthcare use by veterans treated for diabetes mellitus in the Veterans Affairs medical care system.** Am J Manag Care. 2003 Feb;9(2):145-50.

Notes: Use of Veterans Affairs prevalent comorbidity data

Abstract: To estimate the burden of comorbid conditions and to describe patterns of inpatient and outpatient service use by veterans with diabetes mellitus. Retrospective cohort study of 33,481 veterans conducted by means of secondary analysis of Department of Veterans Affairs (VA) healthcare utilization databases. The cohort was constructed by enrolling all veterans treated in the VA medical care system who had their initial VA hospitalization for diabetes mellitus between 1992 and 1997. To estimate the typical annual pattern of service use for diabetes mellitus, 1997 utilization rates per person-year were analyzed based on cohort members surviving into 1997. Data on comorbid conditions were obtained from outpatient and inpatient contacts. The 3 most prevalent coexisting conditions were hypertension (73.4%), ischemic heart disease (35.2%), and alcohol or drug abuse disorders (29.5%). In 1997, the typical cohort member followed for 12 months had 6 primary care visits, 16 other visits for tests or consultations, and 1.3 unscheduled visits for emergency or urgent care and spent approximately 8 days in the hospital. One-year survival was 94.0%. In the VA medical care system, beneficiaries with diabetes mellitus have an extremely heavy burden of comorbidities, face a significant risk

of dying in a given year (approximately 6% in this population), and are heavy users of hospital and outpatient services.

Singh, Mandeep & Rihal, Charanjit S & Lennon, Ryan J & Spertus, John A & Nair, K Sreekumaran & Roger, Veronique L. **Influence of frailty and health status on outcomes in patients with coronary disease undergoing percutaneous revascularization.** Circ Cardiovasc Qual Outcomes. 2011 Sep;4(5):496-502. doi: 10.1161/CIRCOUTCOMES.111.961375.Epub 2011 Aug 30.

Notes: Use of comorbidities to predict mortality using Charlson Index

Abstract: BACKGROUND- Although older patients frequently undergo percutaneous coronary interventions (PCI), frailty, comorbidity, and quality of life are seldom part of risk prediction approaches. We assessed their incremental prognostic value over and above the risk factors in the Mayo Clinic risk score. METHODS AND RESULTS- Patients ≥65 years who underwent PCI were assessed for frailty (Fried criteria), comorbidity (Charlson index), and quality of life [SF-36]. Of the 628 discharged [median follow-up of 35.0 months (interquartile range, 22.7 to 42.9)], 78 died and 72 had a myocardial infarction (MI). Three-year mortality was 28% for frail patients, 6% for nonfrail patients. The respective 3-year rates of death or MI were 41% and 17%. After adjustment, frailty [hazard ratio (HR), 4.19 [95% confidence interval (CI), 1.85, 9.51], physical component score of the SF-36 (HR, 1.59; 95% CI, 1.24 to 2.02), and comorbidity, (HR, 1.10; 95% CI, 1.05, 1.16) were associated with mortality. Frailty was associated with mortality/MI (HR, 2.61, 1.52, 4.50). Models with conventional Mayo Clinic risk score had C-statistics of 0.628, 0.573 for mortality and mortality/MI, respectively. Adding frailty, quality of life, and comorbidity, the C-statistic was (0.675, 0.694, 0.671) for mortality and (0.607, 0.587, 0.576) for mortality/MI, respectively. Including frailty, comorbidities and SF-36, conferred a discernible improvement to predict death and death/MI (integrated discrimination improvement, 0.027 and 0.016, and net reclassification improvement of 43% and 18%, respectively). CONCLUSIONS- After PCI, frailty, comorbidity and poor quality of life are prevalent and are associated with adverse long-term outcomes. Their inclusion improves the discriminatory ability of the Mayo Clinic risk score derived from the routine cardiovascular risk factors.

Chen, Li-Ping & Hsu, Shih-Ping & Peng, Yu-Sen & Chiang, Chih-Kang & Hung, Kuan-Yu. **Periodontal disease is associated with metabolic syndrome in hemodialysis patients.** Nephrol Dial Transplant. 2011 Dec;26(12):4068-73. doi: 10.1093/ndt/gfr209. Epub 2011 May 19.

Notes: Use of claims to predict mortality

Abstract: There are limited validated methods to ascertain comorbidities for risk adjustment in ambulatory populations of patients with diabetes using administrative health-care databases. The objective was to examine the ability of the Johns Hopkins' Aggregated Diagnosis Groups to predict mortality in population-based ambulatory samples of both incident and prevalent subjects with diabetes. Retrospective cohorts constructed using population-based administrative data. The incident cohort consisted of all 346,297 subjects diagnosed with diabetes between 1 April 2004 and 31 March 2008. The prevalent cohort consisted of all 879,849 subjects with pre-existing diabetes on 1 January, 2007. The outcome was death within 1 year of the subject's index date. A logistic regression model consisting of age, sex and indicator variables for 22 of the 32 Johns Hopkins' Aggregated Diagnosis Group categories had excellent discrimination for predicting mortality in incident diabetes patients: the c-statistic was 0.87 in an independent validation sample. A similar model had excellent discrimination for predicting

mortality in prevalent diabetes patients: the c-statistic was 0.84 in an independent validation sample. Both models demonstrated very good calibration, denoting good agreement between observed and predicted mortality across the range of predicted mortality in which the large majority of subjects lay. For comparative purposes, regression models incorporating the Charlson comorbidity index, age and sex, age and sex, and age alone had poorer discrimination than the model that incorporated the Johns Hopkins' Aggregated Diagnosis Groups. Logistical regression models using age, sex and the John Hopkins' Aggregated Diagnosis Groups were able to accurately predict 1-year mortality in population-based samples of patients with diabetes.

Ishani, Areef & Collins, Allan J & Herzog, Charles A & Foley, Robert N. **Septicemia, access and cardiovascular disease in dialysis patients: the USRDS Wave 2 study.** Kidney Int. 2005 Jul;68(1):311-8.

Notes: Use of claims to predict mortality

Abstract: Micro inflammation is linked to cardiovascular disease, and is highly prevalent in dialysis patients. It is logical to postulate that septicemia, a common macro inflammatory occurrence in dialysis patients, contributes to their large burden of cardiovascular disease. The Dialysis Morbidity and Mortality Wave 2 was a randomly selected prospective cohort of incident dialysis patients. Admission claims data were used to define and calculate rates of septicemia or bacteremia and cardiovascular events in those with Medicare as the primary payer. Utilizing Cox proportional hazard models we determined the association between baseline access and the development of bacteremia or sepsis, and also the association between bacteremia or sepsis episodes and subsequent cardiovascular events. The 2358 (59%) patients with Medicare as primary payer were older and more likely to have heart failure than those with other payers, but had similar comorbidity-adjusted mortality hazards. Rates of first septicemia, bacteremia, or either condition, were 7.0, 5.9 and 10.4 events per 100-patient years, respectively. Cox regression identified initial dialysis access as the main antecedent of septicemia or bacteremia. Hazards ratios for hemodialysis with permanent catheters, temporary catheters, and grafts were 1.95 (95% CI 1.47-2.57), 1.76 (95% CI 1.29-2.41), and 1.05 (95% CI 0.82-1.35), respectively, while that for peritoneal dialysis was 0.96 (95% CI 0.75-1.23) (reference arteriovenous fistula). After adjustment for baseline factors, septicemia or bacteremia, as a time-dependent covariate, was associated with subsequent death [hazards ratio (HR) 2.33, 95% CI 1.38-2.28], myocardial infarction (HR 1.78, 95% CI 1.38-2.28), heart failure (HR 1.64, 95% CI 1.39-1.95), peripheral vascular disease (HR 1.64, 95% CI 1.34-2.0), and stroke (HR 2.04, 95% CI 1.27-3.28). Septicemia appears to be an important, potentially preventable, cardiovascular risk factor in dialysis patients.

Jones, Christine D & Loehr, Laura & Franceschini, Nora & Rosamond, Wayne D & Chang, Patricia P & Shahar, Eyal & Couper, David J & Rose, Kathryn M. **Orthostatic hypotension as a risk factor for incident heart failure: the atherosclerosis risk in communities study.** Hypertension. 2012 May;59(5):913-8. doi: 10.1161/HYPERTENSIONAHA.111.188151. Epub 2012 Mar 19.

Notes: Use of claims to measure disease

Abstract: Heart failure causes significant morbidity and mortality. Distinguishing risk factors for incident heart failure can help identify at-risk individuals. Orthostatic hypotension may be a risk factor for incident heart failure; however, this association has not been fully explored, especially in nonwhite populations. The Atherosclerosis Risk in Communities Study included 12363 adults free of prevalent heart failure with baseline orthostatic measurements. Orthostatic hypotension

was defined as a decrease of systolic blood pressure ≥20 mmHg or diastolic blood pressure ≥10 mmHg with position change from supine to standing. Incident heart failure was identified from hospitalization or death certificate disease codes. Over 17.5 years of follow-up, orthostatic hypotension was associated with incident heart failure with multivariable adjustment (hazard ratio: 1.54 [95% CI: 1.30-1.82]). This association was similar across race and sex groups. A stronger association was identified in younger individuals ≤55 years old (hazard ratio: 1.90 [95% CI: 1.41-2.55]) than in older individuals >55 years old (hazard ratio: 1.37 [95% CI: 1.12-1.69]; interaction P=0.034). The association between orthostatic hypotension and incident heart failure persisted with exclusion of those with diabetes mellitus, coronary heart disease, and those on antihypertensives or psychiatric or Parkinson disease medications. However, exclusion of those with hypertension somewhat attenuated the association (hazard ratio: 1.34 [95% CI: 1.00-1.80]). We identified orthostatic hypotension as a predictor of incident heart failure among middle-aged individuals, particularly those 45 to 55 years of age. This association may be partially mediated through hypertension. Orthostatic measures may enhance risk stratification for future heart failure development.

Sudore, Rebecca L & Karter, Andrew J & Huang, Elbert S & Moffet, Howard H & Laiteerapong, Neda & Schenker, Yael & Adams, Alyce & Whitmer, Rachel A & Liu, Jennifer Y & Miao, Yinghui & John, Priya M & Schillinger, **Dean. Symptom burden of adults with type 2 diabetes across the disease course: diabetes & aging study.**

Notes: Prevalent comorbidities

Abstract: Reducing symptom burden is paramount at the end-of-life, but typically considered secondary to risk factor control in chronic disease, such as diabetes. Little is known about the symptom burden experienced by adults with type 2 diabetes and the need for symptom palliation. To examine pain and non-pain symptoms of adults with type 2 diabetes over the disease course - at varying time points before death and by age. Survey follow-up study. 13,171 adults with type 2 diabetes, aged 30-75 years, from Kaiser Permanente, Northern California, who answered a baseline symptom survey in 2005-2006. Pain and non-pain symptoms were identified by self-report and medical record data. Survival status from baseline was categorized into ≤ 6, >6-24, or alive >24 months. Mean age was 60 years; 48 % were women, and 43 % were non-white. Acute pain was prevalent (41.8 %) and 39.7 % reported chronic pain, 24.6 % fatigue, 23.7 % neuropathy, 23.5 % depression, 24.2 % insomnia, and 15.6 % physical/emotional disability. Symptom burden was prevalent in all survival status categories, but was more prevalent among those with shorter survival, p< .001. Adults ≥ 60 years who were alive >24 months reported more physical symptoms such as acute pain and dyspnea, whereas participants <60 years reported more psychosocial symptoms, such as depressed mood and insomnia. Adjustment for duration of diabetes and comorbidity reduced the association between age and pain, but did not otherwise change our results. In a diverse cohort of adults with type 2 diabetes, pain and non-pain symptoms were common among all patients, not only among those near the end of life. However, symptoms were more prevalent among patients with shorter survival. Older adults reported more physical symptoms, whereas younger adults reported more psychosocial symptoms. Diabetes care management should include not only good cardio metabolic control, but also symptom palliation across the disease course.

Sudore, Rebecca L & Karter, Andrew J & Huang, Elbert S & Moffet, Howard H & Laiteerapong, Neda & Schenker, Yael & Adams, Alyce & Whitmer, Rachel A & Liu, Jennifer Y & Miao, Yinghui & John, Priya M & Schillinger, Dean. **Symptom burden of adults with type 2 diabetes across the disease course: diabetes**

& aging study. J Gen Intern Med. 2012 Dec;27(12):1674-81. doi: 10.1007/s11606-012-2132-3. Epub 2012 Aug 2.

Notes: Prevalent comorbidities

Abstract: Reducing symptom burden is paramount at the end-of-life, but typically considered secondary to risk factor control in chronic disease, such as diabetes. Little is known about the symptom burden experienced by adults with type 2 diabetes and the need for symptom palliation. To examine pain and non-pain symptoms of adults with type 2 diabetes over the disease course - at varying time points before death and by age. Survey follow-up study. 13,171 adults with type 2 diabetes, aged 30-75 years, from Kaiser Permanente, Northern California, who answered a baseline symptom survey in 2005-2006. Pain and non-pain symptoms were identified by self-report and medical record data. Survival status from baseline was categorized into ≤ 6, >6-24, or alive >24 months. Mean age was 60 years; 48 % were women, and 43 % were non-white. Acute pain was prevalent (41.8 %) and 39.7 % reported chronic pain, 24.6 % fatigue, 23.7 % neuropathy, 23.5 % depression, 24.2 % insomnia, and 15.6 % physical/emotional disability. Symptom burden was prevalent in all survival status categories, but was more prevalent among those with shorter survival, p< .001. Adults ≥ 60 years who were alive >24 months reported more physical symptoms such as acute pain and dyspnea, whereas participants <60 years reported more psychosocial symptoms, such as depressed mood and insomnia. Adjustment for duration of diabetes and comorbidity reduced the association between age and pain, but did not otherwise change our results. In a diverse cohort of adults with type 2 diabetes, pain and non-pain symptoms were common among all patients, not only among those near the end of life. However, symptoms were more prevalent among patients with shorter survival. Older adults reported more physical symptoms, whereas younger adults reported more psychosocial symptoms. Diabetes care management should include not only good cardiometabolic control, but also symptom palliation across the disease course.

Blaum, Caroline S & Ofstedal, Mary Beth & Liang, Jersey. **Low cognitive performance, comorbid disease, and task-specific disability: findings from a nationally representative survey.** J Gerontol A Biol Sci Med Sci. 2002 Aug;57(8):M523-31.

Notes: Prevalent chronic disease and disability

Abstract: This research evaluated the association of low cognitive performance with both chronic diseases and conditions, and with difficulties in a broad array of task-specific functioning and disability measures in older adults living in the community. Data were from the first wave of the Assets and Health Dynamics Among the Oldest-Old Study, a national panel survey of individuals age 70 and older (n = 6600 age-eligible self-respondents). Low cognitive performance (LCP) was defined as scores in the lowest (poorest performing) 25th percentile of a cognitive performance scale. The associations of LCP with prevalent chronic diseases and conditions and with limitations in 14 tasks (strength and mobility, instrumental activities of daily living, and activities of daily living) were evaluated. Associations of LCP and task limitations were adjusted for potential modifiers and confounders, including demographic characteristics (age, gender, race), educational attainment, chronic diseases, depressive symptoms, and sensory impairments. Data were weighted to account for complex sample design and nonresponse. More than one third of people with LCP had three or more coexisting diseases and conditions. The unadjusted associations of LCP with task functioning were attenuated after covariate adjustment, but even after adjustment, LCP remained significantly and independently

associated with functioning problems in 9 of 14 tasks (borderline with four more), including mobility tasks. Low cognitive performance, regardless of its relationship to clinical dementia, coexists with multiple chronic diseases and conditions. It is independently associated with a broad array of functioning difficulties, even after controlling for demographic characteristics, educational attainment, and chronic conditions. Chronic diseases and conditions, however, attenuate the relationship between LCP and some task difficulties. LCP should be considered an important comorbid condition associated with both chronic diseases and disability that substantially increases the health burden of many older adults who are poorly equipped to handle it.

Bohn, Ethan & Tangri, Navdeep & Gali, Brent & Henderson, Blair & Sood, Manish M & Komenda, Paul & Rigatto, Claudio. **Predicting risk of mortality in dialysis patients: a retrospective cohort study evaluating the prognostic value of a simple chest X-ray.** BMC Nephrol. 2013 Dec 1;14:263. doi: 10.1186/1471-2369-14-263.

Notes: Mortality predictors

Abstract: Clinical outcomes of dialysis patients are variable, and improved knowledge of prognosis would inform decisions regarding patient management. We assessed the value of simple, chest X-ray derived measures of cardiac size (cardiothoracic ratio (CTR)) and vascular calcification (Aortic Arch Calcification (AAC)), in predicting death and improving multivariable prognostic models in a prevalent cohort of hemodialysis patients. Eight hundred and twenty-four dialysis patients with one or more postero-anterior (PA) chest X-ray were included in the study. Using a validated calcification score, the AAC was graded from 0 to 3. Cox proportional hazards models were used to assess the association between AAC score, CTR, and mortality. AAC was treated as a categorical variable with 4 levels (0,1,2, or 3). Age, race, diabetes, and heart failure were adjusted for in the multivariable analysis. The criterion for statistical significance was $p<0.05$. The median CTR of the sample was 0.53 [IQR=0.48,0.58] with calcification scores as follows: 0 (54%), 1 (24%), 2 (17%), and 3 (5%). Of 824 patients, 152 (18%) died during follow-up. Age, sex, race, duration of dialysis, diabetes, heart failure, ischemic heart disease and baseline serum creatinine and phosphate were included in a base Cox model. Both CTR (HR 1.78[1.40,2.27] per 0.1 unit change), area under the curve (AUC)=0.60[0.55,0.65], and AAC (AAC 3 vs 0 HR 4.35[2.38,7.66], AAC 2 vs 0 HR 2.22[1.41,3.49], AAC 1 vs 0 HR 2.43[1.64,3.61]), AUC=0.63[0.58,0.68]) were associated with death in univariate Cox analysis. CTR remained significant after adjustment for base model variables (adjusted HR 1.46[1.11,1.92]), but did not increase the AUC of the base model (0.71[0.66,0.76] vs. 0.71[0.66,0.76]) and did not improve net reclassification performance (NRI=0). AAC also remained significant on multivariable analysis, but did not improve net reclassification (NRI=0). All ranges were based on 95% confidence intervals. Neither CTR nor AAC assessed on chest x-ray improved prediction of mortality in this prevalent cohort of dialysis patients. Our data do not support the clinical utility of X-ray measures of cardiac size and vascular calcification for the purpose of mortality prediction in prevalent hemodialysis patients. More advanced imaging techniques may be needed to improve prognostication in this population.

Shiraki, Masataka & Kuroda, Tatsuhiko & Tanaka, Shiro. **Established osteoporosis associated with high mortality after adjustment for age and co-mobidities in postmenopausal Japanese women.** Intern Med. 2011;50(5):397-404. Epub 2011 Mar 1.

Notes: Measurement of comorbidities

Abstract: Osteoporosis has been reported to increase the risk of mortality. However, these reports did not evaluate the effects of co-mobidities and the severity of osteoporosis on mortality. The aim of our study was to determine whether or not major osteoporotic fractures contribute to the increased mortality risk in Japanese women. We conducted a prospective observational study. Risk factors contributing to mortality were assessed by Cox's proportional hazard model. A total of 1,429 ambulatory postmenopausal female volunteers aged over 50 years old were enrolled in the study. Information was obtained from the subjects on baseline biochemical indices, bone mineral density (BMD), prevalent fractures, and co-morbidities. Mortality was assessed and confirmed by the certificates or hospital records. The subjects were classified into three categories in accordance with or without osteoporosis. The osteoporotic group was further categorized by the basis of the presence or absence of major osteoporotic fractures. Mean age and SD of the participants were 66.5±9.3 (50-90) years old. The participants were followed for a total of 4.5±3.5 years (mean ± SD) and a total of 141 participants (9.9%) died during the observation. In addition to the traditional risks for mortality, such as age (Hazard ratio, 2.817, 95% CI, 2.237-3.560, p<0.0001), BMI (HR 0.504, 0.304-0.824, p=0.0061), prevalent malignancies (HR 2.885, 1.929-4.214, p<0.0001), dementia (HR 1.602, 1.027-2.450, p=0.038) and cardio-vascular disease (HR 1.878, 1.228-2.787, p=0.0043), the serum level of creatinine (HR 2.451, 1.107-5.284, p=0.027) and severity of osteoporosis (HR 1.390, 1.129-1.719, P=0.0018) were found to be significant independent risk factors for all-cause mortality. These results emphasize the importance of osteoporotic fracture in terms of survival.

Quinn, Michael P & Cardwell, Christopher R & Rainey, Andrea & McNamee, Peter T & Kee, Frank & Maxwell, Alexander P & Fogarty, Damian G & Courtney, Aisling E. **Patterns of hospitalisation before and following initiation of haemodialysis: a 5 year single centre study.** Postgrad Med J. 2011 Jun;87(1028):389-93. doi: 0.1136/pgmj.2010.099028. Epub 2011 Feb 12.

Notes: Measurement of comorbidities

Abstract: BACKGROUND The utilisation of healthcare resources by prevalent haemodialysis patients has been robustly evaluated with regard to the provision of outpatient haemodialysis; however, the impact of hospitalisation among such patients is poorly defined. Minimal information is available in the UK to estimate the health and economic burden associated with the inpatient management of prevalent haemodialysis patients. The aim of this study was to assess the pattern of hospitalisation among a cohort of haemodialysis patients, before and following their initiation of haemodialysis. In addition the study sought to assess the impact of their admissions on bed occupancy in a large tertiary referral hospital in a single region in the UK. METHODS All admission episodes were reviewed and those receiving dialysis with the Belfast City Hospital Programme were identified over a 5 year period from January 2001 to December 2005. This tertiary referral centre provides dialysis services for a population of approximately 700 000 and additional specialist renal services for the remainder of Northern Ireland. The frequency and duration of hospitalisation, and contribution to bed day occupancy of haemodialysis patients, was determined and compared to other common conditions which are known to be associated with high bed occupancy. In addition, the pattern and timing of admissions in dialysis patients in relation to their dialysis initiation date was assessed. RESULTS Over the 5 year study period, 798 haemodialysis patients were admitted a total of 2882 times. These accounted for 2.5% of all admissions episodes; the median number of admissions for these patients was 3 (2-5) which compared with 1 (1-2) for non-dialysis patients. The majority of first hospitalisations (54%) were within 100 days before or after commencement of maintenance dialysis therapy. In all clinical specialties the median length of stay for

haemodialysis patients was significantly longer than for patients not on haemodialysis (p=0.004). In multivariate analysis with adjustment for age, gender, and other clinically relevant diagnostic codes, maintenance haemodialysis patients stayed on average 3.75 times longer than other patient groups (ratio of geometric means 3.75, IQR 3.46-4.06). CONCLUSIONS Maintenance haemodialysis therapy is an important risk factor for prolonged hospitalisation regardless of the primary reason for admission. Such patients require admission more frequently than the general hospital population, particularly within 100 days before and after initiation of their first dialysis treatment.

den Elzen, Wendy P J & Willems, Jorien M & Westendorp, Rudi G J & de Craen, Anton J M & Assendelft, Willem J J & Gussekloo, Jacobijn. **Effect of anemia and comorbidity on functional status and mortality in old age: results from the Leiden 85-plus Study.** CMAJ. 2009 Aug 4;181(3-4):151-7. doi: 10.1503/cmaj.090040. Epub 2009 Jul 27.

Notes: Measurement of comorbidities

Abstract: There is limited insight into the attributable effect of anemia and comorbidity on functional status and mortality in old age. The Leiden 85-plus Study is a population-based prospective follow-up study of 562 people aged 85 years. Anemia was defined according to World Health Organization criteria. We measured 3 parameters of functional status at baseline and annually thereafter for 5 years: disability in basic and instrumental activities of daily living, cognitive function and the presence of depressive symptoms. We obtained mortality data from the municipal registry. The prevalence of anemia at baseline was 26.7% (150/562). Participants who had anemia at baseline had more disability in activities of daily living, worse cognitive function and more depressive symptoms than participants without anemia at baseline (p <or= 0.01). These differences disappeared after adjustment for comorbidity. After adjustment for comorbidity in the prospective analyses, anemia at baseline was associated with an additional increase in disability in instrumental activities of daily living during follow-up; incident anemia during follow-up (n = 99) was associated with an additional increase in disability in basic activities of daily living. Prevalent and incident anemia were both associated with an increased risk of death, even after we adjusted for sex, education level, income, residence in a long-term care facility, C-reactive protein level, creatinine clearance and the presence of disease (hazard ratio for prevalent anemia 1.41, 95% confidence interval [CI] 1.13 to 1.76; hazard ratio for incident anemia 2.08, 95% CI 1.60 to 2.70). Anemia in very elderly people appears to be associated with an increased risk of death, independent of comorbidity. However, the associated functional decline appears to be attributed mainly to comorbidity.

Singh, Jasvinder A & Sloan, Jeffrey. **Higher comorbidity, poor functional status and higher health care utilization in veterans with prevalent total knee arthroplasty or total hip arthroplasty.** Clin Rheumatol. 2009 Sep;28(9):1025-33. doi: 10.1007/s10067-009-1201-4. Epub 2009 Jun 11.

Notes: Measurement of comorbidities

Abstract: The objective of this study was to compare comorbidity, functional ability, and health care utilization in veterans with total knee arthroplasty (TKA) or total hip arthroplasty (THA) versus matched control populations. A cohort of veterans using Veterans Affairs (VA) healthcare system reported limitations in six activities of daily living (ADLs; bathing, dressing, eating, walking, transferring, and using the toilet), demographics, and physician-diagnosed comorbidity. VA databases provided healthcare

utilization and International Classification of Diseases-9/Common procedure terminology codes for TKA/THA. Patients were classified as: (1) primary TKA; (2) primary THA; (3) combination group (>or=1 procedure); and (4) control veteran population (no THA/TKA). Multivariable regression analyses compared the risk or counts of ADL limitation and in-/out-patient visits. After multivariable adjustment, TKA, THA or combination groups had significantly higher prevalence of the following compared to veteran controls: arthritis, diabetes, or heart disease ($p < 0.0001$ each), severe (>or=3) ADL limitation (33%, 42%, 42% vs. 24%; $p < 0.0001$), and annual hospitalization rate (24%, 19%, 26% vs. 16%, $p < 0.0001$). Annual outpatient surgery visits were more (2.5, 2.3, 2.3 vs. 2, $p = 0.01$) and risk of any mental health outpatient visit was lower (12%, 11%, 12% vs. 18%, $p = 0.0039$). All ADLs, except eating, were significantly more limited in arthroplasty groups ($p <or= 0.0009$). Severe ADL limitation was more prevalent in veterans with arthroplasty than in two age-matched US cohorts: 13.4 times in >or=65 years; and 1.2-, 1.6-, and 4-fold in >or=85, 75-84, and 65-74 years. Poorer function and higher comorbidity and utilization in veterans with TKA/THA suggest that this group is appropriate for interventions targeted at improving function and decreasing utilization.

Szulc, Pawel & Kiel, Douglas P & Delmas, Pierre D. **Calcifications in the abdominal aorta predict fractures in men: MINOS study.** J Bone Miner Res. 2008 Jan;23(1):95-102.

Notes: Measurement of comorbidities

Abstract: In a cohort of 781 men >or=50 yr of age followed up for 10 yr, extended calcifications in the abdominal aorta were associated with a 2- to 3-fold increase in the risk of osteoporotic fractures regardless of BMD and falls. Cardiovascular disease and osteoporotic fractures are public health problems that frequently coexist. We assessed the relation of the severity of aortic calcifications with BMD and the risk of fracture in 781 men >or=50 yr of age. During a 10-year follow-up, 66 men sustained incident clinical fractures. Calcifications in the abdominal aorta expressed as an aortic calcification score (ACS) were assessed by a semiquantitative method. BMD was measured at the lumbar spine, hip, whole body, and distal forearm. ACS > 2 was associated with a 2-fold increase in the mortality risk after adjustment for age, weight, smoking, comorbidity, and medications. After adjustment for age, body mass index (BMI), smoking, and comorbidity, men in the highest quartile of ACS (>6) had lower BMD of distal forearm, ultradistal radius, and whole body than men in the lower quartiles. Log-transformed ACS predicted fractures when adjusted for age, BMI, age by BMI interaction, prevalent fractures, BMD, and history of two or more falls (e.g., hip BMD; OR = 1.44; $p < 0.02$). ACS, BMD at all the skeletal sites, and history of two or more falls were independent predictors of fracture. Men with ACS > 6 had a 2- to 3-fold increased risk of fracture after adjustment for confounding variables (OR = 2.54-3.04; $p < 0.005$-0.001 according to the site). This long-term prospective study showed that elevated ACS (>6) is a robust and independent risk factor for incident fracture in older men regardless of age, BMI, BMD, prevalent fractures, history of two or more falls, comorbidities, and medications.

Jackson, Lisa A & Nelson, Jennifer C & Benson, Patti & Neuzil, Kathleen M & Reid, Robert J & Psaty, Bruce M & Heckbert, Susan R & Larson, Eric B & Weiss, Noel S. **Functional status is a confounder of the association of influenza vaccine and risk of all cause mortality in seniors.** Int J Epidemiol. 2006 Apr;35(2):345-52. Epub 2005 Dec 20.

Notes: Measurement of comorbidities

Abstract: Functional status limitations may be associated with both an increased risk of death and a decreased likelihood of influenza vaccination, and so may confound the association of influenza vaccination and risk of all-cause mortality in seniors. We conducted a nested case-control study of persons >or=65 years of age that included 252 cases who died during an influenza season and 576 age-matched controls. We identified functional limitations by medical record review, and compared the effect of adjustment for those factors with that of adjustment for disease covariates defined by diagnosis codes, using methods reported by previous influenza vaccine effectiveness studies, on the association of influenza vaccination and risk of death. Functional limitations, such as requiring assistance for bathing, were highly prevalent in cases, even in the subgroup defined as free of comorbidity by diagnosis code criteria, and were associated with a decreased likelihood of vaccination among controls. Adjustment for functional limitations resulted in an estimate of the relative risk of death in vaccinated persons compared with unvaccinated persons that was closer to the null [odds ratio (OR), 0.71; 95% confidence interval (95% CI), 0.47-1.06] than the unadjusted estimate (OR, 0.59; 95% CI, 0.41-0.83). In contrast, adjustment for diagnosis code covariates moved the estimate further from the null (OR, 0.45; 95% CI, 0.30-0.68). Functional limitations appear to be important confounders of the association of vaccination and risk of death, while adjustment for diagnosis code covariates did not control for a healthy vaccinee bias. Further research is needed on methods to reduce the influence of bias in observational studies of influenza vaccine effectiveness.

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Foley, Robert N & Li, Suying & Liu, Jiannong & Gilbertson, David T & Chen, Shu-Cheng & Collins, Allan J. **The fall and rise of parathyroidectomy in U.S. hemodialysis patients, 1992 to 2002.** J Am Soc Nephrol. 2005 Jan;16(1):210-8. Epub 2004 Nov 24.

Notes: Measurement of comorbidities

Abstract: Although the therapeutic approach to managing hyperparathyroidism has changed dramatically, it is unknown whether parathyroidectomy rates continue to decline in the United States. Parathyroidectomy rates were studied in successive annual national cohorts, prevalent on hemodialysis on January 1 of 1992 to 2002, with Medicare as primary payer. Parathyroidectomy was defined as International Classification of Diseases, Ninth Revision, Clinical Modification code 068. The annual incidence of parathyroidectomy was 11.6 per 1000 patient-years in 1992. The incidence declined progressively after 1994, reaching a low of 6.8 per 1000 patient-years in 1998. Rates increased progressively after 1998, reaching 11.8 per 1000 patient-years in 2002. Using proportional hazards modeling, with adjustment for comorbidity and 1992 as the reference group, the lowest adjusted hazards ratio, 0.32 ($P < 0.0001$), was seen in 1998, followed by hazards ratios of 0.39 ($P < 0.0001$) in 1999, 0.41 ($P < 0.0001$) in 2000, 0.52 ($P < 0.0001$) in 2001, and 0.53 ($P < 0.0001$) in 2002. Other antecedents of parathyroidectomy in multivariate models included ESRD network, younger age, female gender, white race, absence of diabetes, longer duration of previous hemodialysis, use of intravenous vitamin D, previous renal transplantation, several comorbid conditions, and parathyroid hormone measurement in the preceding year. With a case-control method, parathyroidectomy was associated with higher mortality rates immediately after surgery, followed, subsequently, by lower long-term rates. Parathyroidectomy rates in U.S. hemodialysis patients increased between 1998 and 2002, a period in which the therapeutic armamentarium for preventing severe hyperparathyroidism expanded considerably.

Miskulin, Dana. **Characterizing comorbidity in dialysis patients: principles of measurement and applications in risk adjustment and patient care.** Perit Dial Int. 2005 Jul-Aug;25(4):320-32.

Notes: General perspective on comorbidities

Abstract: Comorbid conditions are highly prevalent in dialysis patients and are significant predictors of mortality and other adverse outcomes. Accordingly, it is important to account for differences in comorbid illness burden among groups of dialysis patients being compared. At present, there is no consensus on what conditions matter, how each should be defined, and what weights each carries when defining an individual's risk or case-mix severity. A number of comorbidity instruments, generic or disease specific, have been employed in dialysis populations. They differ by the representation and definition of conditions as well as instrument scoring. No instrument has been found to be superior to another in terms of predictive accuracy for mortality, and accuracy across the board is low. Further studies are needed to determine whether improvements would be found with the use of more specifically defined items and through assignment of item weights based on relationships for outcomes specifically in a dialysis population. The roles of other factors in risk prediction, such as markers of nutritional status, inflammation, or other physiological parameters, relative to comorbid conditions also need to be defined. Outcomes other than mortality are likely to identify different factors and/or different relationships than those noted for mortality, which also require study. Comorbidity is important for risk adjusting comparative analyses in nonrandomized trials and quality of care assessments and may, in future, influence payment for dialysis services. Efforts to improve the

management of comorbid illnesses are needed. Comorbid conditions must be documented accurately and uniformly in all dialysis patients to enable these applications.

Plantinga, Laura C & Fink, Nancy E & Melamed, Michal L & Briggs, William A & Powe, Neil R & Jaar, Bernard G. **Serum phosphate levels and risk of infection in incident dialysis patients.** Clin J Am Soc Nephrol. 2008 Sep;3(5):1398-406. doi: 10.2215/CJN.00420108. Epub 2008 Jun 18.

Notes: Dialysis facility care; measurement of comorbidities

Abstract: Hyperphosphatemia is highly prevalent in dialysis patients and may be associated with immune dysfunction. The association of serum phosphate level with infection remains largely unexamined. In an incident cohort of 1010 dialysis patients enrolled from 1995 to 1998 and treated in 80 US clinics, the association of phosphate level (low <3.5; normal 3.5 to 5.5; high >5.5 mg/dl) at baseline and during follow-up with the risk for incident inpatient and outpatient infection-related events was examined. Infectious events were identified from US Renal Data System data (mean follow-up 3.3 yr). Incidence rate ratios for all infections, sepsis, respiratory tract infections, and osteomyelitis were obtained using multivariable Poisson models, adjusting for potential confounders (age, race, gender, smoking, comorbidity, and laboratory values). Infections of any type (n = 1398) were more frequent among patients with high phosphate levels at baseline, relative to normal; this association was not changed by adjustment for parathyroid hormone level. Similarly, high versus normal baseline phosphate was associated with increased risk for sepsis and osteomyelitis but not respiratory tract infections. Associations with calcium were generally NS, and results with calcium-phosphate product mirrored the phosphate results. High phosphate levels may be associated with increased risk for infection, contributing further to the rationale for aggressive management of hyperphosphatemia in dialysis patients.

Andersson, Manne N & Andersson, Roland E. **Causes of short-term mortality after appendectomy: a population-based case-controlled study**. Ann Surg. 2011 Jul;254(1):103-7. doi: 10.1097/SLA.0b013e31821ad9c4.

Notes: Comorbidities to control for risk of mortality

Abstract: This case control study is a detailed analysis of the causes of death and the risk factors of short-term mortality after appendectomy. Although death is a rare event after appendectomy, we found a 7-fold excess mortality after appendectomy overall and a 9-fold excess mortality after negative appendectomy, compared to the background population in a previous study from Sweden, in accordance with others. All patients who died within 30 days after appendectomy, and controls matched to age, sex and period, were identified of 119,060 patients who were operated with appendectomy in 1987 to 1996 from the Swedish National Inpatient Registry. Causes of death and differences between the cases and controls in comorbidity and appendectomy diagnoses were analyzed on the basis of a review of hospital records. Only patients and controls with appendectomy as the only surgical intervention and without prevalent malignant diagnosis were included in the analysis to avoid bias. A total of 179 patients who died within 30 days and 400 matched controls remained for the analyses. Nonproductive and negative exploration was strongly associated with mortality [odds ratio (OR), 5.11; confidence interval (CI), 2.09-12.48; P < 0.001 and OR, 2.38; CI, 1.24-4.57; P = 0.009, respectively] in contrast to perforated appendicitis (OR, 1.60; CI, 0.95-2.70; P = 0.078) after adjustment for age, sex, and comorbidity. Chronic obstructive pulmonary disease (OR, 3.31; CI,

1.05-10.45, P = 0.041), renal insufficiency (OR, 2.32; CI, 1.26-4.27; P = 0.007), and diabetes mellitus were also independent risk factors (OR, 2.39; CI, 1.12-5.12; P = 0.025). Cardiovascular or thromboembolic disease was responsible for the death in more than 50% of the cases, whereas appendicitis was responsible in only 17.9%. Appendicitis is only responsible for a small portion of the deaths after appendectomy. Comorbidity and negative appendectomy are strongly associated with mortality, suggesting that comorbidity, diagnostic failure, and the anesthesiosurgical trauma may play an important role.

van den Bussche, Hendrik & Koller, Daniela & Kolonko, Tina & Hansen, Heike & Wegscheider, Karl & Glaeske, Gerd & von Leitner, Eike-Christin & Schäfer, Ingmar & Schön, Gerhard. **Which chronic diseases and disease combinations are specific to multimorbidity in the elderly? Results of a claims data based cross-sectional study in Germany.** BMC Public Health. 2011 Feb 14;11:101. doi: 10.1186/1471-2458-11-101.

Notes: Comorbidities measured

Abstract: Growing interest in multimorbidity is observable in industrialized countries. For Germany, the increasing attention still goes still hand in hand with a small number of studies on multimorbidity. The authors report the first results of a cross-sectional study on a large sample of policy holders (n = 123,224) of a statutory health insurance company operating nationwide. This is the first comprehensive study addressing multimorbidity on the basis of German claims data. The main research question was to find out which chronic diseases and disease combinations are specific to multimorbidity in the elderly. The study is based on the claims data of all insured policy holders aged 65 and older (n = 123,224). Adjustment for age and gender was performed for the German population in 2004. A person was defined as multimorbid if she/he had at least 3 diagnoses out of a list of 46 chronic conditions in three or more quarters within the one-year observation period. Prevalence and risk-ratios were calculated for the multimorbid and non-multimorbid samples in order to identify diagnoses more specific to multimorbidity and to detect excess prevalence of multimorbidity patterns. 62% of the sample was multimorbid. Women in general and patients receiving statutory nursing care due to disability are overrepresented in the multimorbid sample. Out of the possible 15,180 combinations of three chronic conditions, 15,024 (99%) were found in the database. Regardless of this wide variety of combinations, the most prevalent individual chronic conditions do also dominate the combinations: Triads of the six most prevalent individual chronic conditions (hypertension, lipid metabolism disorders, chronic low back pain, diabetes mellitus, osteoarthritis and chronic ischemic heart disease) span the disease spectrum of 42% of the multimorbid sample. Gender differences were minor. Observed-to-expected ratios were highest when purine/pyrimidine metabolism disorders/gout and osteoarthritis were part of the multimorbidity patterns. The above list of dominating chronic conditions and their combinations could present a pragmatic start for the development of needed guidelines related to multimorbidity.

Sarma, Satyam & Mentz, Robert J & Kwasny, Mary J & Fought, Angela J & Huffman, Mark & Subacius, Haris & Nodari, Savina & Konstam, Marvin & Swedberg, Karl & Maggioni, Aldo P & Zannad, Faiez & Bonow, Robert O & Gheorghiade, Mihai. **Association between diabetes mellitus and post-discharge outcomes in patients hospitalized with heart failure: findings from the EVEREST trial.** Eur J Heart Fail. 2013 Feb;15(2):194-202. doi: 10.1093/eurjhf/hfs153. Epub 2012 Oct 11.

Notes: Comorbidities and mortality

Abstract: We evaluated the impact of diabetes mellitus (DM) and diabetic therapy on outcomes in patients with reduced ejection fraction (EF) after hospitalization for heart failure (HF). DM is prevalent in patients hospitalized with HF, yet inconclusive data exist on the post-discharge outcomes of this patient population. Post-hoc analysis was performed on the EVEREST (Efficacy of Vasopressin Antagonism in Heart Failure Outcome Study with Tolvaptan) study, a randomized trial of patients hospitalized with HF (n = 4133) with median follow-up of 9.9 months. DM status was determined from intake questionnaires and cross-verified by medication history. Univariate relationships were examined using $\chi(2)$ test, t-test, and Wilcoxon tests. The two primary outcomes of (i) all-cause mortality (ACM) and (ii) cardiovascular mortality or HF hospitalization (CVM + HFH) were assessed for those with and without DM and by diabetic treatment strategy using log rank tests and multivariable Cox regression models. DM was present in 40% of participants. Patients with DM were more likely to have hypertension, coronary artery disease, and chronic kidney disease. Diabetes was associated with ACM and CVM + HFH (both $P < 0.001$). Following multivariate risk adjustment, DM was associated with ACM, but this estimate was imprecise [hazard ratio (HR) 1.16; 95% confidence interval (CI) 1.00-1.34] and remained associated with CVM or HFH (HR 1.17; 95% CI 1.04-1.31). Diabetic control strategy did not independently affect outcomes. Diabetes is common in patients hospitalized for heart failure with a reduced EF. These patients have a higher post-discharge CVM and higher HF hospitalizations compared with patients with no diabetes. Different diabetic treatment regimens did not appear to influence post-discharge outcomes.

Ruo, Bernice & Capra, Angela M & Jensvold, Nancy G & Go, Alan S. **Racial variation in the prevalence of atrial fibrillation among patients with heart failure: the Epidemiology, Practice, Outcomes, and Costs of Heart Failure (EPOCH) study.** J Am Coll Cardiol. 2004 Feb 4;43(3):429-35.

Notes: Measurement of comorbidities

Abstract: This study was designed to determine the association between race and atrial fibrillation (AF) among patients with heart failure (HF). Atrial fibrillation is known to complicate HF, but whether its prevalence varies by race, and the reasons why, are not well understood. We identified adults hospitalized with confirmed HF within a large integrated healthcare delivery system. We obtained information on demographics, comorbidity, vital signs, medications, and left ventricular systolic function status. "Atrial fibrillation" was defined as AF or atrial flutter documented by electrocardiogram or prior physician-assigned diagnoses. We evaluated the independent relationship between race and AF using multivariable logistic regression. Among 1,373 HF patients (223 African Americans, 1,150 Caucasians), the prevalence of AF was 36.9% (95% confidence interval [CI] 34.3% to 39.5%). Compared with Caucasians, African Americans were younger (mean age 67 vs. 74 years, $p < 0.001$) and more likely to have hypertension (86.6% vs. 77.7%, $p < 0.01$) and prior diagnosed HF (79.4% vs. 70.7%, $p < 0.01$). African Americans had less prior diagnosed coronary disease, revascularization, hypothyroidism, or valve replacement. Atrial fibrillation was much less prevalent in African Americans (19.7%) than Caucasians (38.3%, $p < 0.001$). After adjustment for risk factors for AF and other potential confounders, African Americans had 49% lower odds of AF (adjusted odds ratio 0.51, 95% CI 0.35 to 0.76). In a contemporary HF cohort, AF was significantly less common among African Americans than among Caucasians. This variation was not explained by differences in traditional risk factors for AF, HF etiology and severity, and treatment.

Penninx, Brenda W J H & Guralnik, Jack M & Onder, Graziano & Ferrucci, Luigi & Wallace, Robert B & Pahor, Marco. **Anemia and decline in physical performance among older persons.** Am J Med. 2003 Aug 1;115(2):104-10.

Notes: Measurement of comorbidities

Abstract: Anemia is prevalent in old age and is potentially modifiable, but its effects on physical function have not been determined. We examined whether anemia in older persons increases the risk of subsequent decline in physical function, as measured by objective performance-based tests. Participants in this 4-year prospective cohort study included 1146 participants, aged 71 years or older, living in Iowa and Washington counties, Iowa. Anemia was defined according to World Health Organization (WHO) criteria as a hemoglobin concentration below 12 g/dL in women and below 13 g/dL in men. An assessment of standing balance, a timed 2.4-m walk, and a timed test of five chair rises were used to assess physical performance; these were combined into a 0 (poor) to 12 (excellent) summary scale. After adjustment for baseline performance score, health status, and demographic characteristics, anemia was associated with greater mean decline in physical performance over 4 years; the adjusted mean decline was 2.3 (95% confidence interval [CI]: 1.7 to 2.8) in subjects with anemia and 1.4 (95% CI: 1.2 to 1.5) in those without anemia (P = 0.003). The association between anemia and greater physical decline was also present in participants who were free of diseases associated with anemia (cancer, infectious disease, and renal failure), and after adjustment for serum cholesterol, iron, and albumin levels. Persons with borderline anemia, a hemoglobin concentration within 1 g/dL above the WHO criteria, also showed greater mean physical decline (1.8; 95% CI: 1.5 to 2.2) than did those with higher hemoglobin concentrations (P = 0.02). This study suggests that anemia in old age is an independent risk factor for decline in physical performance.

Volpato, S & Guralnik, J M & Ferrucci, L & Balfour, J & Chaves, P & Fried, L P & Harris, T B **Cardiovascular disease, interleukin-6, and risk of mortality in older women: the women's health and aging study.** Circulation. 2001 Feb 20;103(7):947-53.

Notes: Measurement of comorbidities

Abstract: Systemic chronic inflammation has been found to be related to all-cause mortality risk in older persons. We investigated whether specific chronic conditions, particularly cardiovascular disease (CVD), affect the association between high interleukin (IL)-6 level and mortality in a sample of disabled older women. IL-6 serum level was measured at baseline in 620 women >/=65 years old. The presence and severity of medical conditions was ascertained by standard criteria that used multiple sources of information. The sample was surveyed over the 3-year follow-up. After adjustment for potential confounders, compared with those in the lowest tertile, women in the highest IL-6 tertile were at higher risk of all-cause mortality. The presence of CVD, however, strongly affected the risk of mortality associated with high IL-6. Among women with prevalent CVD, those with high IL-6 levels had >4-fold risk of death (RR 4.6; 95% CI 2.0 to 10.5) compared with women in the lowest tertile, whereas the relative risk associated with high IL-6 among those without CVD was much lower and not significant (RR 1.8; 95% CI 0.7 to 4.2). Adjustment for all chronic diseases and disease severity measures, including ankle-brachial index, forced expiratory volume, and exercise tolerance, did not change the results. IL-6 level is helpful in identifying a subgroup of older CVD patients with high risk of death over a period of 3 years. Systemic inflammation, as measured by IL-6, may be related to the clinical evolution of older patients with CVD.

Atlantis, Evan & Shi, Zumin & Penninx, Brenda J W H & Wittert, Gary A & Taylor, Anne & Almeida, Osvaldo P. **Chronic medical conditions mediate the association between depression and cardiovascular disease mortality.** Soc Psychiatry Psychiatr Epidemiol. 2012 Apr;47(4):615-25. doi: 10.1007/s00127-011-0365-9. Epub 2011 Mar 8.

Notes: Claims were used to measure comorbidities

Abstract: To determine whether chronic medical conditions mediate the association between depression and cardiovascular disease (CVD) mortality. Data analyzed were from 6,394 subjects aged 25-74 years who participated in extensive health examinations in the NHEFS conducted between 1971 and 1975 and follow-up studies to 1992. CVD mortality was the endpoint. Depression predictors were clinically significant depressive symptoms at baseline by the GWB-D, and/or at 1982-1984 by the CES-D ('baseline', 'new', or 'twice' depression). Chronic conditions were prevalent/incident high blood pressure, diabetes, and non-fatal CVD by examination and/or self-report. Mediation effects were assessed by stepwise adjustments of covariates and additive interactions in competing risks regression models (accounting for other mortality causes) and logit models. Baseline, new, and twice depression were significant predictors of CVD mortality in competing-risks models adjusted for demographics (HRs 1.3, 1.4, and 2.0), but effects were progressively weakened and became non-significant after adjustment for lifestyle factors, prevalent and incident medical conditions, respectively. CVD mortality risk was 80% higher for depression plus incident non-fatal CVD than without (HR 4.0 vs. 3.2, additive interaction), and mediation effects of depression via chronic medical conditions (particularly via incident non-fatal CVD) increased the risk by 2-11% in logit models, independent of all covariates. Several levels of evidence suggest that the association between depression and CVD mortality is partially mediated by prevalent/incident chronic medical conditions, as well as unhealthy lifestyle behaviors. Patients presenting with clinically significant depressive symptoms, particularly if persistent, should be assessed for both chronic conditions and lifestyle risk factors.

Ma, J Z & Ebben, J & Xia, H & Collins, A J. **Hematocrit level and associated mortality in hemodialysis patients.** J Am Soc Nephrol. 1999 Mar;10(3):610-9.

Notes: Claims to measure comorbidities

Abstract: Although a number of clinical studies have shown that increased hematocrits are associated with improved outcomes in terms of cognitive function, reduced left ventricular hypertrophy, increased exercise tolerance, and improved quality of life, the optimal hematocrit level associated with survival has yet to be determined. The association between hematocrit levels and patient mortality was retrospectively studied in a prevalent Medicare hemodialysis cohort on a national scale. All patients survived a 6-mo entry period during which their hematocrit levels were assessed, from July 1 through December 31, 1993, with follow-up from January 1 through December 31, 1994. Patient comorbid conditions relative to clinical events and severity of disease were determined from Medicare claims data and correlated with the entry period hematocrit level. After adjusting for medical diseases, our results showed that patients with hematocrit levels less than 30% had significantly higher risk of all-cause (12 to 33%) and cause-specific death, compared to patients with hematocrits in the 30% to less than 33% range. Without severity of disease adjustment, patients with hematocrit levels of 33% to less than 36% appear to have the lowest risk for all-cause and cardiac mortality. After adjusting for severity of disease, the impact of hematocrit levels of 33% to less than 36% is vulnerable to

the patient sample size but also demonstrates a further 4% reduced risk of death. Overall, these findings suggest that sustained increases in hematocrit levels are associated with improved patient survival.

Fried, L & Bernardini, J & Piraino, B. **Charlson comorbidity index as a predictor of outcomes in incident peritoneal dialysis patients.** Am J Kidney Dis. 2001 Feb;37(2):337-42.

Notes: Charlson Index, comorbidities at incidence

Abstract: A previous study at our center used the Charlson Comorbidity Index (CCI) (an index of comorbidity that includes age) to predict outcomes in a mixed group of incident and prevalent dialysis patients. The purpose of this study was to examine the usefulness of the CCI as a predictor in incident peritoneal dialysis (PD) patients and to examine whether it was a better predictor than simply the number of comorbid conditions or other known predictors, such as age, albumin level, diabetes, and cardiovascular disease. Since 1990, we have collected prospectively comorbidity data at the start of PD. All patients with known comorbidity and serum albumin and who did not have a prior history of hemodialysis or transplant were included (n = 268). Time at risk began at day 1 of PD training. Cox proportional hazards best subset selection was used to screen models to predict patient survival. Candidate models were analyzed further for proportionality and other model assumptions. Univariate analysis showed that significant predictors of mortality were CCI (chi-square = 43.3, P < 0.0001), age (chi-square = 23.7, P < 0.0001), cardiac disease (chi-square = 19.9, P <0.0001), number of comorbid conditions (chi-square = 15.6, P < 0.0001), serum albumin at the start of dialysis (chi-square = 15.3, P = 0.0001), and diabetes (chi-square = 4, P < 0.05). In multivariate analysis, CCI alone was the best predictor. The addition of serum albumin did not improve the model significantly (chi-square = 51.86 versus 49.34). For every increase of 1 in the CCI score, the relative risk of death was 1.54 (95% confidence interval, 1.36 to 1.74). CCI alone scored at the start of PD is a strong predictor of patient survival in incident end-stage renal disease patients on PD. This simple-to-calculate index would be useful to adjust for confounding in future studies and in the adjustment of case mix if Medicare moves to a capitated payment system.

Gracia-Iguacel, Carolina & Gallar, Paloma & Qureshi, Abdul R & Ortega, Olimpia & Mon, Carmen & Ortiz, Milagros & Villarreal, Isabel & Garcia-Lacalle, Concepcion & Olieta, Aniana & Sánchez, Maria & Herrero, Juan C & Vigil, Ana & Lindholm, Beng & Carrero, Juan J. **Vitamin D deficiency in dialysis patients: effect of dialysis modality and implications on outcome**. J Ren Nutr. 2010 Nov;20(6):359-67. doi: 10.1053/j.jrn.2010.03.005. Epub 2010 May 26.

Notes: Charlson comorbidity index used as adjustor for mortality

Abstract: Vitamin D deficiency has been linked to cardiovascular disease and mortality in hemodialysis (HD) patients. The purpose of the present cross-sectional study was to analyze the Vitamin D status of dialysis patients from a single center, study determinants of Vitamin D deficiency, and assess its implications on outcome. A prospective observational study of 115 prevalent dialysis patients was carried out, in which clinical and dialysis-related characteristics including routine biochemistry were studied in relation to levels of 25-hydroxyvitamin-D (25[OH]D, chemiluminescence). Survival was assessed after a median follow-up period of 413 days. 25(OH)D deficiency and insufficiency was present in 51% and 42% of the patients, respectively. Only 7% of the patients showed normal 25(OH)D levels. Peritoneal dialysis patients presented the lowest 25(OH)D levels. Also, a significant difference was found between on-line

hemodiafiltration (OL-HDF) and conventional HD (11 [6 to 16] versus 19 [13 to 27] ng/mL; P < 0.001; 25th to 75th percentiles, conventional HD versus OL-HDF respectively). In multinomial logistic regression analysis, patients on conventional HD had 8.35 greater odds (95% CI [2.04 to 34.20]) of 25(OH)D deficiency than OL-HDF even after adjustment for sex, parathyroid hormone, pH, and Charlson comorbidity index. During the follow-up period, 18 patients died. Both crude and adjusted (hazard ratio, 6.96; 95% CI [1.44 to 33.64]) Cox analysis identified 25(OH)D deficiency as a mortality risk factor. This observational study underlines the high prevalence of hypovitaminosis D in dialysis patients and its strong implications on outcome. Furthermore, our results suggest that OL-HDF was associated with a better preservation of the vitamin D status as compared with conventional HD.

Longenecker, J Craig & Coresh, Josef & Marcovina, Santica M & Powe, Neil R & Levey, Andrew S & Giaculli, Federico & Fink, Nancy E & Klag, Michael J. **Lipoprotein(a) and prevalent cardiovascular disease in a dialysis population: The Choices for Healthy Outcomes in Caring for ESRD (CHOICE) study.** Am J Kidney Dis. 2003 Jul;42(1):108-16.

Notes: Comorbidities at baseline

Abstract: Levels of lipoprotein(a) [Lp(a)], an atherogenic lipoprotein, are elevated in patients with end-stage renal disease and inversely related to the size of apolipoprotein(a) [apo(a)], a glycoprotein bound to Lp(a). We studied the association of Lp(a) level and apo(a) size with prevalent atherosclerotic cardiovascular disease (ASCVD) in 871 incident dialysis patients (261 blacks, 565 whites, 45 other). Lp(a) was measured by an apo(a) size-independent enzyme-linked immunoassay; and apo(a) size was measured by sodium dodecyl sulfate-agarose gel electrophoresis. Prevalent ASCVD, derived from medical records, was defined as coronary heart disease or cerebral or peripheral vascular disease. Adjustment variables included age, sex, race, dialysis modality, diabetes, serum creatinine level, albumin level, and low-density lipoprotein cholesterol level. ASCVD prevalence was 58%. Median Lp(a) levels for those with compared with those without ASCVD were 38 versus 35 nmol/L for whites (P = 0.49) and 100 versus 74 nmol/L for blacks, respectively (P = 0.35). Lp(a) level was associated with ASCVD among those younger than 60 years (odds ratio [OR] for +1 interquartile range of Lp(a), 1.5; P = 0.02), but not among those 60 years and older (OR, 1.0; P = 0.82; P(interaction) by age, 0.08). ORs were 1.3 for all whites (P = 0.03) and 1.1 for all blacks (P = 0.87; P(interaction)by race = 0.53). ORs of ASCVD were 1.7 for whites younger than 60 years (P = 0.01) and 1.2 for blacks younger than 60 years (P = 0.77; P(interaction) by race = 0.42). No association between apo(a) isoform size and ASCVD was present. In an incident dialysis cohort, Lp(a) level was associated with prevalent ASCVD among whites younger than 60 years, but not among blacks or those older than 60 years. Apo(a) isoform size was not associated with prevalent ASCVD. These data suggest that baseline ASCVD is unlikely to strongly confound the potential associations of Lp(a) level and prospectively ascertained ASCVD among incident dialysis patients.

Xia, H & Ebben, J & Ma, J Z & Collins, A J. **Hematocrit levels and hospitalization risks in hemodialysis patients.** J Am Soc Nephrol. 1999 Jun;10(6):1309-16.

Notes: Comorbidities measured

Abstract: The association between hematocrit level and future hospitalization risks in hemodialysis patients has not been fully investigated on a national level. A total of 71,717 prevalent Medicare hemodialysis patients who survived a 6-mo entry period from July 1 through

December 31, 1993 were studied, and their risk of hospitalizations was evaluated the next year. Five hematocrit groups were defined from Medicare recombinant human erythropoietin-treated patients: <27%, 27 to <30%, 30 to <33%, 33 to <36%, and > or =36%. A Cox regression model was used to investigate the association between hematocrit level and the risk of first hospitalization, and the Andersen-Gill regression model evaluated multiple hospitalizations during the next year, adjusting for patient comorbidity and severity of disease. Compared with the baseline group of 30 to <33%, patients with hematocrit levels <30% had a 14 to 30% increased risk of hospitalization without disease severity adjustment (p = 0.0001) and a 7 to 18% increased risk with disease severity adjustment (p = 0.0001). Patients in the 33 to <36% group had the lowest risk at 0.93 and 0.88 (p = 0.0001), with and without adjustment for disease severity. It is concluded that patients with hematocrits of <30% have an increased risk of future hospitalization, with hematocrit levels between 33 and 36% having the lowest associated risks.

Rodrigo-Rincón, Isabel & Martin-Vizcaíno, Marta P & Tirapu-León, Belén & Zabalza-López, Pedro & Abad-Vicente, Francisco J & Merino-Peralta, Asunción & Oteiza-Martínez, Fabiola. **Usefulness of administrative databases for surgical patients' adverse events risk adjustment.** Cir Esp. 2015 Apr 1. pii: S0009-739X(15)00042-1. doi: 10.1016/j.ciresp.2015.01.013. [Epub ahead of print].

Notes: None

Abstract: The aim of this study was to assess the usefulness of clinical-administrative databases for the development of risk adjustment in the assessment of adverse events in surgical patients. The study was conducted at the Hospital of Navarra, a tertiary teaching hospital in northern Spain. We studied 1602 hospitalizations of surgical patients from 2008 to 2010. We analyzed 40 comorbidity variables included in the National Surgical Quality Improvement (NSQIP) Program of the American College of Surgeons using 2 sources of information: The clinical and administrative database (CADB) and the data extracted from the complete clinical records (CR), which was considered the gold standard. Variables were catalogued according to compliance with the established criteria: sensitivity, positive predictive value and kappa coefficient >0.6. The average number of comorbidities per study participant was 1.6 using the CR and 0.95 based on CADB (p<.0001). Thirteen types of comorbidities (accounting for 8% of the comorbidities detected in the CR) were not identified when the CADB was the source of information. Five of the 27 remaining comorbidities complied with the 3 established criteria; 2 pathologies fulfilled 2 criteria, whereas 11 fulfilled 1, and 9 did not fulfil any criterion. CADB detected prevalent comorbidities such as comorbid hypertension and diabetes. However, the CABD did not provide enough information to assess the variables needed to perform the risk adjustment proposed by the NSQIP for the assessment of adverse events in surgical patients.

Górriz, José L & Molina, Pablo & Cerverón, M Jesús & Vila, Rocío & Bover, Jordi & Nieto, Javier & Barril, Guillermina & Martínez-Castelao, Alberto & Fernández, Elvira & Escudero, Verónica & Piñera, Celestino & Adragao, Teresa & Navarro-Gonzalez, Juan F & Molinero, Luis M & Castro-Alonso, Cristina & Pallardó, Luis M & Jamal, Sophie A**. SERUM CYSTATIN C DOES NOT PREDICT MORTALITY OR TREATMENT FAILURE IN PERITONEAL DIALYSIS: A PROSPECTIVE STUDY. Perit Dial Int. 2014 Sep 2**. pii: pdi.2014.00071. [Epub ahead of print].

Notes: None

Abstract: Background: Small solute clearance, especially that derived from residual renal function (RRF), is an independent risk factor for death in peritoneal dialysis (PD) patients.

Assessment of solute clearance is time-consuming and prone to multiple errors. Cystatin C is a small protein which has been used as a glomerular filtration rate (GFR) marker. We investigated whether serum cystatin C concentrations are related to mortality in patients receiving PD. ♦ Methods: New and prevalent PD patients (n = 235) underwent assessment of Kt/Vurea, RRF, weekly creatinine clearance (CCr), normalized protein catabolic rate (nPCR) and a peritoneal equilibration test (PET) at intervals. Blood was collected simultaneously for cystatin C measurement. Patients were followed for a median of 1,429 days (range 12 to 2,964 days) until death or study closure. Cause of death was recorded where given. Cox regression was performed to determine whether cystatin C had prognostic value either independently or with adjustment for other factors (age, sex, dialysis modality, diabetic status, cardiovascular comorbidity, Kt/V, CCr, RRF, nPCR or 4 h dialysate to plasma creatinine ratio (4 h D/PCr) during the PET). The primary outcomes were all-cause mortality and treatment failure. ♦ Results: There were 93 deaths. Increasing age and 4 h D/PCr ratio, decreased RRF and presence of diabetes were significantly [$p < 0.05$] negatively associated with survival and treatment failure. Serum cystatin C was not related to either outcome. ♦ Conclusions: Serum cystatin C concentration does not predict mortality or treatment failure in patients receiving PD.

Hsieh, Cheng-Yang & Lin, Huey-Juan & Sung, Sheng-Feng & Hsieh, Han-Chieh & Lai, Edward Chia-Cheng & Chen, Chih-Hung. **Is renal dysfunction associated with adverse stroke outcome after thrombolytic therapy?** Cerebrovasc Dis. 2014;37(1):51-6. doi: 10.1159/000356348. Epub 2013 Dec 21.

Notes:

Abstract: Renal dysfunction is a prevalent comorbidity in acute stroke patients requiring thrombolytic therapy. Reports studying the relationship between renal dysfunction and risk of postthrombolytic symptomatic intracerebral hemorrhage (SICH) are contradictory. We aimed to compare the safety and effectiveness of thrombolytic therapy in acute stroke patients with and without renal dysfunction. Based on the prospective stroke registries of 4 hospitals in Taiwan from 2007-2012, we identified acute stroke patients who received thrombolytic therapy. Clinically significant renal dysfunction was defined as an estimated glomerular filtration rate (eGFR) <60 ml/min/1.73 m(2). Renal dysfunction was further defined as stage 3 (30 ≤ eGFR < 60 ml/min/ 1.73 m(2)), stage 4 (15 ≤ eGFR < 30 ml/min/1.73 m(2)) and stage 5 (<15 ml/min/1.73 m(2)). The rates of SICH and poor outcome (defined as modified Rankin scale score ≥4) at 3 months after thrombolytic therapy were compared in patients with and without renal dysfunction. SICH was determined according to the definition of the National Institute of Neurological Disorders and Stroke. Multivariable logistic regression was used to determine the effect of renal dysfunction on outcome. Patients with different stages of renal dysfunction were further analyzed to determine the effect of disease severity on outcome. Of the 657 stroke patients with thrombolysis, 239 (36%) had renal dysfunction, including 212 patients in stage 3, 17 patients in stage 4 and 10 patients in stage 5 of renal dysfunction. Patients with renal dysfunction were older and more likely to have hypertension, ischemic heart disease, congestive heart failure and prior antiplatelet use than those without. There were no differences in SICH (8 vs. 7%, p = 0.580) and poor outcome (41 vs. 39%, p = 0.758) between patients with and without renal dysfunction. After multivariable analysis, renal dysfunction was not associated with SICH (odds ratio: 1.03, 95% confidence interval: 0.55-1.92) and poor outcome. Pretreatment stroke severity was the only factor significantly associated with both SICH and poor outcome at 3 months. When stratifying renal dysfunction into stage 3 and stage ≥4, there was no significant increase in SICH as the severity of renal dysfunction increased after multivariable adjustment. Renal dysfunction did not increase the risk of SICH and poor outcome at 3 months after stroke thrombolysis. Further study comparing directly the risk and benefit of thrombolytic therapy versus no therapy in stroke patients with renal dysfunction is warranted.

Hsieh, Cheng-Yang & Lin, Huey-Juan & Sung, Sheng-Feng & Hsieh, Han-Chieh & Lai, Edward Chia-Cheng & Chen, Chih-Hung. **Is renal dysfunction associated with adverse stroke outcome after thrombolytic therapy?** Cerebrovasc Dis. 2014;37(1):51-6. doi: 10.1159/000356348. Epub 2013 Dec 21**.**

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Longenecker, J Craig & Klag, Michael J & Marcovina, Santica M & Powe, Neil R & Fink, Nancy E & Giaculli, Federico & Coresh, Josef. **Small apolipoprotein(a) size predicts mortality in end-stage renal disease: The CHOICE study.** Circulation. 2002 Nov 26;106(22):2812-8.

Notes: None

Abstract: The high mortality rate in end-stage renal disease has engendered interest in nontraditional atherosclerotic cardiovascular disease (ASCVD) risk factors that are more prevalent in end-stage renal disease, such as elevated lipoprotein(a) [Lp(a)] levels. Previous studies suggest that high Lp(a) levels and small apolipoprotein(a) [apo(a)] isoform size are associated with ASCVD, but none have investigated the relationship between Lp(a) level, apo(a) size, and mortality. An inception cohort of 864 incident dialysis patients was followed prospectively. Lp(a) was measured by an apo(a) size-independent ELISA and apo(a) size by Western blot after SDS-agarose gel electrophoresis. Comorbid conditions were determined by

medical record review. Time to death was ascertained through dialysis clinic and Health Care Financing Administration follow-up. Survival analyses were performed with adjustment for baseline demographic, comorbid conditions, albumin, and lipids. Median follow-up was 33.7 months, with 346 deaths, 162 transplantations, and 10 losses to follow-up during 1999 person-years of follow-up. Cox regression analysis showed no association between Lp(a) level and mortality. However, an association between small apo(a) isoform size and mortality was found (hazard ratio, 1.36; P=0.004) after adjusting for age, race, sex, comorbidity score, cause of renal disease, and congestive heart failure. The association was somewhat lower in white patients (hazard ratio 1.34; P=0.019) than in black patients (1.69; P=0.04). No interaction by age, race, sex, diabetes, ASCVD, or Lp(a) level was present. Small apo(a) size, but not Lp(a) level, independently predicts total mortality risk in dialysis patients.

Kautter, John & Pope, Gregory C & Ingber, Melvin & Freeman, Sara & Patterson, Lindsey & Cohen, Michael & Keenan, Patricia. **The HHS-HCC risk adjustment model for individual and small group markets under the Affordable Care Act.** Medicare Medicaid Res Rev. 2014 May 9;4(3). pii: mmrr2014-004-03-a03. doi: 10.5600/mmrr2014-004-03-a03. eCollection 2014**.**

Notes: None

Abstract: Beginning in 2014, individuals and small businesses are able to purchase private health insurance through competitive Marketplaces. The Affordable Care Act (ACA) provides for a program of risk adjustment in the individual and small group markets in 2014 as Marketplaces are implemented and new market reforms take effect. The purpose of risk adjustment is to lessen or eliminate the influence of risk selection on the premiums that plans charge. The risk adjustment methodology includes the risk adjustment model and the risk transfer formula. This article is the second of three in this issue of the Review that describe the Department of Health and Human Services (HHS) risk adjustment methodology and focuses on the risk adjustment model. In our first companion article, we discuss the key issues and choices in developing the methodology. In this article, we present the risk adjustment model, which is named the HHS-Hierarchical Condition Categories (HHS-HCC) risk adjustment model. We first summarize the HHS-HCC diagnostic classification, which is the key element of the risk adjustment model. Then the data and methods, results, and evaluation of the risk adjustment model are presented. Fifteen separate models are developed. For each age group (adult, child, and infant), a model is developed for each cost sharing level (platinum, gold, silver, and bronze metal levels, as well as catastrophic plans). Evaluation of the risk adjustment models shows good predictive accuracy, both for individuals and for groups. Lastly, this article provides examples of how the model output is used to calculate risk scores, which are an input into the risk transfer formula. Our third companion paper describes the risk transfer formula.

Fitch, Kathryn & Broulette, Jonah & Kwong, Winghan Jacqueline. **The economic burden of ischemic stroke and major hemorrhage in medicare beneficiaries with nonvalvular atrial fibrillation: a retrospective claims analysis.** Am Health Drug Benefits. 2014 Jun;7(4):200-9.

Notes: None

Abstract: Understanding the economic implications of oral anticoagulation therapy requires careful consideration of the risks and costs of stroke and major hemorrhage. The majority of patients with atrial fibrillation (AF) are aged ≥65 years, so focusing on the Medicare population is reasonable when discussing the risk for stroke. To examine the relative economic burden

associated with stroke and major hemorrhage among Medicare beneficiaries who are newly diagnosed with nonvalvular atrial fibrillation (NVAF). This study was a retrospective analysis of a 5% sample of Medicare claims data for patients with NVAF from 2006 to 2008. Patients with NVAF without any claims of AF during the 12 months before the first (index) claim for AF in 2007 (baseline period) were identified and were classified into 4 cohorts during a 12-month follow-up period after the index date. These cohorts included (1) no claims for ischemic stroke or major hemorrhage (without stroke or hemorrhage); (2) no claims for ischemic stroke and ≥1 claims for major hemorrhage (hemorrhage only); (3) ≥1 claims for ischemic stroke and no major hemorrhage claims (stroke only); and (4) ≥1 claims each for ischemic stroke and for major hemorrhage (stroke and hemorrhage). The 1-year mean postindex total all-cause healthcare costs adjusted by the Centers for Medicare & Medicaid Services Hierarchical Condition Categories (HCC) score were compared among the study cohorts. Of the 9455 eligible patients included in this study, 3% (N = 261) of the patients had ischemic stroke claims only, 3% (N = 276) had hemorrhage claims only, and <1% (N = 13) had both during the follow-up period. The unadjusted follow-up healthcare costs were $63,781 and $64,596 per patient for the ischemic stroke only and the hemorrhage only cohorts, respectively, compared with $35,474 per patient for those without hemorrhage or stroke claims. After adjustment for HCC risk score, the mean incremental costs for patients with stroke claims only and hemorrhage claims only, relative to those without stroke or hemorrhage claims, were $26,776 (95% confidence interval [CI], $20,785-$32,767; P <.001) and $26,168 (95% CI, $20,375-$31,961; P <.001), respectively. The economic burden of managing patients with NVAF who experience ischemic stroke and hemorrhage were similarly significant during the first year after a diagnosis of NVAF. The burden of major bleeding complications on patients, clinicians, and payers should not be overlooked, and these complications should be considered in conjunction with the cost-savings associated with ischemic stroke risk reduction in future cost-benefit evaluations of oral anticoagulation therapy.

Eisenberg, Michael L & Li, Shufeng & Behr, Barry & Cullen, Mark R & Galusha, Deron & Lamb, Dolores J & Lipshultz, Larry I. **Semen quality, infertility and mortality in the USA.** Hum Reprod. 2014 Jul;29(7):1567-74. Epub 2014 May 15.

Notes: None

Abstract: What is the relationship between semen parameters and mortality in men evaluated for infertility? Among men undergoing an infertility evaluation, those with abnormal semen parameters have a higher risk of death, suggesting a possible common etiology between infertility and mortality. Conflicting data exist that suggest either an inverse relationship or no relationship between semen quality and mortality. A study cohort was identified from two centers, each specializing in infertility care. In California, we identified men with data from 1994 to 2011 in the Stanford Reproductive Endocrinology and Infertility semen database. In Texas, we identified men with data from 1989 to 2009 contained in the andrology database at the Baylor College of Medicine Special Procedures Laboratory who were evaluated for infertility. Mortality was determined by data linkage to the National Death Index or Social Security Death Index. Comorbidity was estimated based on calculation of the Charlson Comorbidity Index or Centers for Medicare & Medicaid Services-Hierarchical Condition Categories Model. In all, 11,935 men were evaluated for infertility from 1989 to 2011. During 92 104 person years of follow-up, 69 of 11,935 men died (0.58%). The mean age at infertility evaluation was 36.6 years with a mean follow-up of 7.7 years. Compared with the general population, men evaluated for infertility had a lower risk of death with 69 deaths observed compared with 176.7 expected (Standardized

mortality rate 0.39, 95% CI 0.30-0.49). When stratified by semen parameters, however, men with impaired semen parameters (i.e. male factor infertility) had significantly higher mortality rates compared with men with normal parameters (i.e. no male factor infertility). Low semen volume, sperm concentration, sperm motility, total sperm count and total motile sperm count were all associated with higher risk of death. In contrast, abnormal sperm morphology was not associated with mortality. While adjusting for current health status attenuated the association between semen parameters and mortality, men with two or more abnormal semen parameters still had a 2.3-fold higher risk of death compared with men with normal semen (95% CI 1.12-4.65). Our cohort represents infertile men, which may limit generalizability. As comorbidity relied on administrative data, granular information on each man regarding infertility diagnosis and lifestyle factors was unavailable. Men with impaired semen parameters have an increased mortality rate in the years following an infertility evaluation suggesting semen quality may provide a marker of health. This study is supported in part by P01HD36289 from the Eunice Kennedy Shriver National Institute for Child Health and Human Development, National Institutes of Health (to D.J.L. and L.I.L.). The project was also partially supported by an NIH CTSA award number UL1 RR025744. None of the authors has any conflict of interest to declare.

Wennberg, David E & Sharp, Sandra M & Bevan, Gwyn & Skinner, Jonathan S & Gottlieb, Daniel J & Wennberg, John E. **A population health approach to reducing observational intensity bias in health risk adjustment: cross sectional analysis of insurance claims.** BMJ. 2014 Apr 10;348:g2392. doi: 10.1136/bmj.g2392.

Notes: None

Abstract: To compare the performance of two new approaches to risk adjustment that are free of the influence of observational intensity with methods that depend on diagnoses listed in administrative databases. Administrative data from the US Medicare program for services provided in 2007 among 306 US hospital referral regions. Cross sectional analysis. 20% sample of fee for service Medicare beneficiaries residing in one of 306 hospital referral regions in the United States in 2007 (n = 5,153,877). The effect of health risk adjustment on age, sex, and race adjusted mortality and spending rates among hospital referral regions using four indices: the standard Centers for Medicare and Medicaid Services--Hierarchical Condition Categories (HCC) index used by the US Medicare program (calculated from diagnoses listed in Medicare's administrative database); a visit corrected HCC index (to reduce the effects of observational intensity on frequency of diagnoses); a poverty index (based on US census); and a population health index (calculated using data on incidence of hip fractures and strokes, and responses from a population based annual survey of health from the Centers for Disease Control and Prevention). Estimated variation in age, sex, and race adjusted mortality rates across hospital referral regions was reduced using the indices based on population health, poverty, and visit corrected HCC, but increased using the standard HCC index. Most of the residual variation in age, sex, and race adjusted mortality was explained (in terms of weighted R2) by the population health index: R2=0.65. The other indices explained less: R2=0.20 for the visit corrected HCC index; 0.19 for the poverty index, and 0.02 for the standard HCC index. The residual variation in age, sex, race, and price adjusted spending per capita across the 306 hospital referral regions explained by the indices (in terms of weighted R2) were 0.50 for the standard HCC index, 0.21 for the population health index, 0.12 for the poverty index, and 0.07 for the visit corrected HCC index, implying that only a modest amount of the variation in spending can be explained by factors most closely related to mortality. Further, once the HCC index is visit corrected it accounts for almost none of the residual variation in age, sex, and race adjusted spending.

Health risk adjustment using either the poverty index or the population health index performed substantially better in terms of explaining actual mortality than the indices that relied on diagnoses from administrative databases; the population health index explained the majority of residual variation in age, sex, and race adjusted mortality. Owing to the influence of observational intensity on diagnoses from administrative databases, the standard HCC index over-adjusts for regional differences in spending. Research to improve health risk adjustment methods should focus on developing measures of risk that do not depend on observation influenced diagnoses recorded in administrative databases.

Shih, Huai-Che & Temkin-Greener, Helena & Votava, Kathryn & Friedman, Bruce. **Medicare home health care patient case-mix before and after the Balanced Budget Act of 1997: effect on dual eligible beneficiaries.** Home Health Care Serv Q. 2014;33(1):58-76. doi: 10.1080/01621424.2013.870100.

Notes: None

Abstract: The Balanced Budget Act (BBA) of 1997 changed the payment system for Medicare home health care (HHC) from cost-based to prospective reimbursement. We used Medical Expenditure Panel Survey data to assess the impact of the BBA on Medicare HHC patient case-mix measured by the Centers for Medicare and Medicaid Services Hierarchical Condition Categories (CMS-HCC) model. There was a significant increase in Medicare HHC patient case-mix between the pre-BBA and Prospective Payment System (PPS) periods. The increase in the standardized-predicted risk score from the Interim Payment System period to PPS was nearly 4 times greater for the dual eligibles (Medicare-Medicaid) than for the Medicare-only population. This significantly greater rise in the HHC resources required by dual eligibles as compared to nonduals could be due to a shift in HHC payers from Medicare only to Medicaid rather than be an actual increase in case-mix per se.

Haas, Lindsey R & Takahashi, Paul Y & Shah, Nilay D & Stroebel, Robert J & Bernard, Matthew E & Finnie, Dawn M & Naessens, James M. **Risk-stratification methods for identifying patients for care coordination.** Am J Manag Care. 2013 Sep;19(9):725-32.

Notes: None

Abstract: Care coordination is a key component of the patient-centered medical home. However, the mechanism for identifying primary care patients who may benefit the most from this model of care is unclear. To evaluate the performance of several risk-adjustment/stratification instruments in predicting healthcare utilization. Retrospective cohort analysis. All adults empaneled in 2009 and 2010 (n = 83,187) in a primary care practice were studied. We evaluated 6 models: Adjusted Clinical Groups (ACGs), Hierarchical Condition Categories (HCCs), Elder Risk Assessment, Chronic Comorbidity Count, Charlson Comorbidity Index, and Minnesota Health Care Home Tiering. A seventh model combining Minnesota Tiering with ERA score was also assessed. Logistic regression models using demographic characteristics and diagnoses from 2009 were used to predict healthcare utilization and costs for 2010 with binary outcomes (emergency department [ED] visits, hospitalizations, 30-day readmissions, and highcost users in the top 10%), using the C statistic and goodness of fit among the top decile. The ACG model outperformed the others in predicting hospitalizations with a C statistic range of 0.67 (CMS-HCC) to 0.73. In predicting ED visits, the C statistic ranged from 0.58 (CMSHCC) to 0.67 (ACG). When predicting the top 10% highest cost users, the performance of the ACG model was good (area under the curve = 0.81) and superior to the others. Although ACG models

generally performed better in predicting utilization, use of any of these models will help practices implement care coordination more efficiently.

Wennberg, John E & Staiger, Douglas O & Sharp, Sandra M & Gottlieb, Daniel J & Bevan, Gwyn & McPherson, Klim & Welch, H Gilbert. **Observational intensity bias associated with illness adjustment: cross sectional analysis of insurance claims.** BMJ. 2013 Feb 21;346:f549. doi: 10.1136/bmj.f549.

Notes: None

Abstract: To determine the bias associated with frequency of visits by physicians in adjusting for illness, using diagnoses recorded in administrative databases. Claims data from the US Medicare program for services provided in 2007 among 306 US hospital referral regions. Cross sectional analysis. 20% sample of fee for service Medicare beneficiaries residing in the United States in 2007 (n=5,153,877). The effect of illness adjustment on regional mortality and spending rates using standard and visit corrected illness methods for adjustment. The standard method adjusts using comorbidity measures based on diagnoses listed in administrative databases; the modified method corrects these measures for the frequency of visits by physicians. Three conventions for measuring comorbidity are used: the Charlson comorbidity index, Iezzoni chronic conditions, and hierarchical condition categories risk scores. The visit corrected Charlson comorbidity index explained more of the variation in age, sex, and race mortality across the 306 hospital referral regions than did the standard index (R(2)=0.21 v 0.11, P<0.001) and, compared with sex and race adjusted mortality, reduced regional variation, whereas adjustment using the standard Charlson comorbidity index increased it. Although visit corrected and age, sex, and race adjusted mortality rates were similar in hospital referral regions with the highest and lowest fifths of visits, adjustment using the standard index resulted in a rate that was 18% lower in the highest fifth (46.4 v 56.3 deaths per 1000, P<0.001). Age, sex, and race adjusted spending as well as visit corrected spending was more than 30% greater in the highest fifth of visits than in the lowest fifth, but only 12% greater after adjustment using the standard index. Similar results were obtained using the Iezzoni and the hierarchical condition categories conventions for measuring comorbidity. The rates of visits by physicians introduce substantial bias when regional mortality and spending rates are adjusted for illness using comorbidity measures based on the observed number of diagnoses recorded in Medicare's administrative database. Adjusting without correction for regional variation in visit rates tends to make regions with high rates of visits seem to have lower mortality and lower costs, and vice versa. Visit corrected comorbidity measures better explain variation in age, sex, and race mortality than observed measures, and reduce observational intensity bias.

Song, Yunjie & Skinner, Jonathan & Bynum, Julie & Sutherland, Jason & Wennberg, John E & Fisher, Elliott S**. Regional variations in diagnostic practices.** N Engl J Med. 2010 Jul 1;363(1):45-53. doi: 10.1056/NEJMsa0910881. Epub 2010 May 12.

Notes: None

Abstract: Current methods of risk adjustment rely on diagnoses recorded in clinical and administrative records. Differences among providers in diagnostic practices could lead to bias. We used Medicare claims data from 1999 through 2006 to measure trends in diagnostic practices for Medicare beneficiaries. Regions were grouped into five quintiles according to the intensity of hospital and physician services that beneficiaries in the region received. We compared trends with respect to diagnoses, laboratory testing, imaging, and the assignment of

Hierarchical Condition Categories (HCCs) among beneficiaries who moved to regions with a higher or lower intensity of practice. Beneficiaries within each quintile who moved during the study period to regions with a higher or lower intensity of practice had similar numbers of diagnoses and similar HCC risk scores (as derived from HCC coding algorithms) before their move. The number of diagnoses and the HCC measures increased as the cohort aged, but they increased to a greater extent among beneficiaries who moved to regions with a higher intensity of practice than among those who moved to regions with the same or lower intensity of practice. For example, among beneficiaries who lived initially in regions in the lowest quintile, there was a greater increase in the average number of diagnoses among those who moved to regions in a higher quintile than among those who moved to regions within the lowest quintile (increase of 100.8%; 95% confidence interval [CI], 89.6 to 112.1; vs. increase of 61.7%; 95% CI, 55.8 to 67.4). Moving to each higher quintile of intensity was associated with an additional 5.9% increase (95% CI, 5.2 to 6.7) in HCC scores, and results were similar with respect to laboratory testing and imaging. Substantial differences in diagnostic practices that are unlikely to be related to patient characteristics are observed across U.S. regions. The use of clinical or claims-based diagnoses in risk adjustment may introduce important biases in comparative-effectiveness studies, public reporting, and payment reforms.

Chukmaitov, Askar S & Harless, David W & Menachemi, Nir & Saunders, Charles & Brooks, Robert G. **How well does diagnosis-based risk-adjustment work for comparing ambulatory clinical outcomes?** Health Care Manag Sci. 2009 Dec;12(4):420-33.

Notes: None

Abstract: This paper examines the empirical consistency of the Diagnosis Cost Groups/Hierarchical Condition Categories (DCG/HCC) risk-adjustment method for comparing 7-day mortality between hospital-based outpatient departments (HOPDs) and freestanding ambulatory surgery centers (ASCs). We used patient level data for the three most common outpatient procedures provided during the 1997-2004 period in Florida. We estimated base-line logistic regression models without any diagnosis-based risk adjustment and compared them to logistic regression models with the DCG/HCC risk-adjustment, and to conditional logit models with a matched cohort risk-adjustment approach. We also evaluated models that adjusted for primary diagnoses only, and then for all available diagnoses, to assess how the frequently absent secondary diagnoses fields in ambulatory surgical data affect risk-adjustment. We found that risk-adjustment using both diagnosis-based methods resulted in similar 7-day mortality estimates for HOPD patients in comparison with ASC patients in two out of three procedures. We conclude that the DCG/HCC risk-adjustment method is relatively consistent and stable, and recommend this risk-adjustment method for health policy research and practice with ambulatory surgery data. We also recommend using risk-adjustment with all available diagnoses.

Mosley, David G & Peterson, Eileen & Martin, David C. **Do hierarchical condition category model scores predict hospitalization risk in newly enrolled Medicare advantage participants as well as probability of repeated admission scores?** J Am Geriatr Soc. 2009 Dec;57(12):2306-10. doi: 10.1111/j.1532-5415.2009.02558.x. Epub 2009 Oct 26.

Notes: None

Abstract: To compare how well hierarchical condition categories (HCC) and probability of repeated admission (P(RA)) scores predict hospitalization. Longitudinal cohort study with 12-month follow-up. A Medicare Advantage (MA) plan. Four thousand five hundred six newly enrolled beneficiaries. HCC scores were identified from enrollment files. The P(RA) tool was administered by mail and telephone. Inpatient admissions were based on notifications. The Mann-Whitney test was used to compare HCC scores of P(RA) responders and nonresponders. The receiver operating characteristic curve provided the area under the curve (AUC) for each score. Admission risk in the top 5% of scores was evaluated using logistic regression. Within 60 days of enrollment, 45.1% of the 3,954 beneficiaries with HCC scores completed the P(RA) tool. HCC scores were lower for the 1,783 P(RA) respondents than the 2,171 nonrespondents (0.71 vs 0.81, P<.001). AUCs predicting hospitalization with regard to HCC and P(RA) were similar (0.638, 95% confidence interval (CI)=0.603-0.674; 0.654, 95% CI=0.618-0.690). Individuals identified in the top 5% of scores using both tools, using HCC alone, or using P(RA) alone had higher risk for hospitalization than those below the 95th percentile (odds ratio (OR)=8.5, 95% CI=3.7-19.4, OR=3.8, 95% CI=2.3-6.3, and OR=3.9, 95% CI=2.3-6.4, respectively). HCC scores provided to MA plans for risk adjustment of revenue can also be used to identify hospitalization risk. Additional studies are required to evaluate whether a hybrid approach incorporating administrative and self-reported models would further optimize risk stratification efforts.

Morse, Alan R & Pyenson, Bruce S. **Medical care cost of Medicare/Medicaid beneficiaries with vision loss.** Ophthalmic Epidemiol. 2009 Jan-Feb;16(1):50-7. doi: 10.1080/09286580802523107.

Notes: None

Abstract: To assess the impact of vision loss on healthcare cost for patients with Medicaid and Medicare and whether these costs are adequately captured by Medicare hierarchical condition categories (HCC) risk adjustment methodology. The public use data set of the Program of All-Inclusive Care for the Elderly (PACE) for 1994-1998, and the Medicare 5% Sample datasets for 2003 and 2004. For the first analysis, up to five years of PACE data for each individual was used to calculate HCC scores (n = 3,459). For the second analysis, claim or encounter data from Medicare Fee-for-Service (FFS) and Medicare Advantage (MA) were used to estimate the cost for each beneficiary in the upcoming payment year (n = 2,108). The increase in medical cost risk overall for visually impaired PACE participants was 10%, increasing to 13% for the non-institutionalized, community-based cohort, but PACE participants in nursing homes with vision loss did not generally result in increased costs. In the Medicare 5% sample, the HCC model under-predicts costs by about 17%. Our analyses provide evidence that healthcare cost risk attributable to vision loss is not adequately captured by Medicare HCC risk adjustment methodology. We hypothesize this is due to additional morbidity and treatment patterns associated with visual impairment.

Hsu, John & Huang, Jie & Fung, Vicki & Price, Mary & Brand, Richard & Hui, Rita & Fireman, Bruce & Dow, William & Bertko, John & Newhouse, Joseph P. **Distributing $800 billion: an early assessment of Medicare Part D risk adjustment.** Health Aff (Millwood). 2009 Jan-Feb;28(1):215-25. doi: 10.1377/hlthaff.28.1.215.

Notes: None

Abstract: The viability and stability of the Medicare Part D prescription drug program depend on accurate risk-adjusted payments. The current approach, prescription drug hierarchical condition

categories (RxHCCs), uses diagnosis and demographic information to predict future drug costs. We evaluated the performance of multiple approaches for predicting 2006 Part D drug costs and plan liability. RxHCCs explain 12 percent of the variation in actual drug costs, overpredict costs for beneficiaries with low actual costs, and underpredict costs for beneficiaries with high actual costs. Combining RxHCCs with individual-level information on prior-year drug use greatly improves performance and decreases incentives for plans to select against bad risks.

Noyes, Katia & Liu, Hangsheng & Temkin-Greener, Helena. **Medicare capitation model, functional status, and multiple comorbidities: model accuracy.** Am J Manag Care. 2008 Oct;14(10):679-90.

Notes: None

Abstract: To examine financial implications of the Centers for Medicare & Medicaid Services Hierarchical Condition Categories (CMS-HCC) risk-adjustment model on Medicare payments for individuals with comorbid chronic conditions. The study used 1992-2000 data from the Medicare Current Beneficiary Survey and corresponding Medicare claims. Pairs of comorbidities were formed based on prior evidence about possible synergy between these conditions and activities of daily living (ADLs) deficiencies, and included heart disease and cancer, lung disease and cancer, stroke and hypertension, stroke and arthritis, congestive heart failure (CHF) and osteoporosis, diabetes and coronary artery disease, and CHF and dementia. For each beneficiary, we calculated the actual Medicare cost ratio as the ratio of the individual's annualized costs to the mean annual Medicare cost for all people in the study. The actual Medicare cost ratios, by ADLs, were compared with HCC ratios under the CMS-HCC payment model. Using multivariate regression models, we tested whether having the identified pairs of comorbidities affected the accuracy of CMS-HCC model predictions. The CMS-HCC model underpredicted Medicare capitation payments for patients with hypertension, lung disease, CHF, and dementia. The difference between the actual costs and predicted payments was partially explained by beneficiary functional status and less-than-optimal adjustment for these chronic conditions. Information about beneficiary functional status should be incorporated in reimbursement models. Underpaying providers who care for populations with multiple comorbidities may provide severe disincentives for managed care plans to enroll such individuals and to appropriately manage their complex and costly conditions.

Briesacher, Becky A & Andrade, Susan E & Fouayzi, Hassan & Chan, K Arnold. **Comparison of drug adherence rates among patients with seven different medical conditions.** Pharmacotherapy. 2008 Apr;28(4):437-43. doi: 10.1592/phco.28.4.437.

Notes: None

Abstract: To compare drug adherence rates among patients with gout, hypercholesterolemia, hypertension, hypothyroidism, osteoporosis, seizure disorders, and type 2 diabetes mellitus by using a standardized approach. Longitudinal study. Health care claims data from 2001-2004. A total of 706,032 adults aged 18 years or older with at least one of the seven medical conditions and with incident use of drug therapy for that condition. Drug adherence was measured as the sum of the days' supply of drug therapy over the first year observed. Covariates were age, sex, geographic residence, type of health plan, and a comorbidity score calculated by using the Hierarchical Condition Categories risk adjuster. Bivariate statistics and stratification analyses were used to assess unadjusted means and frequency distributions. Sample sizes ranged from 4984 subjects for seizure disorders to 457,395 for hypertension. During the first year of drug

therapy, 72.3% of individuals with hypertension achieved adherence rates of 80% or better compared with 68.4%, 65.4%, 60.8%, 54.6%, 51.2%, or 36.8% for those with hypothyroidism, type 2 diabetes, seizure disorders, hypercholesterolemia, osteoporosis, or gout, respectively. Age younger than 60 years was associated with lower adherence across all diseases except seizure disorders. Comorbidity burden and adherence varied by disease. As comorbidity increased, adherence among subjects with osteoporosis decreased, whereas adherence among those with hypertension, hypercholesterolemia, or gout increased. Add-on drug therapies and previous experience with taking drugs for the condition increased adherence among subjects with hypertension, type 2 diabetes, hypothyroidism, or seizure disorders but not the other conditions. This uniform comparison of drug adherence revealed modest variation across six of seven diseases, with the outlier condition being gout.

Kautter, John & Ingber, Melvin & Pope, Gregory C. **Medicare risk adjustment for the frail elderly**. Health Care Financ Rev. 2008 Winter;30(2):83-93.

Notes: None

Abstract: CMS has had a continuing interest in exploring ways to incorporate frailty adjustment into the CMS Hierarchical Condition Categories (CMS-HCC) risk adjustment methodology for Medicare Advantage and other Medicare private organizations. In this article we present research results for Medicare risk adjustment of the frail elderly since the adoption of frailty adjustment for Program of All-Inclusive Care for the Elderly (PACE) organizations in 2004. In particular, we present results on the revised frailty adjuster that is being phased in for PACE organizations between 2008 and 2012.

Noyes, Katia & Liu, Hangsheng & Temkin-Greener, Helena. **Cost of caring for Medicare beneficiaries with Parkinson's disease: impact of the CMS-HCC risk-adjustment model**. Dis Manag. 2006 Dec;9(6):339-48.

Notes: None

Abstract: Previous studies have demonstrated that Medicare risk-adjusted capitation models do not adequately compensate programs serving primarily disabled or frail populations. Using the Medicare Current Beneficiary Survey, we demonstrate that the Centers for Medicare and Medicaid Services-Hierarchical Condition Categories (CMS-HCC) model calculates Medicare capitation payments for Parkinson's patients more accurately than for the general population. The discrepancies between the predicted and actual expenditures estimated at various disability levels were smaller for Parkinson's patients than for other beneficiaries. If the CMS-HCC payment model were to apply to programs that draw a significant percentage of their participants from the Parkinson's disease community, these programs likely would be compensated fairly.

Pope, Gregory C & Kautter, John & Ellis, Randall P & Ash, Arlene S & Ayanian, John Z & Lezzoni, Lisa I & Ingber, Melvin J & Levy, Jesse M & Robst, John**. Risk adjustment of Medicare capitation payments using the CMS-HCC model.** Health Care Financ Rev. 2004 Summer;25(4):119-41.

Notes: None

Abstract: This article describes the CMS hierarchical condition categories (HCC) model implemented in 2004 to adjust Medicare capitation payments to private health care plans for

the health expenditure risk of their enrollees. We explain the model's principles, elements, organization, calibration, and performance. Modifications to reduce plan data reporting burden and adaptations for disabled, institutionalized, newly enrolled, and secondary payer subpopulations are discussed.

Mark, Tami L & Ozminkowski, Ronald J & Kirk, Adele & Ettner, Susan L & Drabek, John. **Risk adjustment for people with chronic conditions in private sector health plans.** Med Decis Making. 2003 Sep-Oct;23(5):397-405.

Notes: None

Abstract: Although the problem of adverse selection into more generous health insurance plans has been the focus of previous work, risk adjustment systems have only recently begun to be implemented to blunt its effect. This study examines the ability of the leading risk adjustment systems to predict health care expenditures for people with chronic conditions, using claims and enrollment data from 2 large employers. Predictive errors and total financial losses/gains are compared for different risk adjustment approaches (primarily hierarchical condition categories [HCCs] and adjusted clinical groups) for several chronic conditions. One of the best performing risk adjustment systems was a regression-based HCC method, which had an average under-prediction error rate of 9% or 6%, depending on the employer. In comparison, more typical actuarial risk adjustments based on just age, gender, and prevailing area wages lead to a prediction error of at least 50%. We did not find evidence that payments for particular chronic conditions would be consistently and significantly under- or overestimated. The leading risk adjustment approaches substantially reduce the incentives for adverse selection but do not eliminate them.

Sales, Anne E & Liu, Chuan-Fen & Sloan, Kevin L & Malkin, Jesse & Fishman, Paul A & Rosen, Amy K & Loveland, Susan & Paul Nichol, W & Suzuki, Norman T & Perrin, Edward & Sharp, Nancy D & Todd-Stenberg, Jeffrey. **Predicting costs of care using a pharmacy-based measure risk adjustment in a veteran population.** Med Care. 2003 Jun;41(6):753-60.

Notes: None

Abstract: Although most widely used risk adjustment systems use diagnosis data to classify patients, there is growing interest in risk adjustment based on computerized pharmacy data. The Veterans Health Administration (VHA) is an ideal environment in which to test the efficacy of a pharmacy-based approach. To examine the ability of RxRisk-V to predict concurrent and prospective costs of care in VHA and compare the performance of RxRisk-V to a simple age/gender model, the original RxRisk, and two leading diagnosis-based risk adjustment approaches: Adjusted Clinical Groups and Diagnostic Cost Groups/Hierarchical Condition Categories. The study population consisted of 161,202 users of VHA services in Washington, Oregon, Idaho, and Alaska during fiscal years (FY) 1996 to 1998. We examined both concurrent and predictive model fit for two sequential 12-month periods (FY 98 and FY 99) with the patient-year as the unit of analysis, using split-half validation. Our results show that the Diagnostic Cost Group /Hierarchical Condition Categories model performs best (R2 = 0.45) among concurrent cost models, followed by ADG (0.31), RxRisk-V (0.20), and age/sex model (0.01). However, prospective cost models other than age/sex showed comparable R2: Diagnostic Cost Group /Hierarchical Condition Categories R2 = 0.15, followed by ADG (0.12), RxRisk-V (0.12), and age/sex (0.01). RxRisk-V is a clinically relevant, open source risk adjustment system that is easily

tailored to fit specific questions, populations, or needs. Although it does not perform better than diagnosis-based measures available on the market, it may provide a reasonable alternative to proprietary systems where accurate computerized pharmacy data are available.

Ettner, S L & Frank, R G & McGuire, T G & Hermann, R C. **Risk adjustment alternatives in paying for behavioral health care under Medicaid.** Health Serv Res. 2001 Aug;36(4):793-811.

Notes: None

Abstract: To compare the performance of various risk adjustment models in behavioral health applications such as setting mental health and substance abuse (MH/SA) capitation payments or overall capitation payments for populations including MH/SA users. The 1991-93 administrative data from the Michigan Medicaid program were used. We compared mean absolute prediction error for several risk adjustment models and simulated the profits and losses that behavioral health care carve outs and integrated health plans would experience under risk adjustment if they enrolled beneficiaries with a history of MH/SA problems. Models included basic demographic adjustment, Adjusted Diagnostic Groups, Hierarchical Condition Categories, and specifications designed for behavioral health. Differences in predictive ability among risk adjustment models were small and generally insignificant. Specifications based on relatively few MH/SA diagnostic categories did as well as or better than models controlling for additional variables such as medical diagnoses at predicting MH/SA expenditures among adults. Simulation analyses revealed that among both adults and minors considerable scope remained for behavioral health care carve outs to make profits or losses after risk adjustment based on differential enrollment of severely ill patients. Similarly, integrated health plans have strong financial incentives to avoid MH/SA users even after adjustment. Current risk adjustment methodologies do not eliminate the financial incentives for integrated health plans and behavioral health care carve-out plans to avoid high-utilizing patients with psychiatric disorders.

Ettner, S L & Frank, R G & Mark, T & Smith, M W. **Risk adjustment of capitation payments to behavioral health care carve-outs: how well do existing methodologies account for psychiatric disability**? Health Care Manag Sci. 2000 Feb;3(2):159-69.

Notes: None

Abstract: This study used 1994-1995 administrative data from a large public employer to examine the viability of commercial risk adjustment systems for setting capitation payments to competing behavioral health care "carve-outs". The ability of Hierarchical Condition Categories and Adjusted Diagnostic Groups to predict psychiatric expenditures was improved by controlling separately for psychiatric disability. However, even the best models underpredicted expenditures of patients with psychiatric disability by 15%. Relative to full capitation, "mixed" payment systems and soft capitation reduce the ability of carve-outs to earn disproportionate profits by enrolling healthy patients and avoiding sick ones, yet also diminish incentives for cost containment.

Beaubrun AC(1), Kanda E, Bond TC, McClellan WM. **Form CMS-2728 data versus erythropoietin claims data: implications for quality of care studies. Ren Fail. 2013;35(3):320-6.** doi: 10.3109/0886022X.2012.747967. Epub 2012 Dec 11.

Notes: None

Abstract: Medical Evidence Report Form CMS-2728 data is frequently used to study US dialysis patients, but the validity of these data have been called into question. We compared predialysis erythropoietin use as recorded on Form CMS-2728 with claims data as part of an assessment of quality of care among hemodialysis patients. Medicare claims were linked to Form CMS-2728 data for 18,870 patients. Dialysis patients, 67 years old or older, who started dialysis from 1 June 2005 to 31 May 2007 were eligible. Logistic and multivariate regressions were used to compare the use of either Form CMS-2728 or the corresponding claims data to predict mortality and the probability of meeting target hemoglobin levels. The sensitivity, specificity, and kappa coefficient for the predialysis erythropoietin indicator were 58.0%, 78.4%, and 0.36, respectively. Patients with a predialysis erythropoietin claim were less likely to die compared with patients without a claim (odds ratio = 0.80 and 95% confidence interval = 0.74-0.87), but there was no relationship observed between predialysis care and death using only Form CMS-2728 predictors. At the facility level, a predialysis erythropoietin claim was associated with a 0.085 increase in the rate of meeting target hemoglobin levels compared with patients without a claim (p = 0.041), but no statistically significant relationship was observed when using the Form CMS-2728 indicators. The agreement between Form CMS-2728 and claims data is poor and discordant results are observed when comparing the use of these data sources to predict health outcomes. Facilities with higher agreement between the two data sources may provide greater quality of care.

Solid CA(1), Collins AJ, Ebben JP, Chen SC, Faravardeh A, Foley RN, Ishani A. **Agreement of reported vascular access on the medical evidence report and on medicare claims at hemodialysis initiation.** BMC Nephrol. 2014 Feb 8;15:30. doi: 10.1186/1471-2369-15-30.

Notes: None

Abstract: BACKGROUND: The choice of vascular access type is an important aspect of care for incident hemodialysis patients. However, data from the Centers for Medicare & Medicaid Services (CMS) Medical Evidence Report (form CMS-2728) identifying the first access for incident patients have not previously been validated. Medicare began requiring that vascular access type be reported on claims in July 2010. We aimed to determine the agreement between the reported vascular access at initiation from form CMS-2728 and from Medicare claims. METHODS: This retrospective study used a cohort of 9777 patients who initiated dialysis in the latter half of 2010 and were eligible for Medicare at the start of renal replacement therapy to compare the vascular access type reported on form CMS-2728 with the type reported on Medicare outpatient dialysis claims for the same patients. For each patient, the reported access from each data source was compiled; the percent agreement represented the percent of patients for whom the access was the same. Multivariate logistic analysis was performed to identify characteristics associated with the agreement of reported access. RESULTS: The two data sources agreed for 94% of patients, with a Kappa statistic of 0.83, indicating an excellent level of agreement. Further, we found no evidence to suggest that agreement was associated with the patient characteristics of age, sex, race, or primary cause of renal failure. CONCLUSION: These results suggest that vascular access data as reported on form CMS-2728 are valid and reliable for use in research studies.

Kim JP(1), Desai M, Chertow GM, Winkelmayer WC. **Validation of reported predialysis nephrology care of older patients initiating dialysis.** J Am Soc Nephrol. 2012 Jun;23(6):1078-85. doi: 10.1681/ASN.2011080871. Epub 2012 Apr 19.

Notes: None

Abstract: The Centers for Medicare and Medicaid Services (CMS) Medical Evidence Report (form CMS-2728) queries providers about the timing of the patient's first nephrologist consultation before initiation of dialysis. The monitoring of disease-specific goals in the Healthy People 2020 initiative will use information from this question, but the accuracy of the reported information is unknown. We defined a cohort of 80,509 patients aged ≥67 years who initiated dialysis between July 2005 and December 2008 with ≥2 years of uninterrupted Medicare coverage as their primary payer. The primary referent, determined from claims data, was the first observed outpatient nephrologist consultation; secondary analyses used the earliest nephrology consultation, whether inpatient or outpatient. We used linear regression models to assess the associations among the magnitude of discrepant reporting and patient characteristics and we tested for any temporal trends. When using the earliest recorded outpatient nephrology encounter, agreement between the two sources of ascertainment was 48.2%, and the κ statistic was 0.29 when we categorized the timing of the visit into four periods (never, <6, 6-12, and >12 months). When we dichotomized the timing of first predialysis nephrology care at >12 or ≤12 months, accuracy was 70% (κ=0.36), but it differed by patient characteristics and declined over time. In conclusion, we found substantial disagreement between information from the CMS Medical Evidence Report and Medicare physician claims on the timing of first predialysis nephrologist care. More-specific instructions may improve reporting and increase the utility of form CMS-2728 for research and public health surveillance.

Fischer MJ(1), Stroupe KT, Hynes DM, Blemur P, Sohn MW, Browning MM, Huo Z,O'Hare AM, Kaufman JS. **Validation of erythropoietin use data on Medicare's End-Stage Renal Disease Medical Evidence Report.** J Rehabil Res Dev. 2010;47(8):751-62.

Notes: None

Abstract: Data from Medicare's End-Stage Renal Disease Medical Evidence Report (Form 2728) suggest that underuse of erythropoiesis-stimulating agents (ESAs) may be contributing to anemia in predialysis patients. However, the data quality of Form 2728 is not known. ESA prescription records were confirmed in Department of Veterans Affairs (VA) data sets and/or ESA claims in Medicare files and compared with data collected on Form 2728 among 8,033 veterans who initiated dialysis in 2000 and 2001 and were eligible for both VA and Medicare coverage in the 12 months preceding dialysis initiation. Among the cohort, predialysis ESA use was found in 4% (n = 323) more veterans by VA/Medicare data sets (n = 2,810) than by Form 2728 (n = 2,487). With the use of VA/Medicare data sets (gold standard), the accuracy of Form 2728 for predialysis ESA use was sensitivity 57.0%, specificity 83.1%, positive predictive value 64.5%, negative predictive value 78.2%, and kappa coefficient 0.41. Sensitivity for reported predialysis ESA use on Form 2728 was lowest among veterans who were female and nonwhite, of low socioeconomic status, and with anemia or other comorbid illnesses. The poor sensitivity and specificity of predialysis ESA use data on Form 2728 raise concerns about the validity of previous reports and study findings. Investigators should recognize these shortcomings and the introduction of possible bias in future research and reports.

Longenecker JC(1), Coresh J, Klag MJ, Levey AS, Martin AA, Fink NE, Powe NR. **Validation of comorbid conditions on the end-stage renal disease medical evidence report: the CHOICE study. Choices for Healthy Outcomes in Caring for ESRD.** J Am Soc Nephrol. 2000 Mar;11(3):520-9.

Notes: None

Abstract: Since 1995, the Medical Evidence Report for end-stage renal disease (Form 2728) has been used nationally to collect information on comorbid conditions. To date, these data have not been validated. A national cross-sectional study of 1005 incident dialysis patients (734 hemodialysis and 271 peritoneal dialysis) enrolled between October 1995 and June 1998 was conducted using clinical data to validate 17 comorbid conditions on Form 2728. Sensitivity and specificity were calculated for each condition. The relationship between patient characteristics and sensitivity was assessed in multivariate analysis. Sensitivity was fairly high (0.67 to 0.83) for HIV disease, diabetes, and hypertension; intermediate (0.40 to 0.52) for peripheral vascular disease, neoplasm, myocardial infarction, cerebrovascular disease, coronary artery disease, cardiac arrest, and congestive heart failure; and poor (<0.36) for dysrhythmia, ambulation status, pericarditis, chronic obstructive pulmonary disease, and smoking. Sensitivity did not change significantly over calendar time. The sensitivity of Form 2728 averaged across all 17 conditions was 0.59 (95% confidence interval, 0.43 to 0.75). The average sensitivity was 0.10 greater in peritoneal dialysis than hemodialysis patients. 0.11 greater in diabetic patients than non diabetic patients, and 0.04 less with each added comorbid condition. The specificity was very good for hypertension (0.91) and excellent (>0.95) for the other 16 conditions. Comorbid conditions are significantly underreported on Form 2728, but diagnoses are not falsely attributed to patients. Scientific research, quality of care comparisons, and payment policies that use Form 2728 data should take into account these limitations. Considerable effort should be expended to improve Form 2728 coding if it is to provide accurate estimates of total disease burden in end-stage renal disease patients.

Miskulin D1, Bragg-Gresham J, Gillespie BW, Tentori F, Pisoni RL, Tighiouart H, Levey AS, Port FK. Key **comorbid conditions that are predictive of survival among hemodialysis patients.** Clin J Am Soc Nephrol. 2009 Nov;4(11):1818-26. doi: 10.2215/CJN.00640109. Epub 2009 Sep 24.

Notes: None

Abstract: BACKGROUND AND OBJECTIVES: Abstracting information about comorbid illnesses from the medical record can be time-consuming, particularly when a large number of conditions are under consideration. We sought to determine which conditions are most prognostic and whether comorbidity continues to contribute to a survival model once laboratory and clinical parameters have been accounted for.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: Comorbidity data were abstracted from the medical records of Dialysis Outcomes and Practice Pattern Study (DOPPS) I, II, and III participants using a standardized questionnaire. Models that were composed of different combinations of comorbid conditions and case-mix factors were compared for explained variance (R(2)) and discrimination (c statistic).

RESULTS: Seventeen comorbid conditions account for 96% of the total explained variance that would result if 45 comorbidities that were expected to be predictive of survival were added to a demographics-adjusted survival model. These conditions together had more discriminatory power (c statistic 0.67) than age alone (0.63) or serum albumin (0.60) and were equivalent to a combination of routine laboratory and clinical parameters (0.67). The strength of association of the individual comorbidities lessened when laboratory/clinical parameters were added, but all

remained significant. The total R(2) of a model adjusted for demographics and laboratory/clinical parameters increased from 0.13 to 0.17 upon addition of comorbidity.

CONCLUSIONS: A relatively small list of comorbid conditions provides equivalent discrimination and explained variance for survival as a more extensive characterization of comorbidity. Comorbidity adds to the survival model a modest amount of independent prognostic information that cannot be substituted by clinical/laboratory parameters.

Salter ML(1), Orandi B(2), McAdams-DeMarco MA(3), Law A(3), Meoni LA(4), Jaar BG(5), Sozio SM(6), Kao WH(7), Parekh RS(8), Segev DL(9). **Patient- and Provider-Reported Information about Transplantation and Subsequent Waitlisting**. J Am Soc Nephrol. 2014 Dec;25(12):2871-7. doi: 10.1681/ASN.2013121298. Epub 2014 Aug 28.

Notes: None

Abstract: Because informed consent requires discussion of alternative treatments, proper consent for dialysis should incorporate discussion about other renal replacement options including kidney transplantation (KT). Accordingly, dialysis providers are required to indicate KT provision of information (KTPI) on CMS Form-2728; however, provider-reported KTPI does not necessarily imply adequate provision of information. Furthermore, the effect of KTPI on pursuit of KT remains unclear. We compared provider-reported KTPI (Form-2728) with patient-reported KTPI (in-person survey of whether a nephrologist or dialysis staff had discussed KT) in a prospective ancillary study of 388 hemodialysis initiates. KTPI was reported by both patient and provider for 56.2% of participants, by provider only for 27.8%, by patient only for 8.3%, and by neither for 7.7%. Among participants with provider-reported KTPI, older age was associated with lack of patient-reported KTPI. Linkage with the Scientific Registry for Transplant Recipients showed that 20.9% of participants were subsequently listed for KT. Patient-reported KTPI was independently associated with a 2.95-fold (95% confidence interval [95% CI], 1.54 to 5.66; P=0.001) higher likelihood of KT listing, whereas provider-reported KTPI was not associated with listing (hazard ratio, 1.18; 95% CI, 0.60 to 2.32; P=0.62). Our findings suggest that patient perception of KTPI is more important for KT listing than provider-reported KTPI. Patient-reported and provider-reported KTPI should be collected for quality assessment in dialysis centers because factors associated with discordance between these metrics might inform interventions to improve this process.

Layton JB1, Hogan SL, Jennette CE, Kenderes B, Krisher J, Jennette JC, McClellan WM. **Discrepancy between Medical Evidence Form 2728 and renal biopsy for glomerular diseases.** Clin J Am Soc Nephrol. 2010 Nov;5(11):2046-52. doi: 10.2215/CJN.03550410. Epub 2010 Aug 5.

Notes: None

Abstract: BACKGROUND AND OBJECTIVES:

The United States Renal Data System (USRDS) is a commonly utilized database for epidemiologic research of ESRD patients. USRDS uses Medical Evidence Form 2728 to collect medical information about ESRD patients. The validity of the Form 2728 "primary cause of renal failure" field for glomerular diseases has not been evaluated, although inconsistencies between Form 2728 information and medical records have been documented previously with respect to comorbidities.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS:

Form 2728 information was linked with renal biopsy results from the Glomerular Disease Collaborative Network (GDCN) for 217 patients with biopsy-confirmed glomerular diseases who had reached ESRD. Biopsy results were compared with the Form 2728 "primary cause of renal failure" field. Diseases were considered individually, and also categorized into commonly used disease groups. Percentage of agreement and disease-specific measures of validity were calculated.

RESULTS:

Overall agreement between renal biopsy and Form 2728 was low (14.8% overall, 23.0% when categorized). Agreement was better after Form 2728 was revised in 1995 (10.0% before versus 23.2% after overall). The cause of ESRD field was left blank in 57% of the forms submitted for glomerular disease patients. Individual glomerular diseases had very low specificities, but tended to have high positive predictive values.

CONCLUSIONS:

Form 2728 does not accurately reflect the renal pathology diagnosis as captured by biopsy. The large degree of missing data and misclassification should be of concern to those performing epidemiologic research using Form 2728 information on glomerular diseases.

Merkin SS1, Cavanaugh K, Longenecker JC, Fink NE, Levey AS, Powe NR. **Agreement of self-reported comorbid conditions with medical and physician reports varied by disease among end-stage renal disease patients**. J Clin Epidemiol. 2007 Jun;60(6):634-42. Epub 2006 Dec 11.

Notes: None

Abstract: To compare self-report of eight diseases with review of medical records and physician reports.

STUDY DESIGN AND SETTING:

In a cohort of 965 incident end-stage renal disease (ESRD) patients (Choices for Healthy Outcomes in Caring for End-stage renal disease study), data on existing medical conditions were obtained from medical record abstraction, physician report (CMS Form 2728), and self-report in a baseline questionnaire. We evaluated agreement with kappa statistics (k) and sensitivity of self-report. Regression models were used to examine characteristics associated with agreement.

RESULTS:

The results showed excellent or substantial agreement between self-report and the medical record for diabetes (k=0.93) and coronary artery intervention (k=0.79), and poor agreement for chronic obstructive pulmonary disease (k=0.20). Physician-reported prevalence for all diseases was equal or lower than that by self-report. Male patients were more likely to inaccurately report hypertension. Compared to white patients, African American patients were more likely to inaccurately report cardiovascular diseases.

CONCLUSION:

In ESRD patients, self-report agreement with the medical record varies with the specific disease. Awareness of diseases of the cardiovascular system appears to be low. African American and male ESRD patients are at risk of low awareness of disease and educational interventions are needed in this high-risk population

Davidoff AJ(1), Gardner LD, Zuckerman IH, Hendrick F, Ke X, Edelman MJ. **Validation of disability status, a claims-based measure of functional status for cancer treatment and outcomes studies.** Med Care. 2014 Jun;52(6):500-10. doi: 10.1097/MLR.0000000000000122.

Notes: Use of claims date to calculate Charlson Comorbidity Index

Abstract: BACKGROUND: In prior research, we developed a claims-based prediction model for poor patient disability status (DS), a proxy measure for performance status, commonly used by oncologists to summarize patient functional status and assess ability of a patient to tolerate aggressive treatment. In this study, we implemented and validated the DS measure in 4 cohorts of cancer patients: early and advanced non-small cell lung cancers (NSCLC), stage IV estrogen receptor-negative (ER-) breast cancer, and myelodysplastic syndromes (MDS).

DATA AND METHODS: SEER-Medicare data (1999-2007) for the 4 cohorts of cancer patients. Bivariate and multivariate logistic regression tested the association of the DS measure with designated cancer-directed treatments: early NSCLC (surgery), advanced NSCLC (chemotherapy), stage IV ER- breast cancer (chemotherapy), and MDS (erythropoiesis-stimulating agents). Treatment model fit was compared across model iterations.

RESULTS: In both unadjusted and adjusted results, predicted poor DS was strongly associated with a lower likelihood of cancer treatment receipt in all 4 cohorts [early NSCLC (N=20,280), advanced NSCLC (N=31,341), stage IV ER- breast cancer (N=1519), and MDS (N=6058)] independent of other patient, contextual, and disease characteristics, as well as the Charlson Comorbidity Index. Inclusion of the DS measure into models already controlling for other variables did not significantly improve model fit across the cohorts.

CONCLUSIONS: The DS measure is a significant independent predictor of cancer-directed treatment. Small changes in model fit associated with both DS and the Charlson Comorbidity Index suggest that unobserved factors continue to play a role in determining cancer treatments.

Kim Le T(1), Winfree KB, Yang H, Marynchenko M, Yu AP, Frois C, Wu EQ. **Treatment patterns and economic burden of metastatic and recurrent locally-advanced head and neck cancer patients.** J Med Econ. 2012;15(4):786-95. doi: 10.3111/13696998.2012.682632. Epub 2012 Apr 20.

Notes: Use of Medicare claims to calculate Charlson Comorbidity Index

Abstract: OBJECTIVE: To characterize treatment patterns and measure the economic burden associated with metastatic (mHNC) and recurrent, locally-advanced head and neck cancer (rHNC).

METHODS: Administrative claims from Medicare- and privately-insured individuals during 2004-2008 were used in this retrospective database study of patients with advanced HNC. Patients diagnosed with HNC were matched 1:1 to cancer-free controls to measure the incremental economic burden of HNC. Outcomes of interest were measured during the 6 months following the date of a secondary tumor diagnosis for metastatic patients or the date of a diagnosis

indicating rHNC. To assess treatment patterns, HNC patients were evaluated for the use frequency of treatments (radiotherapy, chemotherapy and surgery). Costs were reported in 2008 US$ from a third-party payer perspective and were analyzed using generalized linear models and two-part regression models adjusting for differences in age and baseline Charlson Comorbidity Index (excluding cancer diagnoses) between the HNC and control cohorts. Components of cost included inpatient, outpatient and other medical services as well as pharmacy costs.

RESULTS: The mHNC cohort consisted of 1042 patients and the rHNC cohort included 324 patients. The most common treatments for mHNC patients were supportive care (90.2%), radiation therapy (48.5%), surgery (41.9%) and chemotherapy (38.3%). Patients with rHNC frequently received HNC-related supportive care (71.0%), radiation therapy (67.9%) and chemotherapy (27.2%); HNC-related surgery was infrequent (12.7%) during the study period. The 6-month incremental adjusted total costs were $60,414 per patient for mHNC and $21,141 per patient for rHNC ($p<0.0001$). Approximately 46-58% of the incremental cost was attributable to outpatient visits, 27-37% to inpatient costs and 11-13% to pharmacy, depending on the HNC cohort.

LIMITATIONS: The identification of mHNC/rHNC was based on diagnosis codes and treatment patterns with the limitation of the claims database.

CONCLUSIONS: Metastatic and recurrent, locally-advanced HNC patients frequently receive cancer-related treatments and incur substantial economic burden.

Chen S(1), Plauschinat CA, Wu N, Fraser K, Boulanger L. **Economic impact of using inhaled corticosteroids without prior exacerbation among elderly patients with chronic obstructive pulmonary disorder**. J Med Econ. 2011;14(4):458-62. doi: 10.3111/13696998.2011.588981. Epub 2011 Jun 9.

Notes: Use of claims to calculate Charlson Comorbidity Index

Abstract: OBJECTIVE: To assess the economic impact of initiating inhaled corticosteroids

(ICS) without evidence of prior exacerbation among elderly patients with chronic obstructive pulmonary disease (COPD) in the US.

METHODS: This retrospective study used administrative claims to identify newly diagnosed COPD patients between 1/1/2005 and 6/30/2006 who were dispensed ICS. The dispense date of the first ICS was set as the index date. Patients with prior diagnoses for asthma, cystic fibrosis, or lung cancer were excluded. Cohorts were constructed based on whether ICS therapy was concordant with recommended guidelines of having prior COPD exacerbation. Each COPD patient with prior exacerbation was matched to four patients without exacerbation based on age, gender, Charlson Comorbidity Index, and whether COPD diagnosis code was not elsewhere specified (i.e., 496). Multivariate regressions were estimated to assess the association between use of ICS therapy without prior exacerbation and total healthcare costs, controlling for demographics and clinical characteristics.

RESULTS: The study included 3650 patients: 730 with prior exacerbation and 2920 without prior exacerbation. Patients were 76 years of age and 54% were male. Those with prior exacerbation were more likely to have inpatient stays both prior to (74.4 vs. 44.1%, $p<0.05$) and following (37.0 vs. 33.1%, $p<0.05$) the index date. Controlling for patient characteristics, patients who

were dispensed ICS without prior exacerbation had $1859 higher in total costs (p<0.05) compared to patients with prior exacerbation during the 12 months following ICS initiation.

LIMITATIONS: The retrospective design of this study limits the interpretation of findings as association and not causality. This study is subject to selection bias due to unobservable confounders.

CONCLUSIONS: Among COPD patients, initiation of ICS without prior exacerbation appears to be associated with increased healthcare costs. These findings suggest that ICS initiation without evidence of exacerbation as consistent with guidelines is associated with adverse economic consequences.

Unützer J(1), Schoenbaum M, Katon WJ, Fan MY, Pincus HA, Hogan D, Taylor J. **Healthcare costs associated with depression in medically Ill fee-for-service medicare participants.** J Am Geriatr Soc. 2009 Mar;57(3):506-10. doi: 10.1111/j.1532-5415.2008.02134.x. Epub 2009 Jan 16.

Notes: Use of Medicare claims to calculate Charlson Comorbidity Index

Abstract:

OBJECTIVES: To examine the association between depression and healthcare costs in medically ill fee-for-service (FFS) Medicare recipients.

STUDY DESIGN: Observational analysis of Medicare claims data.

SETTING: Medicare Health Support (MHS) program at Green Ribbon Health. PARTICIPANTS: Fourteen thousand nine hundred two participants with diabetes mellitus, congestive heart failure (CHF), or both.

MEASUREMENTS: This study examined participant data for a 12-month period before MHS enrollment (collected between November 2004 and August 2006). Twelve-month healthcare costs (based on Medicare claims) in 2,108 participants with International Classification of Diseases, Ninth Revision, claims diagnoses of depression, 1,081 participants with possible depression (positive depression screen on the two-item Patient Health Questionnaire or self reported antidepressant use), and 11,713 participants without depression were compared. Gamma regression models were used to adjust for demographic and clinical differences and nonnormal distribution of cost data. RESULTS: Participants with depression had significantly higher total healthcare costs than those without ($20,046 vs $11,956; P<.01). Higher costs were observed in participants with depression in every cost category except specialty mental health care, which accounted for less than 1% of total healthcare costs. Participants with depression had higher costs in each quartile of increasing medical severity (measured using the Charlson Comorbidity Index). These differences remained statistically significant after adjusting for demographic and other clinical differences.

CONCLUSION: Depression is associated with significantly higher healthcare costs in FFS Medicare recipients with diabetes mellitus and CHF. Only a small proportion of the increased costs are spent on mental health specialty care.

Mucha L(1), Shaohung S, Cuffel B, McRae T, Mark TL, Del Valle M. **Comparison of cholinesterase inhibitor utilization patterns and associated healthcare costs in Alzheimer's disease.** J Manag Care Pharm. 2008 Jun;14(5):451-61.

Notes: None

Abstract:

BACKGROUND: Sustained treatment with a cholinesterase inhibitor (ChEI) is used in the management of the symptoms of Alzheimer's disease (AD). However, the characteristic declines in learning and memory seen in AD may erode the patient's ability to adhere to medication regimens with or without caregiver support.

OBJECTIVES: To examine differences by type of ChEI in (1) monthly prevalence of use, (2) nonpersistence, (3) switching from the index drug to another ChEI, (4) number of days on therapy, (5) medication possession ratio (MPR), and (6) an estimate of the relationship of these characteristics to total annual health care expenditures.

METHODS: Data were from the MarketScan Medicare Supplemental and Coordination of Benefits 2001-2003 database, which comprised 1.47 million Medicare beneficiaries during this 3-year time period. Inclusion criteria were: (1) aged 65 years or older; (2) at least 1 claim with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 331.0 for AD in any of 15 diagnosis fields on outpatient claims or any of 2 diagnosis fields on inpatient claims at any time during 18 months of observation; (3) at least 1 pharmacy claim for donepezil, galantamine, or rivastigmine preceded by a 6-month period without a ChEI claim; and (4) at least 12 months of follow-up data, for a minimum 18 months continuous enrollment. Multivariate analyses, including logistic regression and exponential conditional mean models, tested for cohort differences in ChEI utilization, controlling for demographics, region of the country, type of insurer, and the Charlson Comorbidity Index (comorbid diagnoses). Using exponential conditional mean models, we also examined the relationship between utilization characteristics and all-cause (i.e., not specific to AD) health care expenditures for a 12-month period, including inpatient and outpatient (physician) care, laboratory and radiology services, emergency room (ER) use, prescription drugs, and long-term care services (e.g., nursing home care, home health visits) paid by Medicare or private insurance, but excluding long-term care services paid by Medicaid. Expenditure was defined as allowed charge (i.e., the total payment received by the service provider including plan and patient paid amounts.) RESULTS: More than 70% of the patients who received ChEI therapy and who otherwise met the inclusion criteria were excluded from this study due to the absence of at least 1 claim with a diagnosis for AD. Of the 3,177 patients included in the study, the index ChEI was donepezil for 62.8% of the patients (n=1,994); 17.2% received galantamine (n=546) and 20.1% received rivastigmine (n=637). The total number of days of index therapy dispensed was greater for those starting on donepezil (mean [median, SD] days=226 [263, 115]) compared with rivastigmine (206 [233, 120], P<0.001), but was not significantly different compared with galantamine (216 [250, 119], P=0.085). Monthly prevalence of use was similar for the 3 drugs until month 5 when a smaller proportion of rivastigmine patients had index medication on hand (65.9%) compared with 72.1% of donepezil patients (P=0.003) and 72.7% of galantamine patients (P=0.012). At 12 months, the likelihood of receiving the index ChEI was higher for donepezil (61.1%) than for either rivastigmine (50.1%, P<0.001) or galantamine (56.4%, P=0.048) and was higher for galantamine than for rivastigmine (P=0.030). The rate of switching for donepezil patients was significantly lower (14.5%) than the switch rate for rivastigmine patients (21.5%, P<0.001) and was similar to the switch rate for galantamine patients (15.0%, P=0.781 for donepezil vs. galantamine; P=0.004 for galantamine vs. rivastigmine). Rates of nonpersistence, measured as having at least 1 gap in therapy of 30 days or more during the 1-year follow-up, were 63.5% for donepezil, 63.7% for

galantamine (P=0.933 for donepezil vs. galantamine), and 68.0% for rivastigmine (P=0.042 for donepezil vs. rivastigmine). MPRs and total days supply of any ChEI did not significantly differ among the 3 drugs. Results of multivariate models showed that, controlling for index ChEI drug, each additional month of ChEI treatment was associated with a reduction of 1% in total all-cause health care costs. The mean (SD) total all-cause 1-year health care costs for patients initiated on the 3 ChEIs were not significantly different: $12,112 ($16,437) for donepezil, $12,137 ($19,154) for galantamine (P=0.978), and $12,853 ($14,543) for rivastigmine (P=0.278).

CONCLUSIONS: During the first year following initiation of ChEI therapy, patients initiated on donepezil had a greater days supply of the index medication than did patients initiated on rivastigmine. At 12 months following treatment initiation, the proportion of patients in therapy was higher for donepezil than for either rivastigmine or galantamine and was higher for galantamine than for rivastigmine. Patients treated with either donepezil or galantamine were less likely to switch from the index drug to another ChEI than were patients treated with rivastigmine. All-cause 1-year health care costs for patients initiated on the 3 ChEIs were not significantly different.

Blanchette CM(1), Gutierrez B, Ory C, Chang E, Akazawa M. **Economic burden in direct costs of concomitant chronic obstructive pulmonary disease and asthma in a Medicare Advantage population.** J Manag Care Pharm. 2008 Mar;14(2):176-85.

Notes: Use of claims to calculate Charlson Comorbidity Index as measure of severity

Abstract:

BACKGROUND: Chronic obstructive pulmonary disease (COPD) is a highly prevalent disease whose sufferers consume a large amount of resources. Among community-dwelling Medicare beneficiaries, 12% reported that they had COPD in 2002. For clinicians, differentiating COPD from asthma may be difficult, but among patients with COPD and asthma, approximately 20% have both conditions. The economic impact of concomitant asthma and COPD is potentially large but has not been studied.

OBJECTIVE: To assess the cost burden of asthma in patients with COPD in a Medicare Advantage population.

METHODS: We reviewed the database of a large health plan that contained information from more than 30 distinct plans covering approximately 25 million members. We identified Medicare beneficiaries aged 40 years or older with medical and pharmacy benefits and medical claims with International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes for COPD or asthma over a 1-year identification period (calendar year 2004). We assigned patients to 2 cohorts based on diagnoses on medical claims (any diagnosis field) during 2004; the COPD cohort had at least 1 medical claim for COPD, and the COPD + asthma cohort had at least 1 claim for COPD and at least 1 claim for asthma. A patient's index date was the first date during 2004 in which there was a medical claim with a diagnosis code for COPD or asthma. To confirm diagnosis, each patient was required to have at least 1 additional claim for COPD (COPD cohort) or at least 1 claim for COPD and at least 1 claim for asthma (COPD

+ asthma cohort) during the 24-month period from 12 months before through 12 months after the index date. We excluded patients who (1) were not continuously enrolled during the 12 months before and after the index date and (2) did not have at least 1 pharmacy claim for a drug of any type (to verify pharmacy benefits). Outcome measures included the use of emergency room (ER) and hospital services, and cost (net provider payment after subtraction of member cost share), categorized as all-cause, non-respiratory, and respiratory-related. ER use and inpatient hospital stays were identified using place-of-service codes. A minimum of 2 consecutive dates of service (length of stay [LOS] of at least 1 day) was required to indicate an inpatient hospitalization. An LOS of at least 1 day was required to distinguish inpatient services from other services (e.g., procedures or tests) reported on claims with an inpatient place of service. Multivariate analyses adjusted for age, gender, census region, and Charlson Comorbidity Index (CCI). Ordinary least squares regression was used to predict respiratory-related total health care costs, and logistic regression was used to predict the occurrence of at least 1 acute event, defined as use of either an ER or an inpatient hospital. All 2-way interactions were considered, and only those with significant results were included in the models. All reported P values were 2-sided with a 0.05 significance level.

RESULTS: During 2004, 68,532 individuals within the database were enrolled in a Medicare Advantage plan. After application of the other inclusion criteria, we excluded approximately 11% of the patients who did not have 1 pharmacy claim of any type. There were 8,086 patients (11.8%) who had at least 1 medical claim with diagnosis codes for COPD and at least 1 other medical claim for either COPD or asthma and were continuously enrolled for at least 24 months. The COPD + asthma cohort numbered 1,843 patients (22.8%), and the COPD cohort numbered 6,243 patients (77.2%). Compared with COPD patients without asthma, patients with COPD + asthma were slightly younger, and a higher proportion was female. There were differences between the 2 cohorts in geographic distribution, and the COPD + asthma cohort had a higher disease severity with a mean CCI score of 2.6 (standard deviation [SD], 2.1) compared with the COPD cohort (2.3 [2.3], $P < 0.001$). Respiratory-related pharmacy costs were a relatively small part of total respiratory-related health care costs: approximately 5.7% for the COPD cohort and 8.8% for the COPD + asthma cohort. Respiratory-related costs accounted for 22.0% of total all-cause health care costs for the COPD cohort and 28.7% for the COPD + asthma cohort. Mean ([SD], median) unadjusted respiratory-related health care costs were $7,240 ([$15,057], $1,957) for the COPD + asthma cohort and $5,158 ([$11,881], $808) in the COPD cohort. After adjusting for covariates, patients in the COPD + asthma cohort were more likely to have at least 1 acute event (e.g., ER visits and hospitalizations) than patients in the COPD cohort (adjusted odds ratio, 1.6; 95% CI, 1.4-1.7) and had $1,931 (37.1%) greater adjusted respiratory-related health care costs--$7,135 versus $5,204 for the COPD cohort ($P < 0.001$).

CONCLUSION: Medicare beneficiaries with COPD and asthma incur higher health care costs and use more health care services than those with COPD without asthma.

Jiannong Liu, Zhi Huang, David T. Gilbertson, Robert N. Foley and Allan J. Collins. **An improved comorbidity index for outcome analyses among dialysis patients.** Kidney Int. 2010 Jan;77(2):141-51. doi: 10.1038/ki.2009.413. Epub 2009 Nov 11.

Abstract: Since comorbid conditions are highly prevalent among patients with end-stage renal disease, indexes measuring them have been widely used to describe the comorbidity burden and to predict outcomes as well as adjust for their roles as confounders. The current comorbidity indexes, however, were developed for general populations or on small patient cohorts. In this study we developed a new index for mortality analyses of dialysis patients based on the 2000 US incident dialysis population, and validated this using the 1999 and 2001 incident and 2000 prevalent dialysis patient populations. Numerical weights were assigned to the comorbid conditions of atherosclerotic heart disease, congestive heart failure, cerebrovascular accident/transient ischemic attack, peripheral vascular disease, dysrhythmia, other cardiac diseases, chronic obstructive pulmonary disease, gastrointestinal bleeding, liver disease, cancer, and diabetes. A patient's comorbidity score was the sum of the weights corresponding to the individual conditions present and could be used as a continuous variable in analyses. Our index performance was almost identical to the individual comorbid conditions regarding model fit, predictive ability, and effect on inference, and it outperformed the widely used Charlson Comorbidity Index.

End Stage Renal Disease (ESRD) Quality Measure Development, Maintenance, and Support

End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR) Technical Expert Panel Environmental Scan

Environmental Scan Summary

UM-KECC performed a preliminary scan of the National Quality Forum measure database, with a focus on identifying currently endorsed measures that meet the following criteria:

1. Measures that have mortality or hospitalization is focal event (hospitalization could reflect general hospital admissions, readmissions, or ED use) AND
2. Measure reflects risk-standardization OR
3. Measure concerns care coordination between a hospital and another care provider.

A number of cause-specific hospitalization and mortality measures are included in this summary. These measures use risk standardization, and because the causes reflect conditions that many dialysis patients have, we felt it they were sufficiently related to inform our assessment of risk adjustment for prevalent comorbidities.

We also note that there are no competing measures of mortality and hospitalization for specifically designed for dialysis patients.

Measure list

Hospitalization/Readmission/Emergency Department Use

Measure Title	Standardized Readmission Ratio (SRR) for dialysis facilities
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The Standardized Readmission Ratio (SRR) is defined to be the ratio of the number of index discharges from acute care hospitals that resulted in an unplanned readmission to an acute care hospital within 30 days of discharge for Medicare-covered dialysis patients treated at a particular dialysis facility to the number of readmissions that would be expected given the discharging hospitals and the characteristics of the patients as well as the national norm for dialysis facilities. Note that in this document, "hospital" always refers to acute care hospital.
Numerator	Each facility's observed number of hospital discharges that are followed by an unplanned hospital readmission within 30 days of discharge.
Denominator	The expected number of unplanned readmissions in each facility, which is derived from a model that accounts for patient characteristics and discharging acute care hospitals.
Exclusions	Hospital discharges that: • Are not live discharges • Result in a patient dying within 30 days with no readmission • Are against medical advice • Include a primary diagnosis for cancer, mental health or rehabilitation • Occur after a patient's 12th admission in the calendar year • Are from a PPS-exempt cancer hospital • Result in a transfer to another hospital on the same day
Risk Adjustment	To estimate the probability of 30-day unplanned readmission, we use a two-stage model, the first of which is a double random-effects logistic regression model. In this stage of the model, both dialysis facilities and hospitals are represented as random effects, and regression adjustments are made for a set of patient-level characteristics. From this model, we obtain the estimated standard deviation of the random effects of hospitals (Diggle, et. al., 2002).

Measure Title	Standardized Readmission Ratio (SRR) for dialysis facilities
	The second stage of the model is a mixed-effects logistic regression model, in which dialysis facilities are modeled as fixed effects and hospitals are modeled as random effects, with the standard deviation specified as equal to its estimates from the first model. The expected number of readmissions for each facility is estimated as the summation of the probabilities of readmission of all patients in this facility and assuming the national norm (i.e., the median) for facility effect. This model accounts for a given facility's case mix using the same set of patient-level characteristics as those in the first model. Patient-Level Risk Adjustors As mentioned previously, the model accounts for a set of patient-level characteristics: • Sex • Age • Years on dialysis • Diabetes as cause of ESRD • BMI at incidence of ESRD • Length (days) of index hospitalization • Past-year comorbidities: We identify all unique ICD-9 diagnosis codes from each patient's prior year of Medicare claims. We group these diagnosis codes by diagnosis area using HHS' Hierarchical Condition Categories (CCs). The CCs used in calculation of the SRR are: o CCs 177, 178: Amputation status o CC 108: COPD o CC 79: Cardiorespiratory failure/shock o CC 46: Coagulation defects & other specified hematological disorders o CCs 51, 52: Drug and alcohol disorders o CCs 25, 26: End-Stage Liver Disease o CC 109: Fibrosis of lung or other chronic lung disorders o CCs 67–69, 100, 101: Hemiplegia, paraplegia, paralysis o CC 158: Hip fracture/dislocation o CC 174: Major organ transplants (excl. kidney) o CC 7: Metastatic cancer/acute leukemia o CC 44: Other hematological disorders o CCs 6, 111–113: Other infectious disease & pneumonias o CCs 10–12: Other major cancers

Measure Title	Standardized Readmission Ratio (SRR) for dialysis facilities
	o CC 32: Pancreatic disease o CCs 54–56, 58, 60: Psychiatric comorbidity o CC 77: Respirator dependence/tracheostomy status o CC 38: Rheumatoid arthritis & inflammatory connective tissue disease o CC 74: Seizure disorders & convulsions o CC 2: Septicemia/shock o CCs 8,9: Severe cancer o CCs 1, 3–5: Severe infection o CCs 148, 149: Ulcers • Discharged with high-risk condition: We define a high-risk diagnosis as any diagnosis area that was rare in our population but had a 30-day readmission rate of at least 40%. We did not include high-risk diagnosis groups related to cancer or mental health. We group these conditions using the Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications Software (CCS). The CCS areas identified as high-risk are: o CCS 5: HIV infection o CCS 6: Hepatitis o CCS 56: Cystic fibrosis o CCS 57: Immunity disorders o CCS 61: Sickle cell anemia o CCS 190: Fetal distress and abnormal forces of labor o CCS 151: Other liver diseases o CCS 182: Hemorrhage during pregnancy; abruptio placenta; placenta previa o CCS 186: Diabetes or abnormal glucose tolerance complicating pregnancy; childbirth; or the puerperium o CCS 210: Systemic lupus erythematosus and connective tissue disorders o CCS 243: Poisoning by nonmedicinal substances The coefficients for the patient characteristics resulting from the logistic model are shown below. Table 1. Effects of Patient Characteristics on Readmission Rates for Medicare-Covered Dialysis Patients, 20092013
NQF Endorsed	Under review, #2496

Measure Title	Standardized Readmission Ratio (SRR) for dialysis facilities
Clinical Condition	Prevention, Renal, Renal: End Stage Renal Disease (ESRD)

Measure Title	Standardized Hospitalization Ratio for Admissions
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Risk-adjusted standardized hospitalization ratio for admissions for dialysis facility patients.
Numerator	Number of inpatient hospital admissions among eligible patients at the facility during the reporting period.
Denominator	Number of hospital admissions that would be expected among eligible patients at the facility during the reporting period, given the patient mix at the facility.
Exclusions	None.
Risk Adjustment	The regression model used to compute a facility's "expected" number of hospitalizations for the SHR measure contains many factors thought to be associated with hospitalization rates. Specifically, the model adjusts for patient age, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status, BMI at incidence, comorbidities at incidence, and calendar year. The stage 1 model allows the baseline hospitalization rates to vary between strata, which are defined by facilities, but assumes that the regression coefficients are the same across all strata; this approach is robust to possible differences between facilities in the patient mix being treated. In essence, it avoids a possible confounding between facility effects and patient covariates as can arise, for example, if patients with favorable values of the covariate tend to be treated at facilities with better treatment policies and outcomes. Thus, for example, if patients with diabetes as a cause of ESRD tended to be treated at better facilities, one would underestimate the effect of diabetes unless the model is adjusted for facility. In this model, this is done by stratification. The patient characteristics included in the stage 1 model as covariates are • Age: We determine each patient's age for the birth date provided in the SIMS and REMIS databases and group patients into the following categories: 0-14 years old, 15-24 years old, 25-44 years old, 45-59 years

Measure Title	Standardized Hospitalization Ratio for Admissions
	old, 60-74 years old, or 75+ years old. • Sex: We determine each patient's sex from his/her Medical Evidence Form (CMS-2728). • Diabetes as cause of ESRD: We determine each patient's primary cause of ESRD from his/her CMS-2728. • Duration of ESRD: We determine each patient's length of time on dialysis using the first service date from his/her CMS-2728, claims history (all claim types), the SIMS database and the SRTR database and categorize as 91 days-6 months, 6 months-1 year, 1-2 years, 2-3 years, 3-5 years, or 5+ years as of the period start date. • Nursing home status: Using the Nursing Home Minimum Dataset, we determine if a patient was in a nursing home the previous year. • BMI at incidence: We calculate each patient's BMI as the height and weight provided on his/her CMS 2728. BMI is included as a log-linear term. • Comorbidities at incidence are determined using a selection of comorbidities reported on the CMS-2728 namely, alcohol dependence, atherosclerotic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, congestive heart failure, diabetes (includes currently on insulin, on oral medications, without medications, and diabetic retinopathy), drug dependence, inability to ambulate, inability to transfer, malignant neoplasm, cancer, other cardiac disease, peripheral vascular disease, and tobacco use (current smoker). Each comorbidity is included as a separate covariate in the model. • Calendar year • Categorical indicator variables are included as covariates in the stage I model to account for records with missing values for cause of ESRD, comorbidities at incidence (missing CMS-2728), and BMI. These variables have a value of 1 if the patient is missing the corresponding variable and a value of 0 otherwise. Another categorical indicator variable is included as a covariate in the stage 1 model to flag records where the patient has at least one of the incident comorbidities listed earlier. This variable has a value of 1 if the patient has at least one of the comorbidities and a value of 0 otherwise. • Beside main effects, two-way interaction terms between age, sex and duration and cause of ESRD are also included: • Diabetes as cause of ESRD*Duration of ESRD • Diabetes as cause of ESRD*Sex • Diabetes as cause of ESRD*Age • Age*Sex The denominator of the SHR stems from a proportional rates model (Lawless and Nadeau, 1995; Lin et al., 2000; Kalbfleisch and Prentice, 2002). This is the recurrent event analog of the well-known proportional

Measure Title	Standardized Hospitalization Ratio for Admissions
	hazards or Cox model (Cox, 1972; Kalbfleisch and Prentice, 2002). To accommodate large-scale data, we adopt a model with piecewise constant baseline rates (e.g. Cook and Lawless, 2007) and the computational methodology developed in Liu, Schaubel and Kalbfleisch (2012).
NQF Endorsed	Yes, #1463
Clinical Condition	Renal: End Stage Renal Disease (ESRD)

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
Measure Developer	Bridges to Excellence
Measure Description	Percent of adult population aged 18 – 65 years who were admitted to a hospital with stroke, were followed for one-month after discharge, and had one or more potentially avoidable complications (PACs). PACs may occur during the index stay or during the 30-day post discharge period (Please reference attached document labeled NQF_Stroke_PACs_Risk_Adjustment_2.16.10.xls, tabs labeled CIP_Index PAC_Stays and CIP_PAC_Readmission). We define PACs during each time period as one of three types: (A) PACs during the Index Stay (Hospitalization): (1) PACs related to the anchor condition: The index stay is regarded as having a PAC if during the index hospitalization for stroke the patient develops one or more complications such as hypertensive encephalopathy, malignant hypertension, coma, anoxic brain damage, or respiratory failure etc. that may result directly from stroke or its management. (2) PACs due to Comorbidities: The index stay is also regarded as having a PAC if one or more of the patient's controlled comorbid conditions is exacerbated during the hospitalization (i.e. it was not present on admission). Examples of these PACs are diabetic emergency with hypo- or hyperglycemia, pneumonia, lung complications, acute myocardial infarction, gastritis, ulcer, GI hemorrhage etc.

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	(3) PACs suggesting Patient Safety Failures: The index stay is regarded as having a PAC if there are one or more complications related to patient safety issues. Examples of these PACs are septicemia, meningitis, other infections, phlebitis, deep vein thrombosis, pulmonary embolism or any of the CMS-defined hospital acquired conditions (HACs). (B) PACs during the 30-day post discharge period: (1) PACs related to the anchor condition: Readmissions and emergency room visits during the 30-day post discharge period after a stroke are considered as PACs if they are for hypertensive encephalopathy, malignant hypertension, respiratory failure, coma, anoxic brain damage etc. (2) PACs due to Comorbidities: Readmissions and emergency room visits during the 30-day post discharge period are also considered PACs if they are due to an exacerbation of one or more of the patient's comorbid conditions, such as a diabetic emergency with hypo- or hyperglycemia, pneumonia, lung complications, acute myocardial infarction, acute renal failure etc. (3) PACs suggesting Patient Safety Failures: Readmissions or emergency room visits during the 30-day post discharge period are considered PACs if they are due to sepsis, infections, deep vein thrombosis, pulmonary embolism, or for any of the CMS-defined hospital acquired conditions (HACs). The enclosed workbook labeled NQF_Stroke_PACs_Risk_Adjustment_2.16.10.xls, gives the frequency and costs associated with each of these types of PACs during the index hospitalization (tab labeled CIP_Index PAC_Stays) and for readmissions and emergency room visits during the 30-day post-discharge period (tab labeled CIP_PAC_Readmission). The information is based on a two-year national commercially insured population (CIP) claims database. The database had 4.7 million covered lives and $95 billion in "allowed amounts" for claims costs. The database was an administrative claims database with medical as well as pharmacy claims. The two tabs demonstrate the most common PACs that occurred in patients hospitalized with stroke.
Numerator	Outcome: Potentially avoidable complications (PACs) in patients hospitalized for stroke occurring during the index stay or in the 30-day post-discharge period.

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
Denominator	Adult patients aged 18 – 65 years who had a relevant hospitalization for stroke (with no exclusions) and were followed for one-month after discharge.
Exclusions	Denominator exclusions include exclusions of either "patients" or "claims" based on the following criteria: (1)"Patients" excluded are those with that have any form of cancer, ESRD (end-stage renal disease), transplants such as lung or heart-lung transplant or complications related to transplants, intracranial trauma, pregnancy and delivery, HIV, or suicide. (2)"Claims" are excluded from the stroke measure if they are considered not relevant to stroke care or are for major surgical services that suggests that stroke may be a comorbidity or complication associated with the procedure e.g. CABG procedure. Patients where the index hospitalization claim is excluded are automatically excluded from both the numerator and the denominator.
Risk Adjustment	Conceptual Model Variations in outcomes across populations may be due to patient-related factors or due to provider-controlled factors. When we adjust for patient-related factors, the remaining variance in PACs are due to factors that could be controlled by all providers that are managing or co-managing the patient, both during and after the hospitalization. We have developed a "severity index" based on patient-related factors such as patient demographics and comorbidities. The severity-adjusted PAC counts give a fair comparison of PACs and PAC rates from population to population and helps providers determine the degree of PACs that are not related to patient-level factors but due to factors that they could control and thus result in fewer PACs being incurred by patients and paid for by payers. Methodology Overview A severity index is calculated for each patient based on the risk-adjustment model for professional and other services that determines the cost drivers for typical care for a given condition. Demographic variables, comorbid conditions, various types of services as well as different patient-level pharmacy indicators are fed into the model. Conditions and services that lead to higher costs and increased resource consumption are weighted more heavily in our model. For example, DME use is associated with a higher coefficient in the model. The model determines the patient-level factors that are drivers for increased financial risk. For each patient the "predicted" log coefficients from the severity adjustment model are summed to give the patient level severity index. Summing the patient level severity index helps derive the population level severity index. Adjusting the overall PAC rates by the severity-index for the population helps adjust for variations in outcomes related to severity. The risk-adjustment variables that were included were patient demographic factors such as age and gender, medical comorbidities, procedures performed, as well as pharmacy variables. Variable Descriptions:

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	AGE CONTINUOUS VARIABLE GENDER FEMALE (MALE IS REFERENCE) BACL1 ANTICOAGULANTS EDIAB ANTIDIABETICS ESTER STEROIDS ETHYR THYROID DRUGS GIACD ANTACIDS AND ANTISPASMODICS GIEM ANTIEMETICS HACEI ACEI, ARB, ANTI-RENIN DRUGS HBBLK BETA-BLOCKERS HCLBK CALCIUM CHANNEL BLOCKING AGENTS HDIUR DIURETICS HNITR NITRATES AND OTHER ANTIANGINALS HOTHR OTHER CARDIOVASCULAR AGENTS HPLT ANTIPLATELET AGENTS, THROMBIN INHIBITORS HSTN STATINS AND OTHER ANTI-LIPID AGENTS HVSDL VASODILATORS IANTB ANTIBIOTICS LBDIL BRONCHODILATORS AND OTHER ANTIASTHMATICS LDECG DECONGESTANTS AND ANTIHISTAMINICS LOTHR INHALERS AND RESPIRATORY AGENTS M10 DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS M12 ESSENTIAL HYPERTENSION M13 HYPERTENSION WITH COMPLICATIONS AND SECONDARY HYPERTENSION M14 HEART VALVE AND CONGENITAL HEART DISORDERS M15 CORONARY ATHEROSCLEROSIS AND OTHER HEART DISEASE M16 CHF, CARDITIS, CARDIOMYOPATHY M18 DISEASES OF ARTERIES ARTERIOLES AND CAPILLARIES M2 DIABETES MELLITUS WITH CHRONIC END-ORGAN DAMAGE M20 CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND BRONCHIECTASIS M22 OTHER RESPIRATORY INFECTIONS AND DISEASES M23 ESOPHAGEAL DISORDERS

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	M24 DISEASES OF THE DIGESTIVE SYSTEM M26 CHRONIC RENAL FAILURE AND OTHER KIDNEY DISEASE M29 DISEASES OF THE SKIN AND CONNECTIVE TISSUE M32 CARDIAC DYSRHYTHMIAS M35 DISEASES OF BONES, JOINTS, SPINE M36 PREVENTATIVE, REHABILITATION AND AFTER CARE M37 NAUSEA, VOMITING, MALAISE, FATIGUE, FEVER M39 DEMENTIA, PARKINSON´S DISEASE M4 DIABETES MELLITUS WITHOUT COMPLICATION M40 RETINOPATHY, VISION DEFECTS, BLINDNESS M5 FLUID AND ELECTROLYTE DISTURBANCES M6 OTHER ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES AND IMMUNITY DISORDERS M7 DISORDERS OF LIPID METABOLISM M8 ANEMIA, COAGULATION, HEMORRHAGIC DISORDERS M9 MENTAL AND BEHAVIORAL ILLNESS MSKRL SKELETAL MUSCLE RELAXANT COMBINATIONS NACNV ANTICONVULSANTS NANLG ANALGESICS AND ANTI-INFLAMMATORY NDEPR ANTIDEPRESSANTS NMCNS MISCALLENAEOUS CNS AGENTS NSEDT SEDATIVES AND HYPNOTICS P1 EYE, ENT, ORAL PROCEDURES P13 RESPIRATORY DIAGNOSTIC AND MINOR THERAPEUTIC PROCEDURES P14 NERVOUS SYSTEM, ENDOCRINE, HEAD AND NECK MINOR PROCEDURES P15 GI DIAGNOSTIC AND MINOR THERAPEUTIC PROCEDURES P23 RADIOLOGY AND RADIONUCLEAR DIAGNOSTIC SERVICES P26 PHYSICAL THERAPY AND REHABILITATION P27 ANCILLARY, HOME HEALTH, TRANSPORT P28 MEDICATION ADMINISTRATION P29 MENTAL HEALTH SERVICES P31 DME, VISUAL AND HEARING AIDS P35 CT HEAD, CEREBRAL ANGIOGRAM, DIAGNOSTIC TESTS HEAD AND NECK

Measure Title	Proportion of Patients Hospitalized with Stroke that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	P4 INVASIVE VASCULAR DIAGNOSTIC & MINOR THERAPEUTIC PROCEDURES P6 NON-INVASIVE CARDIOVASCULAR PROCEDURES SRF1 HEMORRHAGIC STROKE SRF2 ISCHAEMIC, MIGRAINE, THROMBOEMBOLIC STROKE, CVA SRF3 TRANSIENT CEREBRAL ISCHEMIA, TIA SRF5 CHRONIC CEREBROVASCULAR DISEASE SRF6 SYNCOPE, COLLAPSE, DIZZINESS, HYPOTENSION SRF7 LATE EFFECTS OF CEREBROVASCULAR DISEASE SRF8 OBESITY, SLEEP APNEA SRF9 TOBACCO USE ZNUTR IRON AND OTHER NUTRITIONAL SUPPLEMENTS
NQF Endorsed	Yes, #0705
Clinical Condition	Neurology, Neurology: Stroke/Transient Ischemic Attack (TIA)

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
Measure Developer	Bridges to Excellence
Measure Description	Percent of adult population aged 18 – 65 years who were admitted to a hospital with acute myocardial infarction (AMI), were followed for one-month after discharge, and had one or more potentially avoidable complications (PACs). PACs may occur during the index stay or during the 30-day post discharge period (Please reference attached document labeled NQF_AMI_PACs_Risk_Adjustment_2.16.10.xls, tabs labeled CIP_Index PAC_Stays and CIP_PAC_Readmission). We define PACs during each time period as one of three types: (A) PACs during the Index Stay (Hospitalization):

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	(1) PACs related to the anchor condition: The index stay is regarded as having a PAC if during the index hospitalization the patient develops one or more complications such as cardiac arrest, ventricular fibrillation, cardiogenic shock, stroke, coma, acute post-hemorrhagic anemia etc. that may result directly due to AMI or its management. (2) PACs due to Comorbidities: The index stay is also regarded as having a PAC if one or more of the patient's controlled comorbid conditions is exacerbated during the hospitalization (i.e. it was not present on admission). Examples of these PACs are diabetic emergency with hypo- or hyperglycemia, tracheostomy, mechanical ventilation, pneumonia, lung complications gastritis, ulcer, GI hemorrhage etc. (3) PACs suggesting Patient Safety Failures: The index stay is regarded as having a PAC if there are one or more complications related to patient safety issues. Examples of these PACs are septicemia, meningitis, other infections, phlebitis, deep vein thrombosis, pulmonary embolism or any of the CMS-defined hospital acquired conditions (HACs). (B) PACs during the 30-day post discharge period: (1) PACs related to the anchor condition: Readmissions and emergency room visits during the 30-day post discharge period after an AMI are considered as PACs if they are for angina, chest pain, another AMI, stroke, coma, heart failure etc. (2) PACs due to Comorbidities: Readmissions and emergency room visits during the 30-day post discharge period are also considered PACs if they are due to an exacerbation of one or more of the patient's comorbid conditions, such as a diabetic emergency with hypo- or hyperglycemia, pneumonia, lung complications, tracheostomy, mechanical ventilation etc. (3) PACs suggesting Patient Safety Failures: Readmissions or emergency room visits during the 30-day post discharge period are considered PACs if they are due to sepsis, infections, phlebitis, deep vein thrombosis, or for any of the CMS-defined hospital acquired conditions (HACs). The enclosed workbook labeled NQF_AMI_PACs_Risk_Adjustment_2.16.10.xls, gives the frequency and

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	costs associated with each of these types of PACs during the index hospitalization (tab labeled CIP_Index PAC_Stays) and for readmissions and emergency room visits during the 30-day post-discharge period (tab labeled CIP_PAC_Readmission). The information is based on a two-year national commercially insured population (CIP) claims database. The database had 4.7 million covered lives and $95 billion in "allowed amounts" for claims costs. The database was an administrative claims database with medical as well as pharmacy claims. The two tabs demonstrate the most common PACs that occurred in patients hospitalized with AMI.
Numerator	Outcome: Potentially avoidable complications (PACs) in patients hospitalized for AMI occurring during the index stay or in the 30-day post-discharge period.
Denominator	Adult patients aged 18 – 65 years who had a relevant hospitalization for AMI (with no exclusions) and were followed for one-month after discharge
Exclusions	Denominator exclusions include exclusions of either "patients" or "claims" based on the following criteria: (1)"Patients" excluded are those that have any form of cancer, ESRD (end-stage renal disease), transplants such as lung or heart-lung transplant or complications related to transplants, pregnancy and delivery, HIV, or suicide. (2)"Claims" are excluded from the AMI measure if they are considered not relevant to AMI care or are for major surgical services that suggests that AMI may be a comorbidity associated with the procedure e.g. CABG procedure. Patients where the index hospitalization claim is excluded are automatically excluded from both the numerator and the denominator.
Risk Adjustment	Conceptual Model Variations in outcomes across populations may be due to patient-related factors or due to provider-controlled factors. When we adjust for patient-related factors, the remaining variance in PACs are due to factors that could be controlled by all providers that are managing or co-managing the patient, both during and after hospitalization. Statistical Method: Logistic Regression model to determine the probability of a patient incurring a PAC Demographic variables, comorbid conditions, as well as clinical severity indicators are fed as independent risk factors into the model. Risk Factors are collected historically. Subtype information is collected from the index claim and any look-back period, if relevant. Subtypes are clinical severity indicators suggesting severity of the episode itself, for example, the extent of the infarction in an AMI patient. For each patient the "predicted" coefficients from the risk adjustment models are summed to give the predicted probabilities of the occurrence of a PAC. Risk Factors :(Please refer to the enclosed excel workbook entitled (NQF_AMI_all_codes_risk_adjustment 06.30.15.xls). The risk factors along with their codes are listed in the tabs called "All Risk Factors I-9" and "All Risk Factors I-10" and also listed below: AGE CONTINUOUS VARIABLE GENDER FEMALE = 1 (MALE IS REFERENCE = 0)

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	Risk Factor # Risk Factor Name RF0101 Anoxic Brain Damage, persistent vegetative state RF0102 Delirium, Meningitis, Encephalitis RF0103 Previous Stroke, Paralysis RF0104 Cerebral Palsy and Other Paralytic Syndromes RF0105 Spinal Cord Disorders/Injuries RF0106 Polyneuropathy RF0107 Multiple Sclerosis RF0108 Convulsions, Epilepsy RF0109 Dementia RF0110 Parkinson´s and Huntington´s Diseases RF0111 Cerebrovascular Disease RF0115 after care, rehabilitation RF0201 visual loss, blindness, retinal tear, detachment RF0301 ENT, Upper Respiratory Problems RF0401 Respiratory Failure, O2, ventilator dependence RF0402 Advanced COPD, Asthma RF0403 Empyema, bronchiectasis, Pneumonias RF0404 Aspiration Pneumonia, Laryngeal Problems RF0406 TB, Pneumoconiosis, Aspergillosis RF0407 Tobacco use, Lung disease due to External Fumes RF0408 Other Lung Disease RF0501 Previous Shock, Syncope, Vent Fibrillation RF0503 Advanced CHF RF0504 Cardiomyopathy, valve disorders RF0505 Cardiac Arrhythmias, Heart Block RF0506 Pacemaker, AICD RF0507 Endocarditis, Other post surgical cardiac problems RF0508 Other Cardiovascular Disease RF0511 DVT, Pulm Embolism, Pulm Heart Disease RF0512 Unstable Angina

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	RF0513 Hypotension, chronic, orthostatic RF0514 Hyperlipidemia RF0515 Intraaortic Balloon Pump RF0516 ventricular assist device, ecmo, prolonged bypass RF0517 Previous electrophysiology studies, cryoablation RF0518 Recent AMI RF0519 Previous PCI RF0520 Previous CABG RF0521 Previous Heart & Valve Surgery RF0522 Previous aortic reconstruction RF0523 Previos carotid endarterectomy RF0524 Aortic and peripheral vascular disease RF0525 Advanced Aortic and Vascular Disease RF0601 GI Bleed RF0602 Intestinal Obstruction/Perforation RF0603 Acute Gastritis, Duodenitis RF0604 Gastroduodenal Ulcer RF0606 Intestinal Uro-genital Fistula RF0607 Abdominal hernia w complications RF0608 Vascular insufficiency of intestine RF0609 Inflammatory Bowel Disease RF0610 Irritable Bowel RF0611 Diverticulitis, Meckel´s RF0612 Digestive congenital anomalies RF0613 Intestinal infection RF0614 Esophageal Perforation, Hmg, Barretts, Compl Hiatal Hernia RF0615 Abnormal weight loss RF0616 Achalasia, Esophageal spasm, Stricture, Dysphagia RF0617 GERD, Hiatal Hernia, Other Upper GI Disorders RF0618 Previous Bariatric Surgery RF0619 Hx of colon polyps, family Hx of colon cancer RF0620 Enterostomy, GI devices, lap band

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	RF0701 Pancreatic Disease RF0702 Perforation, fistula GB, bile duct, pancreas RF0703 Gall stones, cholecystitis RF0704 End-Stage Liver Disease RF0705 Hepatitis, Cirrhosis, Other Hepatbiliary Disorders RF0706 Recent Gall Bladder, Hepatobilary Surgery RF0707 Acute Pancreatitis, pseudo cyst RF0801 Bone/Joint/Muscle Infections/Necrosis RF0802 Muscular Dystrophy RF0803 Osteoporosis, ostetits deformans, pathological fracture RF0804 Rheumatoid Arthritis and Inflammatory Connective Tissue Disease RF0805 Gout and other crystal arthropathies RF0806 Other arthropathies RF0807 Osteoarthritis RF0808 Joint Deformities RF0809 Knee derangements RF0810 Traumatic Dislocation Knee RF0811 Dislocation Hip RF0812 Synovitis, Ruture Tendon RF0813 Status Knee Replacement RF0814 Status Total Hip Replacement RF0901 Decubitus Ulcer RF0902 Skin and wound problems RF1001 Diabetes, poor control RF1002 Advanced diabetes RF1003 diabetes RF1101 Acute renal failure RF1102 Dialysis Dependent RF1103 Nephritis RF1104 Chronic renal failure RF1105 Urinary Tract Infections RF1301 Endometriosis

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	RF1302 Fibroid uterus, benign tumors of female organs RF1303 Pelvic Inflammatory disease RF1304 Uterine prolapse, cystocele, vaginocele RF1305 Female Harmonal Disorders RF1306 Ovarian, Broad Ligament Disorders RF1308 Other disorders of uterus, cervix RF1309 Menopausal Disorders RF1310 Menstrual Disorders RF1401 Multiparity, multigravida RF1402 Elderly Primi, other RF1403 Poor obstetric history RF1406 Cervical incompetence RF1407 Abnormalities of uterus, female genital tract RF1408 Hypertension, pre-eclampsia in Pregnancy RF1409 Severe pre-eclampsia w HTN, Eclampsia RF1410 Maternal, gestational diabetes, large for date RF1411 Genital Herpes RF1412 Infections of genitourinary tract, venereal disease in pregnancy RF1413 Infectious Diseases in Mother RF1414 Cardiovascular disease in Mother RF1415 Mental Disorders in Mother RF1416 Epilepsy in Mother RF1417 Liver and biliary tract disorders in mother RF1418 Kidney Disease in Mother RF1419 Other Maternal conditions RF1421 Cephalopelvic Disproportion due to maternal causes RF1436 Peripartum Cardiomyopathy RF1441 Previous Cesarean section RF1450 Maternal Obesity, previous Bariatric Surgery RF1454 Previous Rupture Uterus, Obstetrical Trauma RF1458 Complicated Pregnancy Delivery RF1460 Thrombophlebitis, DVT during Pregnancy

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	RF1461 Puerperal Sepsis, other major puerperal complications RF1462 Obstetrical Embolism, Air, Amniotic Fluid, Pulm, Pyemic RF1467 Tobacco Use in Mother RF1601 Bleeding Disorders RF1602 Severe Hematological Disorders RF1603 Disorders of Immunity RF1604 Nutritional and other Anemias RF1605 Long-term use of anticoag, Aspirin RF1701 Head and Neck Cancers RF1702 Lung and Intrathoracic Cancers RF1703 Neuroendocrine, Myeloproliferative Cancers RF1704 Poorly differentiated, Secondary, Metastatic Cancers RF1705 Other Tumors RF1706 Acute Leukemia RF1707 Cancer uterus, localized female organs RF1708 Colorectal, Hepatobiliary and other GI cancers RF1709 Breast, Prostate, Thyroid cancers RF1710 Testicular Cancer and localized of male organs RF1711 Cancer of Bladder and Urinary Tract RF1712 Musculoskeletal Cancers RF1801 Sepsis, MRSA, Opportunitistic infections RF1901 Schizophrenia RF1902 Major Depressive, Bipolar, and Paranoid Disorders RF2001 Drug/Alcohol Psychosis RF2002 Drug/Alcohol Dependence RF2101 Drug Reactions, long term use of drugs RF2102 Intra-abdominal injury RF2201 Extensive Third-Degree Burns RF2301 Major Organ Transplant Status RF2302 Artificial Openings for Feeding or Elimination RF2303 Complications of Medical & Surgical Care and Trauma RF2304 severe morbid obesity

Measure Title	Proportion of Patients Hospitalized with AMI that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	RF2305 morbid obesity RF2306 obesity RF2307 mild sleep apnea, hypoventilation RF2308 moderate sleep apnea, hypoventilation RF2309 obstructive sleep apnea RF2310 Severe Protein-Calorie Malnutrition RF2311 Mild-mod malnutrition RF2401 Severe Head Injury RF2402 Major Head Injury RF2403 Vertebral Fractures without Spinal Cord Injury RF2404 Falls, Fractures RF2405 Amputation RF2501 HIV/AIDS Subtypes for AMI AMI Subtypes STEMI Subendocardial infarct Previous CABG, PCI Morbid Obesity Obesity As you may notice some of the covariates (risk factors) such as obesity are collected from both historical claims as well as from the index stay and look-back period of the episode.
NQF Endorsed	Yes, #0704
Clinical Condition	Cardiovascular, Cardiovascular: Acute Myocardial Infarction

Measure Title	Proportion of Patients Hospitalized with Pneumonia that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
Measure Developer	Bridges To Excellence
Measure Description	Percent of adult population aged 18 – 65 years who were admitted to a hospital with Pneumonia, were followed for one-month after discharge, and had one or more potentially avoidable complications (PACs). PACs may occur during the index stay or during the 30-day post discharge period (Please reference attached document labeled NQF Pneumonia PACs Risk Adjustment 2.16.10.xls, tabs labeled CIP_Index PAC_Stays and CIP_PAC_Readmission). We define PACs during each time period as one of three types: (A) PACs during the Index Stay (Hospitalization): (1) PACs related to the anchor condition: The index stay is regarded as having a PAC if during the index hospitalization the patient develops one or more of the avoidable complications that can result from pneumonia, such as respiratory failure, respiratory insufficiency, pneumothorax, pulmonary collapse, or requires respiratory intubation and mechanical ventilation, incision of pleura, thoracocentesis, chest drainage, tracheostomy etc. (2) PACs due to Comorbidities: The index stay is also regarded as having a PAC if one or more of the patient's controlled comorbid conditions is exacerbated during the hospitalization (i.e. it was not present on admission). Examples of these PACs are diabetic emergency with hypo- or hyperglycemia, stroke, coma, gastritis, ulcer, GI hemorrhage, acute renal failure etc. (3) PACs suggesting Patient Safety Failures: The index stay is regarded as having a PAC if there is one or more complication related to patient safety issues. Examples of these PACs are infections, sepsis, phlebitis, deep vein thrombosis, pulmonary embolism or any of the CMS-defined hospital acquired conditions (HACs). (B) PACs during the 30-day post discharge period: (1) PACs related to the anchor condition: Readmissions and emergency room visits during the 30-day post discharge period are considered PACs if they are for potentially avoidable complications of pneumonia such as respiratory failure, respiratory insufficiency, pneumonia, respiratory intubation, mechanical ventilation, etc.

Measure Title	Proportion of Patients Hospitalized with Pneumonia that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	(2) PACs due to Comorbidities: Readmissions and emergency room visits during the 30-day post discharge period are also considered PACs if they are due to an exacerbation of one or more of the patient's comorbid conditions, such as a diabetic emergency with hypo- or hyperglycemia, stroke, coma, gastritis, ulcer, GI hemorrhage, acute renal failure etc. (3) PACs suggesting Patient Safety Failures: Readmissions or emergency room visits during the 30-day post discharge period are considered PACs if they are due to sepsis, infections, phlebitis, deep vein thrombosis, or for any of the CMS-defined hospital acquired conditions (HACs). The enclosed workbook labeled NQF Pneumonia PACs Risk Adjustment 2.16.10.xls, gives the frequency and costs associated with each of these types of PACs during the index hospitalization (tab labeled CIP_Index PAC_Stays) and for readmissions and emergency room visits during the 30-day post-discharge period (tab labeled CIP_PAC_Readmission). The information is based on a two-year national commercially insured population (CIP) claims database. The database had 4.7 million covered lives and $95 billion in "allowed amounts" for claims costs. The database was an administrative claims database with medical as well as pharmacy claims. The two tabs demonstrate the most common PACs that occurred in patients hospitalized with pneumonia.
Numerator	Outcome: Potentially avoidable complications (PACs) in patients hospitalized for pneumonia occurring during the index stay or in the 30-day post-discharge period.
Denominator	Adult patients aged 18 – 65 years who had a relevant hospitalization for Pneumonia (with no exclusions) and were followed for one-month after discharge.
Exclusions	Denominator exclusions include exclusions of either "patients" or "claims" based on the following criteria: (1)"Patients" excluded are those that have any form of cancer (especially cancer of lung and bronchus), thalassemia, sickle-cell disease, ESRD (end-stage renal disease), transplants such as lung or heart-lung transplant or complications related to transplants, pregnancy and delivery, HIV, or suicide. (2)"Claims" are excluded from the Pneumonia measure if they are considered not relevant to pneumonia care or are for major surgical services that suggests that pneumonia may be a comorbidity associated with the procedure e.g. CABG procedure. Patients where the index hospitalization claim is excluded are automatically

Measure Title	Proportion of Patients Hospitalized with Pneumonia that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	excluded from both the numerator and the denominator.
Risk Adjustment	Conceptual Model Variations in outcomes across populations may be due to patient-related factors or due to provider-controlled factors. When we adjust for patient-related factors, the remaining variance in PACs are due to factors that could be controlled by all providers that are managing or co-managing the patient, both during and after the hospitalization. We have developed a "severity index" based on patient-related factors such as patient demographics and comorbidities. The severity-adjusted PAC counts give a fair comparison of PACs and PAC rates from population to population and helps providers determine the degree of PACs that are not related to patient-level factors but due to factors that they could control and thus result in fewer PACs being incurred by patients and paid for by payers. Methodology Overview A severity index is calculated for each patient based on the risk-adjustment model for professional and other services that determines the cost drivers for typical care for a given condition. Demographic variables, comorbid conditions, various types of services as well as different patient-level pharmacy indicators are fed into the model. Conditions and services that lead to higher costs and increased resource consumption are weighted more heavily in our model. For example, DME use is associated with a higher coefficient in the model. The model determines the patient-level factors that are drivers for increased financial risk. For each patient the "predicted" log coefficients from the severity adjustment model are summed to give the patient level severity index. The risk-adjustment variables that were included were patient demographic factors such as age and gender, medical comorbidities, procedures performed, as well as pharmacy variables. Variable Descriptions : AGE CONTINUOUS VARIABLE BACL1 ANTICOAGULANTS EDIAB ANTIDIABETICS ESTER STEROIDS GENDER 1=M 0=F GIEM ANTIEMETICS HACEI ACEI, ARB, ANTI-RENIN DRUGS HBBLK BETA-BLOCKERS HCLBK CALCIUM CHANNEL BLOCKING AGENTS HDIUR DIURETICS

Measure Title	Proportion of Patients Hospitalized with Pneumonia that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	HNITR NITRATES AND OTHER ANTIANGINALS HOTHR OTHER CARDIOVASCULAR AGENTS HPLT ANTIPLATELET AGENTS, THROMBIN INHIBITORS HVSDL VASODILATORS IANTB ANTIBIOTICS LBDIL BRONCHODILATORS AND OTHER ANTIASTHMATICS LDECG DECONGESTANTS AND ANTIHISTAMINICS LOTHR INHALERS AND RESPIRATORY AGENTS M1 TB, MYCOSES, OTHER INFECTIOUS AND PARASITIC DISEASES M10 DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS M12 ESSENTIAL HYPERTENSION M13 HYPERTENSION WITH COMPLICATIONS AND SECONDARY HYPERTENSION M14 HEART VALVE AND CONGENITAL HEART DISORDERS M15 CORONARY ATHEROSCLEROSIS AND OTHER HEART DISEASE M16 CHF, CARDITIS, CARDIOMYOPATHY M18 DISEASES OF ARTERIES ARTERIOLES AND CAPILLARIES M20 CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND BRONCHIECTASIS M21 ASTHMA M22 OTHER RESPIRATORY INFECTIONS AND DISEASES M23 ESOPHAGEAL DISORDERS M24 DISEASES OF THE DIGESTIVE SYSTEM M26 CHRONIC RENAL FAILURE AND OTHER KIDNEY DISEASE M29 DISEASES OF THE SKIN AND CONNECTIVE TISSUE M3 THYROID DISORDERS M32 CARDIAC DYSRHYTHMIAS M35 DISEASES OF BONES, JOINTS, SPINE M36 PREVENTATIVE, REHABILITATION AND AFTER CARE M37 NAUSEA, VOMITING, MALAISE, FATIGUE, FEVER M4 DIABETES MELLITUS WITHOUT COMPLICATION M5 FLUID AND ELECTROLYTE DISTURBANCES M6 OTHER ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES AND IMMUNITY DISORDERS M7 DISORDERS OF LIPID METABOLISM

Measure Title	Proportion of Patients Hospitalized with Pneumonia that have a Potentially Avoidable Complication (during the Index Stay or in the 30-day Post-Discharge Period)
	M8 ANEMIA, COAGULATION, HEMORRHAGIC DISORDERS M9 MENTAL AND BEHAVIORAL ILLNESS NSEDT SEDATIVES AND HYPNOTICS P14 NERVOUS SYSTEM, ENDOCRINE, HEAD AND NECK MINOR PROCEDURES P15 GI DIAGNOSTIC AND MINOR THERAPEUTIC PROCEDURES P23 RADIOLOGY AND RADIONUCLEAR DIAGNOSTIC SERVICES P27 ANCILLARY, HOME HEALTH, TRANSPORT P28 MEDICATION ADMINISTRATION P31 DME, VISUAL AND HEARING AIDS P35 BRONCHOSCOPY, MEDIASTINOSCOPY P36 CT SCAN AND OTHER RESPIRATORY DIAGNOSTIC PROCEDURES P6 NON-INVASIVE CARDIOVASCULAR PROCEDURES PNRF10 OBESITY, SLEEP APNEA PNRF11 OTHER RESPIRATORY SYMPTOMS, SUPPL O2 PNRF12 PNEUMONIA: SALMONELLA, POST VIRAL, TB, FUNGAL, OTHER PNRF2 STREPT, PNEUMOCOCCAL, H.INFLUENZAE, OTHER SPECIFIED PNEUMONIAE PNRF3 MYCOPLASMA, CHLAMYDIA, BRONCHOPNEUMONIA PNRF5 STAPH, MRSA, GRAM NEG & ANAEROBIC PNEUMONIA PNRF6 ACUTE RESPIRATORY INFECTIONS PNRF7 ACUTE EXACERBATION OF COPD, ASTHMA PNRF8 PLEURAL EFFUSION PNRF9 TOBACCO USE SMKS SMOKING CESSATION AGENTS ZNUTR IRON AND OTHER NUTRITIONAL SUPPLEMENTS
NQF Endorsed	Yes, #0708
Clinical Condition	Pulmonary/Critical Care, Pulmonary/Critical Care: Pneumonia

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	This measure estimates the risk-standardized rate of unplanned, all-cause readmissions for patients (Medicare fee-for-service [FFS] beneficiaries) discharged from an Inpatient Rehabilitation Facility (IRF) who were readmitted to a short-stay acute-care hospital or a Long-Term Care Hospital (LTCH), within 30 days of an IRF discharge. The measure is based on data for 24 months of IRF discharges to non-hospital post-acute levels of care or to the community. A risk-adjusted readmission rate for each facility is calculated as follows: Step 1: Calculate the standardized risk ratio of the predicted number of readmissions at the facility divided by the expected number of readmissions for the same patients if treated at the average facility. The magnitude of the risk-standardized ratio is the indicator of a facility's effects on readmission rates. Step 2: The standardized risk ratio is then multiplied by the mean rate of readmission in the population (i.e., all Medicare FFS patients included in the measure) to generate the facility-level standardized readmission rate. For this measure, readmissions that are usually for planned procedures are excluded. Please refer to Appendix Tables A1-A5 for a list of planned procedures. The measure specifications are designed to harmonize with CMS' hospital-wide readmission (HWR) measure to a great extent. The HWR (NQF #1789) estimates the hospital-level, risk-standardized rate of unplanned, all-cause readmissions within 30 days of a hospital discharge, similar to this IRF readmission measure.
Numerator	The numerator is mathematically related to the number of patients in the target population who have the event of an unplanned readmission in the 30- day post-discharge window. The measure does not have a simple form for the numerator and denominator—that is, the risk adjustment method used does not make the observed number of readmissions the numerator and a predicted number the denominator. Instead, the numerator is the risk-adjusted estimate of the number of unplanned readmissions that occurred within 30 days from discharge. This estimate includes risk adjustment for patient characteristics and a statistical estimate of the facility effect beyond patient mix.

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
Denominator	The denominator is computed with the same model used for the numerator. It is the model developed using all non-excluded IRF stays in the national data. For a particular facility the model is applied to the patient population, but the facility effect term is 0. In effect, it is the number of readmissions that would be expected for that patient population at the average IRF. The measure includes all the IRF stays in the measurement period that are observed in national Medicare FFS data and do not fall into an excluded category.
Exclusions	The measure excludes some IRF patient stays; some of these exclusions result from data limitations. The following are the measure's denominator exclusions, including the rationale for exclusion: 1. IRF patients who died during the IRF stay. Rationale: A post-discharge readmission measure is not relevant for patients who died during their IRF stay. 2. IRF patients less than 18 years old. Rationale: IRF patients under 18 years old are not included in the target population for this measure. Pediatric patients are relatively few and may have different patterns of care from adults. 3. IRF patients who were transferred at the end of a stay to another IRF or short-term acute care hospital. Rationale: Patients who were transferred to another IRF or short-term acute-care hospital are excluded from this measure because the transfer suggests that either their IRF treatment has not been completed or that their condition worsened, requiring a transfer back to the acute care setting. The intent of the measure is to follow patients deemed well enough to be discharged to a less intensive care setting (i.e., discharged to less intense levels of care or to the community). 4. Patients who were not continuously enrolled in Part A FFS Medicare for the 12 months prior to the IRF stay admission date, and at least 30 days after IRF stay discharge date. Rationale: The adjustment for certain comorbid conditions in the measure requires information on acute inpatient bills for 1 year prior to the IRF admission, and readmissions must be observable in the observation window following discharge. Patients without Part A coverage or who are enrolled in Medicare Advantage plans will not have complete inpatient claims in the system. 5. Patients who did not have a short-term acute-care stay within 30 days prior to an IRF stay admission

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
	date. Rationale: This measure requires information from the prior short-term acute-care stay in the elements used for risk adjustment. 6. IRF patients discharged against medical advice (AMA). Rationale: Patients discharged AMA are excluded because these patients have not completed their full course of treatment in the opinion of the facility. 7. IRF patients for whom the prior short-term acute-care stay was for nonsurgical treatment of cancer. Rationale: Consistent with the HWR Measure, patients for whom the prior short-term acute-care stay was for nonsurgical treatment of cancer are excluded because these patients were identified as following a very different trajectory after discharge, with a particularly high mortality rate. 8. IRF stays with data that are problematic (e.g., anomalous records for hospital stays that overlap wholly or in part or are otherwise erroneous or contradictory). Rationale: This measure requires accurate information from the IRF stay and prior short-term acute-care stays in the elements used for risk adjustment. No-pay IRF stays involving exhaustion of Part A benefits are also excluded.
Risk Adjustment	The statistical method, including risk adjustment, has many similarities with that used in the HWR measure. A hierarchical regression method is used in which a logistic regression predicting the probability of a countable (unplanned) readmission is run. The risk adjusters are predictor variables. The patient characteristics related to each discharge and a marker for the specific discharging IRF are included in the equation. The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into IRFs. The statistical model estimates both the average predictive effect of the patient characteristics across all IRFs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. The facility effects are assumed to be randomly distributed around the average (according to a normal distribution). When computing the facility effect, hierarchical modeling accounts for the known predictors of readmissions, on average, such as patient characteristics, the observed facility rate, and the number of IRF stays eligible for the measure. The estimated facility effect is determined mostly by the facility's own data if the number of patient discharges is relatively large (as the estimate would be relatively precise), but is adjusted toward the average if the number of patient discharges is small (as that would yield an estimate of lower precision).

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
	The estimated equation is used twice in the measure. The sum of the probabilities of readmission of all patients in the facility measure, including both the effects of patient characteristics and the IRF, is the "predicted number" of readmissions after adjusting for case mix. The same equation is used without the IRF effect to compute the "expected number" of readmissions for the same patients at the average IRF. The ratio of the predicted-to-expected number of readmissions is a measure of the degree to which the readmissions are higher or lower than what would otherwise be expected. This risk-standardized ratio is then multiplied by the mean readmission rate for all IRF stays to get the risk-standardized readmission rate for each facility. This estimation procedure is redone for each measurement period. Reestimating the equations for each measurement period allows the estimated effects of the patient characteristics to vary over time as medical treatment patterns change. The measurement period covers two years of IRF stays and the required time before and after the stays to create all the variables. Having two years of data increases the sample size for each facility and the precision of the estimates. Risk-adjustment variables include demographic and eligibility characteristics; principal diagnoses; types of surgery or procedure from the prior short-term stay; comorbidities; length of stay and ICU/CCU utilization from the immediately prior short-term stay; and number of admissions in the year preceding the IRF admission. The risk adjustment variables include the following: -Age/sex categories -Original reason for Medicare entitlement (age, disability or ESRD) -Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the CCS classes for ICD-9 procedures developed by AHRQ -Receiving dialysis in prior short-term stay, defined by presence of revenue code -Principal diagnosis on prior short-term bill as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ. -IRF Case-mix groups on the IRF bill -Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before IRF admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS) -Length of stay in the prior short-term hospital stay (categorical to account for nonlinearity)

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
	-Prior acute ICU/CCU utilization (days) (categorical) -Count of prior short-term discharges in the 365 days before the IRF admission (categorical)
NQF Endorsed	Yes, #2502
Clinical Condition	N/A
Measure Title	Hospital 30-day, all-cause, risk-standardized readmission rate (RSRR) following heart failure (HF) hospitalization
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital-level risk-standardized readmission rate (RSRR) for patients discharged from the hospital with a principal diagnosis of heart failure (HF). The outcome is defined as unplanned readmission for any cause within 30 days of the discharge date for the index admission. A specified set of planned readmissions do not count as readmissions. The target population is patients 18 and over. CMS annually reports the measure for patients who are 65 years or older and are either enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals or are hospitalized in Veterans Health Administration (VA) facilities.
Numerator	The outcome for this measure is 30-day readmission. We define readmission as an inpatient admission for any cause, with the exception of certain planned readmissions, within 30 days from the date of discharge from the index HF admission. If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first one is counted as a readmission. The measure looks for a dichotomous yes or no outcome of whether each admitted patient has an unplanned readmission within 30 days. However, if the first readmission after discharge is considered planned, any subsequent unplanned readmission is not counted as an outcome for that index admission because the unplanned readmission could be related to care provided during the intervening planned readmission rather than during the index admission.
Denominator	The target population for this measure is patients aged 18 years and older discharged from the hospital with a principal diagnosis of HF with a complete claims history for the 12 months prior to admission. The measure is currently publicly reported by CMS for patients 65 years and older who are either Medicare FFS beneficiaries admitted to non-federal hospitals or patients admitted to VA hospitals. As noted above, this measure can also be used for an all-payer population aged 18 years and older. We have explicitly tested the measure in both patients aged 18+ years and those aged 65+ years.

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
Exclusions	For all cohorts, the measure excludes admissions for patients: -Discharged against medical advice (AMA); -Admitted with HF within 30 days of discharge from a qualifying index admission (Admissions within 30 days of discharge of an index admission will be considered readmissions. No admission is counted as a readmission and an index admission. The next eligible admission after the 30-day time period following an index admission will be considered another index admission.) For Medicare FFS patients, the measure additionally excludes admissions for patients: -Without at least 30 days post-discharge enrollment in FFS Medicare
Risk Adjustment	Our approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et. al., 2006). The measure employs a hierarchical logistic regression model to create a hospital level 30-day RSRR. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals (Normand & Shahian, 2007). At the patient level, the model adjusts the log-odds of readmission within 30-days of discharge for age, sex, and selected clinical covariates. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of readmission, after accounting for patient risk. Candidate and Final Risk-adjustment Variables: Candidate variables were patient-level risk-adjustors that were expected to be predictive of readmission, based on empirical analysis, prior literature, and clinical judgment, including age, sex, and indicators of comorbidity and disease severity. For each patient, covariates are obtained from Medicare claims extending 12 months prior to and including the index admission. For the measure currently implemented by CMS, these risk-adjusters are identified using both inpatient and outpatient Medicare FFS claims data. However, in the all-payer hospital discharge database measure, the risk adjustment variables can be obtained only from inpatient claims in the prior 12 months and the index admission. (This was tested explicitly in our all-payer testing, as many all-payer datasets do not include outpatient claims.) The model adjusts for case mix differences based on the clinical status of patients at the time of admission. We use condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes. A file that contains a list of the ICD-9-CM codes and their groupings into CCs is attached in data field S.2b (Data Dictionary or Code Table). In addition, only comorbidities that convey information about the patient at admission or in the 12-months prior, and not complications that arise during the course of the hospitalization, are included in the risk-adjustment. Hence, we do not risk adjust for CCs that may represent adverse events of care and that are only recorded

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
	during the index admission. The final set of risk-adjustment variables is: **Demographics** Age-65 (years above 65, continuous) Male **Comorbidities** History of CABG (ICD-9-CM V45.81, 36.10–36.16) Cardio-respiratory failure and shock (CC 79) Congestive heart failure (CC 80) Acute coronary syndrome (CC 81, 82) Coronary atherosclerosis or angina (CC 83, 84) Valvular and rheumatic heart disease (CC 86) Specified arrhythmias (CC 92, 93) Other and unspecified heart disease (CC 94) Vascular or circulatory disease (CC 104-106) Metastatic cancer and acute leukemia (CC 7) Cancer (CC 8-12) Diabetes mellitus or DM complications (CC 15-20, 119, 120) Protein-calorie malnutrition (CC 21) Disorders of fluid, electrolyte, acid-base (CC 22, 23) Liver or biliary disease (CC 25-30) Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34) Other gastrointestinal disorders (CC 36) Severe hematological disorders (CC 44) Iron deficiency and other anemias and blood disease (CC 47) Dementia and other specified brain disorders (CC 49, 50) Drug/alcohol abuse/dependence/psychosis (CC 51-53) Major psychiatric disorders (CC 54-56) Depression (CC 58) Other psychiatric disorders (CC 60) Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178) Stroke (CC 95, 96) Chronic obstructive pulmonary disease (CC 108)

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
	Fibrosis of lung and other chronic lung disorders (CC 109) Asthma (CC 110) Pneumonia (CC 111-113) End-stage renal disease or dialysis (CC 130) Renal failure (CC 131) Nephritis (CC 132) Other urinary tract disorders (CC 136) Decubitus ulcer or chronic skin ulcer (CC 148, 149)
NQF Endorsed	Yes, #0330
Clinical Condition	Cardiovascular, Cardiovascular: Congestive Heart Failure
Measure Title	All-Cause Hospital Transfer/Admission
Measure Developer	ASC Quality Collaboration
Measure Description	Rate of ASC admissions requiring a hospital transfer or hospital admission upon discharge from the ASC
Numerator	Ambulatory surgical center (ASC) admissions requiring a hospital transfer or hospital admission upon discharge from the ASC.
Denominator	All ASC admissions
Exclusions	None
Risk Adjustment	No
NQF Endorsed	Yes, #0265
Clinical Condition	Surgery

Measure Title	Acute Care Hospitalization During the First 60 Days of Home Health
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Percentage of home health stays in which patients were admitted to an acute care hospital during the 60 days following the start of the home health stay.
Numerator	Number of home health stays for patients who have a Medicare claim for an unplanned admission to an acute care hospital in the 60 days following the start of the home health stay.
Denominator	Number of home health stays that begin during the 12-month observation period. A home health stay is a sequence of home health payment episodes separated from other home health payment episodes by at least 60 days.
Exclusions	The following are excluded: home health stays for patients who are not continuously enrolled in fee-for-service Medicare during the numerator window (60 days following the start of the home health stay) or until death; home health stays that begin with a Low Utilization Payment Adjustment (LUPA) claim; home health stays in which the patient receives service from multiple agencies during the first 60 days; and home health stays for patients who are not continuously enrolled in fee-for-service Medicare for the 6 months prior to the start of the home health stay.
Risk Adjustment	Multinomial logit with outcomes of "No acute event", "Emergency Department use but no Hospitalization", and "Acute Care Hospitalization". Risk factors include: Prior Care Setting – where the beneficiary received care immediately prior to beginning the home health stay. Variables are defined by examining Medicare institutional claims for the 30 days prior to Stay_Start_Date. Categories are Community (no Inpatient or Skilled Nursing Claims), Inpatient stay of 0-3 days, Inpatient stay of 4-8 days, Inpatient more than 9 days, Skilled Nursing stay of 0-13 days, Skilled Nursing stay of 14-41 days, and Skilled Nursing stay of 42+ days. A patient cared for in both a skilled nursing facility and an inpatient hospital during the 30 days prior to starting home health care is included in the skilled nursing categories not the inpatient categories.The length of stay is determined from the last inpatient or skilled nursing stay prior to beginning home health care. Age and Gender Interactions – Age categories are <65, 65-74, 75-84, 85+ and are determined based on the patient's age at Stay_Start_Date. Dual (Medicare/Medicaid) eligibility– A beneficiary with at least one month of Medicaid enrollment in the 6 months prior to Stay_Start_Date is considered dual eligible.

Measure Title	Acute Care Hospitalization During the First 60 Days of Home Health
	CMS Hierarchical condition categories (HCCs) –HCCs were developed for the risk adjustment model used in determining capitation payments to Medicare Advantage plans and are calculated using Part A and B Medicare claims. While the CMS-HHC model uses a full year of claims data to calculate HCCs, for these measures, we use only 6 months of data to limit the number of home health stays excluded due to missing HCC data. Details of the CMS-HCC model and the code lists for defining the HCCs can be found here: https://www.cms.gov/MedicareAdvtgSpecRateStats/06_Risk_adjustment.asp A description of the development of the CMS-HCC model can be found here: https://www.cms.gov/HealthCareFinancingReview/Downloads/04Summerpg119.pdf
NQF Endorsed	Yes, #0171
Clinical Condition	N/A

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital-level risk-standardized readmission rate (RSRR) of unplanned, all-cause readmission after admission for any eligible condition within 30 days of hospital discharge. The measure reports a single summary risk-standardized readmission rate (RSRR), derived from the volume-weighted results of five different models, one for each of the following specialty cohorts based on groups of discharge condition categories or procedure categories: surgery/gynecology, general medicine, cardiorespiratory, cardiovascular, and neurology, each of which will be described in greater detail below. The measure also indicates the hospital-level standardized risk ratios (SRR) for each of these five specialty cohorts. The outcome is defined as unplanned readmission for any cause within 30 days of the discharge date for the index admission. Admissions for planned procedures that are not accompanied by an acute diagnosis do not count as readmissions in the measure outcome. The target population is patients 18 and over. CMS annually reports the measure for patients who are 65 years or older and are enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals.
Numerator	The outcome for this measure is 30-day readmission. We define readmission as an inpatient admission for any cause, with the exception of certain planned readmissions, within 30 days from the date of discharge from an eligible index admission. If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first one is counted as a readmission. However, if the first readmission after discharge is considered planned, any subsequent unplanned readmission is not counted as an outcome for that index admission, because the unplanned readmission could be related to care provided during the intervening planned readmission rather than during the index admission.
Denominator	The target population for this measure is patients aged 18 years and older discharged from the hospital with a complete claims history for the 12 months prior to admission. The measure is currently publicly reported by CMS for those 65 years and older who are Medicare FFS beneficiaries admitted to non-federal hospitals. As noted above, this measure can also be used for an all-payer population aged 18 years and older. We have explicitly tested the measure in both patients aged 18+ years and those aged 65+ years.

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)
Exclusions	For all cohorts, the measure excludes admissions for patients: -Admitted to a PPS-exempt cancer hospital; -Without at least 30 days post-discharge enrollment in Medicare FFS; -Discharged against medical advice (AMA); -Admitted for primary psychiatric diagnoses; -Admitted for rehabilitation; or -Admitted for medical treatment of cancer. Additionally, in the all-payer cohort, we exclude obstetric admissions because the measure was developed among patients aged 65 years or older.
Risk Adjustment	Hierarchical logistic regression models are used to model the log-odds of readmission within 30 days of discharge, as a function of patient-level demographic and clinical characteristics and a random hospital-level intercept. This model specification accounts for within-hospital correlation of the observed outcomes and models the assumption that underlying differences in quality among the health care facilities being evaluated lead to systematic differences in outcomes. In brief, the approach simultaneously models two levels (patient and hospital) to account for the variance in patient outcomes within and between hospitals [1]. At the patient level, each model adjusts the log-odds of readmission within 30-days of discharge for age and selected clinical covariates. The second level models the hospital-specific intercepts as following a normal distribution. The hospital intercept represents the underlying hospital specific risk of readmission, after accounting for patient risk. If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts should be identical across all hospitals. We use a fixed, common set of variables in all our models for simplicity and ease of data collection and analysis. However, we estimate a hierarchical logistic regression model for each specialty cohort separately, and the coefficients associated with each variable may vary across specialty cohorts. To group ICD-9-CM codes into comorbid risk variables, we use CMS Condition Category (CMS-CCs) groups, the grouper used in previous CMS risk-standardized outcomes measures [2]. See Table 5 for the final list of comorbid risk variables. The models also include a condition-specific indicator for all condition categories with sufficient volume (defined as those with more than 1,000 admissions nationally each year for Medicare FFS data) as well as a single indicator for conditions with insufficient volume in each model. Table 5: Final comorbid risk variables

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)

	Risk Variable Group Label//CMS-CCs [2]//Description//"X" if not adjusted for if only present on index admission (complication)
	Age// n/a//Age (-18)//
	Cond. Ind.// n/a//Condition indicator (AHRQ CCS)//
	rv1// 1, 3-5//Severe infection//
	rv1//1//HIV/AIDS//
	rv1//3//Central nervous system infection//
	rv1//4//Tuberculosis//
	rv1//5//Opportunistic infections//
	rv2// 6, 111-113//Other infectious disease & pneumonias//
	rv2//6//Other infectious disease//x
	rv2//111//Aspiration and specified bacterial pneumonias//x
	rv2//112//Pneumococcal pneumonia, emphysema, lung abscess//x
	rv2//113//Viral and unspecified pneumonia, pleurisy//x
	rv3// 7//Metastatic cancer/acute leukemia//
	rv4// 8, 9//Severe cancer//
	rv4//8//Lung, upper digestive tract, and other severe cancers//
	rv4//9//Other major cancers//
	rv6// 10, 11, 12//Other major cancers//
	rv6//10//Breast, prostate, colorectal and other cancers and tumors//
	rv6//11//Other respiratory and heart neoplasms//
	rv6//12//Other digestive and urinary neoplasms//
	rv9// 15-20, 119, 120//Diabetes mellitus //
	rv9//15//Diabetes with renal manifestation//
	rv9//16//Diabetes with neurologic or peripheral circulatory manifestation//
	rv9//17//Diabetes with acute complications//x
	rv9//18//Diabetes with ophthalmologic manifestation//
	rv9//19//Diabetes with no or unspecified complications//
	rv9//20//Type I diabetes mellitus//
	rv9//119//Proliferative diabetic retinopathy and vitreous hemorrhage//
	rv9//120//Diabetic and other vascular retinopathies//
	rv10// 21//Protein-calorie malnutrition//

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)
	rv11// 25, 26//End-stage liver disease// rv11//25//End-stage liver disease// rv11//26//Cirrhosis of liver// rv12// 44//Other hematologoical disorders// rv14// 51-52//Drug and alcohol disorders// rv14//51//Drug/alcohol psychosis// rv14//52//Drug/alcohol dependence// rv15// 54-56, 58, 60//Psychiatric comorbidity// rv15//54//Schizophrenia// rv15//55//Major depressive, bipolar, and paranoid disorders// rv15//56//Reactive and unspecified psychosis// rv15//58//Depression// rv15//60//Other psychiatric disorders// rv18// 67-69, 100-102, 177, 178//Hemiplegia, paraplegia, paralysis, functional disability// rv18//67//Quadriplegia, other extensive paralysis// rv18//68//Paraplegia// rv18//69//Spinal cord disorders/Injuries// rv18//100//Hemiplegia/hemiparesis// rv18//101//Diplegia (upper), monoplegia, and other paralytic syndromes// rv18//102//Speech, language, cognitive, perceptual// rv18//177//Amputation status, lower limb/amputation// rv18//178//Amputation status, upper limb// rv19// 74//Seizure disorders and convulsions// rv20// 80//CHF//x rv21// 81-84, 89, 98, 99, 103-106//Coronary atherosclerosis or angina, cerebrovascular disease// rv21//81//Acute myocardial infarction//x rv21//82//Unstable angina and other acute ischemic heart disease//x rv21//83//Angina pectoris/old myocardial infarction// rv21//84//Coronary atherosclerosis/other chronic ischemic heart disease// rv21//89//Hypertensive heart and renal disease or encephalopathy// rv21//98//Cerebral atherosclerosis and aneurysm// rv21//99//Cerebrovascular disease, unspecified//

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)
	rv21//103//Cerebrovascular disease late effects, unspecified// rv21//104//Vascular disease with complications//x rv21//105//Vascular disease//x rv21//106//Other circulatory disease//x rv24// 92, 93//Specified arrhythmias// rv24//92//Specified heart arrhythmias// rv24//93//Other heart rhythm and conduction disorders// rv26// 108//Chronic obstructive pulmonary disease// rv27// 109//Fibrosis of lung or other chronic lung disorders// rv29// 130//Dialysis status//x rv30// 148-149//Ulcers// rv30//148//Decubitus ulcer //x rv30//149//Decubitus ulcer or chronic skin ulcer// rv31// 2//Septicemia/shock//x rv32// 22-23//Disorders of fluid, electrolyte, acid-base// rv32//22//Other significant endocrine and metabolic disorders//x rv32//23//Disorders of fluid/electrolyte/acid-base//x rv33// 47//Iron deficiency//x rv34// 79//Cardio-respiratory failure or cardio-respiratory shock//x rv39// 131//Acute renal failure//x rv40// 32//Pancreatic disease// rv41// 38//Rheumatoid arthritis and inflammatory connective tissue disease// rv42// 77//Respirator dependence/tracheostomy status// rv43// 128, 174//Transplants// rv43//128//Kidney transplant status// rv43//174//Major organ transplant status// rv44// 46//Coagulation defects and other specified hematological disorders// rv45// 158//Hip fracture/dislocation//
NQF Endorsed	Yes, #1789

Measure Title	Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)
Clinical Condition	N/A

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate (RSRR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital-level risk-standardized readmission rate (RSRR) for patients discharged from the hospital with either a principal diagnosis of COPD or a principal diagnosis of respiratory failure with a secondary diagnosis of acute exacerbation of COPD. The outcome is defined as unplanned readmission for any cause within 30 days of the discharge date for the index admission. A specified set of planned readmissions do not count as readmissions. The target population is patients 40 and over. CMS will annually report the measure for patients who are 65 years or older, are enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals.
Numerator	The outcome for this measure is 30-day readmission. We define readmission as an inpatient admission for any cause, with the exception of certain planned readmissions, within 30 days from the date of discharge from the index admission for patients discharged from the hospital with either a principal diagnosis of COPD or a principal diagnosis of respiratory failure with a secondary diagnosis of acute exacerbation of COPD. If a patient has more than one unplanned admission within 30 days of discharge from the index admission, only the first one is counted as a readmission. The measure looks for a dichotomous yes or no outcome of whether each admitted patient has an unplanned readmission within 30 days. However, if the first readmission after discharge is considered planned, any subsequent unplanned readmission is not counted as an outcome for that index admission because the unplanned readmission could be related to care provided during the intervening planned readmission rather than during the index admission.
Denominator	The target population for this measure is patients aged 40 years and older discharged from the hospital with either a principal diagnosis of COPD (see codes below) OR a principal diagnosis of respiratory failure (see codes below) WITH a secondary discharge diagnosis of acute exacerbation of COPD (see codes below) and with a complete claims history for the 12 months prior to admission. CMS will annually report the measure for patients who are 65 years or older, are enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals. As noted above, this claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 40 years or older. We have explicitly tested the measure in both age groups.
Exclusions	For all cohorts, the measure excludes admissions for patients: -Discharged against medical advice (AMA); -Admitted with COPD within 30 days of discharge from a qualifying index admission (Admissions within 30

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate (RSRR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	days of discharge of an index admission will be considered readmissions. No admission is counted as a readmission and an index admission. The next eligible admission after the 30-day time period following an index admission will be considered another index admission.) For Medicare FFS patients, the measure additionally excludes admissions for patients: -Without at least 30 days post-discharge enrollment in FFS Medicare
Risk Adjustment	Our approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et. al., 2006). The measure employs a hierarchical logistic regression model to create a hospital level 30-day RSRR. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals (Normand & Shahian, 2007). At the patient level, the model adjusts the log-odds of readmission within 30-days of discharge for age, sex, and selected clinical covariates. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of readmission, after accounting for patient risk. Candidate and Final Risk-adjustment Variables: Candidate variables were patient-level risk-adjustors that were expected to be predictive of readmission, based on empirical analysis, prior literature, and clinical judgment, including age and indicators of comorbidity and disease severity. For each patient, covariates are obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusts for case mix differences based on the clinical status of patients at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes, and combinations of CCs as candidate variables. A file that contains a list of the ICD-9-CM codes and their groupings into CCs is attached in data field S.2b (Data Dictionary or Code Table). In addition, only comorbidities that convey information about the patient at admission or in the 12- months prior, and not complications that arise during the course of the hospitalization, are included in the risk-adjustment. Hence,we do not risk adjust for CCs that may represent adverse events of care and that are only recorded in the index admission. The final set of risk adjustment variables is: **Demographics** Age (years above 65, continuous)

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate (RSRR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	Comorbidities History of Mechanical Ventilation (ICD-9 procedure codes: 93.90, 96.70, 96.71, 96.72) Sleep Apnea (ICD-9 diagnosis codes: 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57) Respirator Dependence/Respiratory Failure (CC 77-78) Cardio-Respiratory Failure and Shock (CC 79) Congestive Heart Failure (CC 80) Acute Coronary Syndrome (CC 81-82) Chronic Atherosclerosis or angina (CC 83-84) Arrhythmias (CC 92-93) Other and Unspecified Heart Disease (CC 94) Vascular or Circulatory Disease (CC 104-106) Fibrosis of Lung and Other Chronic Lung Disorder (CC 109) Pneumonia (CC 111-113) History of Infection (CC 1,3-6) Metastatic Cancer and Acute Leukemia (CC 7) Lung, Upper Digestive Tract, and Other Severe Cancers (CC 8) Lymphatic, Head and Neck, Brain, and Other Major Cancers; Breast, Colorectal and other Cancers and Tumors; Other Respiratory and Heart Neoplasms (CC 9-11) Other Digestive and Urinary Neoplasms (CC 12) Diabetes and DM Complications (CC 15-20, 119-120) Protein-Calorie Malnutrition (CC 21) Disorders of Fluid/Electrolyte/Acid-Base(CC 22-23) Other Endocrine/Metabolic/Nutritional Disorders (CC 24) Pancreatic Disease (CC 32) Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders (CC 34) Other Gastrointestinal Disorders (CC 36) Severe Hematological Disorders (CC 44) Iron Deficiency and Other/Unspecified Anemia and Blood Disease (CC 47) Dementia or Senility (CC 49-50) Drug/Alcohol Induced Dependence/Psychosis (CC 51-52)

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate (RSRR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	Major Psychiatric Disorders (CC 54-56) Depression (CC 58) Anxiety Disorders (CC 59) Other Psychiatric Disorders (CC 60) Quadripelgia, Paraplegia, Paralysis, Functional Disability (CC 67-69, 100-102, 177-178) Polyneuropathy (CC 71) Hypertensive Heart and Renal Disease or Encephalopathy (CC 89) Stroke (CC 95-96) Renal Failure (CC 131) Decubitus Ulcer or Chronic Skin Ulcer(CC 148-149) Cellulitis, Local Skin Infection (CC 152) Vertebral Fractures (CC 157)
NQF Endorsed	Yes, #1891
Clinical Condition	Pulmonary/Critical Care, Pulmonary/Critical Care: Chronic Obstructive Pulmonary Disease (COPD), Pulmonary/Critical Care: Dyspnea

Measure Title	Rehospitalization During the First 30 Days of Home Health
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Percentage of home health stays in which patients who had an acute inpatient hospitalization in the 5 days before the start of their home health stay were admitted to an acute care hospital during the 30 days following the start of the home health stay.
Numerator	Number of home health stays for patients who have a Medicare claim for an admission to an acute care hospital in the 30 days following the start of the home health stay.
Denominator	Number of home health stays that begin during the relevant observation period for patients who had an acute inpatient hospitalization in the five days prior to the start of the home health stay. A home health stay is a sequence of home health payment episodes separated from other home health payment episodes by at least 60 days.
Exclusions	The measure denominator excludes several types of home health stays: First, the measure denominator for the Rehospitalization During the First 30 Days of Home Health measure excludes the following home health stays that are also excluded from the all-patient claims-based NQF 0171 Acute Care Hospitalization measure: (i) Stays for patients who are not continuously enrolled in fee-for-service Medicare during the measure numerator window; (ii) Stays that begin with a Low-Utilization Payment Adjustment (LUPA). Stays with four or fewer visits to the beneficiary qualify for LUPAs; (iii) Stays in which the patient is transferred to another home health agency within a home health payment episode (60 days); and (iv) Stays in which the patient is not continuously enrolled in Medicare fee-for-service during the previous six months. Second, to be consistent with the Hospital-Wide All-Cause Unplanned Readmission measure (as of January 2013), the measure denominator excludes stays in which the hospitalization occurring within 5 days of the start of home health care is not a qualifying inpatient stay. Hospitalizations that do not qualify as index hospitalizations include admissions for the medical treatment of cancer, primary psychiatric disease, or rehabilitation care, and admissions ending in patient discharge against medical advice. Third, the measure denominator excludes stays in which the patient receives treatment in another setting in the 5 days between hospital discharge and the start of home health. Finally, stays with missing payment-episode authorization strings (needed for risk-adjustment) are excluded.
Risk Adjustment	The measure developer used a multinomial logistic model to account for beneficiary factors that may affect rates of hospitalization but are outside of the home health agency's control. Because these measures evaluate two different but related outcomes, one multinomial logistic framework models the

Measure Title	Rehospitalization During the First 30 Days of Home Health
	three disjoint outcomes: no acute care use (no event), emergency department use without hospital readmission, and rehospitalization. A multinomial logistic model allows for the same risk factors to affect the possible outcomes in different ways while also constraining predicted probabilities of all three events to sum to one hundred percent. The risk adjustment model uses six months of claims prior to the start of home health care to obtain information about the beneficiary. The measure developer identified a set of 404 covariates that consisted of statistically significant predictors of acute care rehospitalization or emergency use without hospital readmission. CMS published the risk adjustment model specifications on the Home Health Quality Initiative page in December 2013. The five beneficiary-level risk factors included in the multinomial logistic regression model are as follows: 1. Prior Care Setting Because beneficiaries who enter home health care from different prior care settings may have different health statuses, this model takes into account beneficiaries' immediate prior care setting. The categorical variables included in this risk factor are defined by examining Medicare claims for the 6 months prior to the start of the home health stay. One categorical variable captures prior care use in the 30 days prior to the start of home health (and prior to the index hospitalization). A second variable includes information about care received more than 30 days prior to home health but within 6 months of the start of the home health stay and identifies patients with hospitalizations, SNF care, or emergency department use during this time frame. Finally, the risk adjustment model accounts for the length of index hospital stay (i.e., one to two weeks, and greater than two weeks). 2. Age and Sex Interactions The risk adjustment model includes age and sex interactions from the Enrollment Database (EDB) as covariates to account for the differing effects of age on the outcomes for each sex. Age is subdivided into 12 bins for each sex: aged 0 to 34, 35 to 44, 45 to 54, five-year age bins from 55 to 95, and a 95 and older category. Age is determined based on the patient's age at the start of the home health stay. The model includes a binary indicator for each age-bin, sex combination. The omitted category is 65-69 year old males. 3. Health Status To account for beneficiary health status, the risk adjustment model uses three measures: (i) CMS' Hierarchical Condition Categories (HCCs), (ii) Diagnosis-Related Groupings (DRGs), (iii) and Activities of Daily Living (ADLs). First, the risk adjustment uses CMS' HCCs. HCCs were developed for the risk adjustment model used in determining capitation payments to Medicare Advantage plans and are calculated using Part A and B Medicare claims.* While the CMS-HHC model uses a full year of claims data to calculate HCCs,** the rehospitalization and ED use without hospital readmission measures use only six months of data to limit the number of home health stays excluded due to missing claims history. Binary indicators for all HCCs and CCs from the 2008 CMS HCC model that are not hierarchically ranked and that were statistically significant predictors of rehospitalization or ED use without hospital readmission are included in the

Measure Title	Rehospitalization During the First 30 Days of Home Health
	model. Next, the risk adjustment model includes the DRG of the qualifying inpatient stay. DRGs are used for Medicare payment to classify inpatient stays that are clinically related and are expected to have similar levels of resource use. Most DRGs are classified based largely on the primary diagnosis on the inpatient claim.*** Finally, risk adjustment for these measures also takes into account patient functional status by including the four separate ADL scores that appear on the home health claim. These four scores range from 0 to 16 and are calculated as part of the home health payment process by combining information from several OASIS items: (i) Dressing upper or lower body (OASIS fields M1810 or M1820) (ii) Bathing (M1830) (iii) Toileting (M1840) (iv) Transferring (M1850) (v) Ambulation (M1860) 4. Medicare Enrollment Status The model employs reason for Medicare eligibility, including ESRD status and disability status as covariates because beneficiaries with ESRD or who are disabled constitute a fundamentally different health profile than other Medicare beneficiaries. Additionally, the model includes interactions between original disabled status and sex. 5. Additional Interaction Terms Interaction terms account for the additional effect two risk factors may have when present simultaneously, which may be more or less than the additive effect of each factor separately. For example, a beneficiary with chronic heart failure and chronic obstructive pulmonary disease may be at greater risk for hospitalization than would be estimated by adding the risk of hospitalization for each condition separately. All interaction terms included in the 2008 and 2012 HCC risk adjustment models that were statistically significant predictors of rehospitalization or emergency department use without readmission were included. * A description of the development of the CMS-HCC model can be found here: https://www.cms.gov/HealthCareFinancingReview/Downloads/04Summerpg119.pdf ** Details of the CMS-HCC model and the code lists for defining the HCCs can be found here: https://www.cms.gov/MedicareAdvtgSpecRateStats/06_Risk_adjustment.asp *** Details of the DRG system can be found here: http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AcutePaymtSysfctsht.pdf ****This methodology differs from the ADL score included in the Home Health Resource Grouper (HHRG), which is a categorization of one of the four ADL scores. Further information can be found at: http://www.cms.gov/Medicare/Medicare-Fee-for-Service- Payment/HomeHealthPPS/CaseMixGrouperSoftware.html

Measure Title	Rehospitalization During the First 30 Days of Home Health
NQF Endorsed	Yes, #2380
Clinical Condition	N/A
Measure Title	Hospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Number of hospital discharges from an acute care hospital (PPS or CAH) per 1000 FFS Medicare beneficiaries at the state and community level by quarter and year.
Numerator	Number of hospital discharges from an acute care hospital (PPS or CAH)
Denominator	Medicare FFS beneficiaries, prorated based on the number of days of FFS eligibility in the time period (quarter or year).
Exclusions	None
Risk Adjustment	For the annual measure there is no risk adjustment. For the quarterly measure we add a seasonal adjustment. This allows for comparison of any and all quarters (e.g., Q1 2011; Q2 2011; Q3 2012) and trending for a state/territory or community. Without the adjustment only like quarters (e.g., Q1 2010 and Q1 2011) can be compared. The seasonal adjustment was computed by calculating the quarterly rate for each quarter, then the average rate for each quarter of the year (e.g., the Q1 average was calculated as the average of all Q1 rates: Q1 2009, Q1 2010, Q1 2011, Q1 2012, and Q1 2013). The four quarter averages were then averaged to obtain the overall mean. Next, the overall mean is subtracted from the average rate for each quarter of the year to obtain the seasonal adjustments. Finally, the seasonally adjusted rates are computed as the observed rates minus the seasonal adjustments. The seasonal adjustments are computed separately for each state and community. We did not adjust for any patient characteristics
NQF Endorsed	Yes, #2503
Clinical Condition	N/A

Measure Title	30-day Rehospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Number of rehospitalizations occurring within 30 days of discharge from an acute care hospital (prospective payment system (PPS) or critical access hospital (CAH)) per 1000 FFS Medicare beneficiaries at the state and community level by quarter and year.
Numerator	Number of rehospitalizations within 30 days of discharge from an acute care hospital (PPS or CAH).
Denominator	Medicare FFS beneficiaries, prorated based on the number of days of FFS eligibility in the time period (quarter or year).
Exclusions	None
Risk Adjustment	For the annual measure there is no risk adjustment. For the quarterly measure we add a seasonal adjustment. This allows for comparison of any and all quarters (e.g., Q1 2011; Q2 2011; Q3 2012) and trending for a state/territory or community. Without the adjustment only like quarters (e.g., Q1 2010 and Q1 2011) can be compared. The seasonal adjustment was computed by calculating the quarterly rate for each quarter, then the average rate for each quarter of the year (e.g., the Q1 average was calculated as the average of all Q1 rates: Q1 2009, Q1 2010, Q1 2011, Q1 2012, and Q1 2013). The four quarter averages were then averaged to obtain the overall mean. Next, the overall mean is subtracted from the average rate for each quarter of the year to obtain the seasonal adjustments. Finally, the seasonally adjusted rates are computed as the observed rates minus the seasonal adjustments. The seasonal adjustments are computed separately for each state and community. We did not adjust for any patient characteristics.
NQF Endorsed	Yes, #2504
Clinical Condition	N/A

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	This measure estimates the risk-standardized rate of unplanned, all-cause readmissions for patients (Medicare fee-for-service [FFS] beneficiaries) discharged from a Long-Term Care Hospital (LTCH) who were readmitted to a short-stay acute-care hospital or a Long-Term Care Hospital (LTCH), within 30 days of an LTCH discharge. The measure is based on data for 24 months of LTCH discharges to non-hospital post-acute levels of care or to the community. A risk-adjusted readmission rate for each facility is calculated as follows: Step 1: Calculate the standardized risk ratio of the predicted number of readmissions at the facility divided by the expected number of readmissions for the same patients if treated at the average facility. The magnitude of the risk-standardized ratio is the indicator of a facility's effects on readmission rates. Step 2: The standardized risk ratio is then multiplied by the mean rate of readmission in the population (i.e., all Medicare FFS patients included in the measure) to generate the facility-level standardized readmission rate. For this measure, readmissions that are usually for planned procedures are excluded. Please refer to Appendix Tables A1-A5 for a list of planned procedures. The measure specifications are designed to harmonize with CMS' hospital-wide readmission (HWR) measure to a great extent. The HWR (NQF #1789) estimates the hospital-level, risk-standardized rate of unplanned, all-cause readmissions within 30 days of a hospital discharge, similar to this LTCH readmission measure.
Numerator	The numerator is mathematically related to the number of patients in the target population who have the event of an unplanned readmission in the 30- day post-discharge window. The measure does not have a simple form for the numerator and denominator—that is, the risk adjustment method used does not make the observed number of readmissions the numerator and a predicted number the denominator. Instead, the numerator is the risk-adjusted estimate of the number of unplanned readmissions that occurred within 30 days from discharge. This estimate includes risk adjustment for patient characteristics and a statistical estimate of the facility effect beyond patient mix.

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
Denominator	The denominator is computed with the same model used for the numerator. It is the model developed using all non-excluded LTCH stays in the national data. For a particular facility the model is applied to the patient population, but the facility effect term is 0. In effect, it is the number of readmissions that would be expected for that patient population at the average LTCH. The measure includes all the LTCH stays in the measurement period that are observed in national Medicare FFS data and do not fall into an excluded category.
Exclusions	The measure excludes some LTCH patient stays; some of these exclusions result from data limitations. The following are the measure's denominator exclusions, including the rationale for exclusion: 1.LTCH patients who died during the LTCH stay. Rationale: A post-discharge readmission measure is not relevant for patients who died during their LTCH stay. 2.LTCH patients less than 18 years old. Rationale: LTCH patients under 18 years old are not included in the target population for this measure. Pediatric patients are relatively few and may have different patterns of care from adults. 3.LTCH patients who were transferred at the end of a stay to another LTCH or short-term acute-care hospital. Rationale: Patients who were transferred to another LTCH or short-term acute-care hospital are excluded from this measure because the transfer suggests that either their LTCH treatment has not been completed or that their condition worsened, requiring a transfer back to the acute care setting. The intent of the measure is to follow patients deemed well enough to be discharged to a less intensive care setting (i.e., discharged to less intense levels of care or to the community). 4.Patients who were not continuously enrolled in Part A FFS Medicare for the 12 months prior to the LTCH stay admission date, and at least 30 days after LTCH stay discharge date. Rationale: The adjustment for certain comorbid conditions in the measure requires information on acute inpatient bills for 1 year prior to the LTCH admission, and readmissions must be observable in the observation window following discharge. Patients without Part A coverage or who are enrolled in Medicare Advantage plans will not have complete inpatient claims in the system.

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
	5.Patients who did not have a short-term acute-care stay within 30 days prior to an LTCH stay admission date. Rationale: This measure requires information from the prior short-term acute-care stay in the elements used for risk adjustment. 6.LTCH patients discharged against medical advice (AMA). Rationale: Patients discharged AMA are excluded because these patients have not completed their full course of treatment in the opinion of the facility. 7.LTCH patients for whom the prior short-term acute-care stay was for nonsurgical treatment of cancer. Rationale: Consistent with the HWR Measure, patients for whom the prior short-term acute-care stay was for nonsurgical treatment of cancer are excluded because these patients were identified as following a very different trajectory after discharge, with a particularly high mortality rate. 8.LTCH stays with data that are problematic (e.g., anomalous records for hospital stays that overlap wholly or in part or are otherwise erroneous or contradictory). Rationale: This measure requires accurate information from the LTCH stay and prior short-term acute-care stays in the elements used for risk adjustment. No-pay LTCH stays involving exhaustion of Part A benefits are also excluded.
Risk Adjustment	The statistical method, including risk adjustment, has many similarities with that used in the HWR measure. A hierarchical regression method is used in which a logistic regression predicting the probability of a countable (unplanned) readmission is run. The risk adjusters are predictor variables. The patient characteristics related to each discharge and a marker for the specific discharging LTCH are included in the equation. The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into LTCHs. The statistical model estimates both the average predictive effect of the patient characteristics across all LTCHs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. The facility effects are assumed to be randomly distributed around the average (according to a normal distribution). When computing the facility effect, hierarchical modeling accounts for the known predictors of readmissions, on average, such as patient characteristics, the observed facility rate, and the number of LTCH stays eligible for the measure. The estimated facility effect is determined mostly by the facility's own data if the number of patient discharges is relatively large (as the estimate would be relatively precise), but is adjusted toward the

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
	average if the number of patient discharges is small (as that would yield an estimate of lower precision). We used the following model: [SEE EQUATION 1 IN ATTACHMENT] The estimated equation is used twice in the measure. The sum of the probabilities of readmission of all patients in the facility measure, including both the effects of patient characteristics and the LTCH, is the "predicted number" of readmissions after adjusting for case mix. The same equation is used without the LTCH effect to compute the "expected number" of readmissions for the same patients at the average LTCH. The ratio of the predicted-to-expected number of readmissions is a measure of the degree to which the readmissions are higher or lower than what would otherwise be expected. This risk-standardized ratio is then multiplied by the mean readmission rate for all LTCH stays to get the risk-standardized readmission rate for each facility. This estimation procedure is redone for each measurement period. Reestimating the equations for each measurement period allows the estimated effects of the patient characteristics to vary over time as medical treatment patterns change. The measurement period covers two years of LTCH stays and the required time before and after the stays to create all the variables. Having two years of data increases the sample size for each facility and the precision of the estimates. Risk-adjustment variables include demographic and eligibility characteristics; principal diagnoses; types of surgery or procedure from the prior short-term stay; comorbidities; length of stay and ICU/CCU utilization from the immediately prior short-term stay; and number of admissions in the year preceding the LTCH admission. The risk adjustment variables include the following: -Age/sex categories -Original reason for Medicare entitlement (age, disability or ESRD) -Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the CCS classes for ICD-9 procedures developed by AHRQ -Long-term ventilator patient in LTCH, defined by ICD-9 procedure code. -Principal diagnosis on prior short-term bill as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ. -Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before LTCH admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS) -Length of stay in the prior short-term hospital stay (categorical to account for nonlinearity)

Measure Title	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
	-Prior acute ICU/CCU utilization (days) (categorical) -Count of prior short-term discharges in the 365 days before the LTCH admission (categorical)
NQF Endorsed	Yes, #2512
Clinical Condition	N/A

Measure Title	Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Rate of risk-standardized, all-cause, unplanned hospital visits within 7 days of an outpatient colonoscopy among Medicare fee-for-service (FFS) patients aged 65 years and older.
Numerator	The outcome for this measure is all-cause, unplanned hospital visits within 7 days of an outpatient colonoscopy. We define a hospital visit as any emergency department (ED) visit, observation stay, or unplanned inpatient admission.
Denominator	Colonoscopies performed at hospital outpatient departments (HOPDs) and ambulatory surgical centers (ASCs) for Medicare FFS patients aged 65 years and older.
Exclusions	We established the following exclusion criteria after reviewing the literature, examining existing measures, and discussing alternatives with the working group and technical expert panel (TEP) members. The goal was to be as inclusive as possible; we excluded only those high-risk procedures and patient groups for which risk adjustment would not be adequate or for which hospital visits were not typically a quality signal. The exclusions, based on clinical rationales, prevent unfair distortion of performance results. 1) Colonoscopies for patients who lack continuous enrollment in Medicare FFS Parts A and B in the 1 month after the procedure. Rationale: We exclude these patients to ensure full data availability for outcome assessment. 2) Colonoscopies that occur concurrently with high-risk upper gastrointestinal (GI) endoscopy procedures. Rationale: Patients undergoing concurrent high-risk upper GI endoscopy procedures, such as upper GI endoscopy procedures for the control of bleeding or treatment of esophageal varices, are often unwell and have a higher risk profile than typical colonoscopy patients. Therefore these patients have a

Measure Title	Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy
	disproportionally higher risk for the outcome. 3) Colonoscopies for patients with a history of inflammatory bowel disease (IBD). Rationale: We exclude these patients because: -IBD is a chronic condition; patients with IBD undergo colonoscopy for both surveillance due to increased cancer risk and for evaluation of acute symptoms. IBD is likely to be coded as the primary diagnosis prompting the procedure irrespective of whether the patients are undergoing a screening procedure or a diagnostic procedure in the setting of an acute exacerbation of IBD. Therefore, we may not be able to adequately risk adjust for these patients as we cannot identify relatively well versus acutely unwell patients among visits coded as IBD. -Our aim is to capture hospital visits which reflect the quality of care. Admissions for acutely ill IBD patients who are evaluated with an outpatient colonoscopy and are subsequently admitted for medical treatment of an IBD flare do not reflect the quality of the colonoscopy. In our 2010 Medicare 20% FFS Full Development Sample (see Measure Testing Form Section 1.2 and 1.7 for full description of the dataset), more than one third of IBD patients admitted to the hospital with colonoscopy had a discharge diagnosis of IBD, indicating their admission was for medical treatment of their IBD. We therefore excluded this group so that providers who treat a disproportionate number of IBD patients will not be disadvantaged in the measure. 4) Colonoscopies for patients with a history of diverticulitis. Rationale: We exclude these patients because: -It is unclear what the health status is of patients coded with a history of diverticulitis, making it difficult to fully risk adjust for patients' health. Colonoscopies performed on patients with a history of diverticulitis are likely to be coded as diverticulitis as the primary diagnosis irrespective of whether the patients are undergoing a screening procedure or a diagnostic procedure (i.e., are acutely unwell with active disease). Furthermore, the codes for diverticulitis and diverticulosis may not be consistently used; patients with diverticulosis may be erroneously coded as diverticulitis. Therefore, we may not be able to adequately risk adjust as we cannot identify relatively well versus acutely unwell patients among visits coded as diverticulitis. -Admissions for acutely ill patients with a history of diverticulitis who are evaluated with an outpatient colonoscopy and are subsequently admitted for medical treatment of do not reflect the quality of the colonoscopy. In our 2010 Medicare 20% FFS Full Development Sample (see Measure Testing Form Section 1.2 and 1.7 for full description of the dataset) more than one quarter of patients with a history of

Measure Title	Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy
	diverticulitis admitted to the hospital post colonoscopy had a discharge diagnosis of diverticulitis, indicating they were admitted for medical treatment of the condition. These admissions are likely unrelated to the quality of the colonoscopy. We therefore excluded this group so that providers who treat a disproportionate number of diverticulitis patients will not be disadvantaged in the measure.
Risk Adjustment	Our approach to risk adjustment is tailored to, and appropriate for, a publicly reported outcome measure as articulated in published scientific guidelines [1,2]. We use a two-level hierarchical logistic regression model to estimate risk-standardized hospital visit rates. This approach accounts for the clustering of patients within facilities and variation in sample size. The risk-standardization model has 15 patient-level variables (age, concomitant upper GI endoscopy, polypectomy and 12 comorbidity variables). We define comorbidity variables using condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9 diagnosis codes. A map showing the assignment of ICD-9 codes to CCs can be found in the attached Data Dictionary, sheet "S.14 CC-ICD-9 Map." Certain CCs are considered possible complications of care and are not risk-adjusted for if they only occur at the procedure. This is because only comorbidities that convey information about the patient at the time of the procedure or in the 12 months prior, and not complications that arose during the colonoscopy procedure, are included in the risk adjustment. See attached Data Dictionary, sheet "S.14 Stat Risk Model Method" for CCs that are considered possible complications of care and are not risk-adjusted for if they only occur at the procedure. Model Variables The patient-level risk-adjustment variables are: Age Categorized (65-69; 70-74; 75-79; 80-84; 85+) Concomitant Endoscopy Polypectomy during Procedure Chronic Heart Failure (CC 80) Ischemic Heart Disease (CC 81-84) Stroke/Transient Ischemic Attack (TIA) (CC 95-97) Chronic Lung Disease (CC 108-110) Metastatic Cancer (CC 7-9) Liver Disease (CC 25-30) Iron Deficiency Anemia (CC 47) Disorders of Fluid, Electrolyte, Acid-Base (CC 23) Pneumonia (CC 111-113)

Measure Title	Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy
	Psychiatric Disorders (CC 54-56, 58-60) Drug and Alcohol Abuse/Dependence (CC 51-53) Arrhythmia (CC 92-93) Age Categorized x Arrhythmia Interaction Note: The relationship between risk of a hospital visit within 7 days and age was modified by the presence or absence of a cardiac arrhythmia (p-value for interaction <0.001). Therefore, we included an interaction term (age categorized x arrhythmia) in the final model.
NQF Endorsed	Yes, #2579
Clinical Condition	Cancer: Screening, Gastrointestinal (GI), Gastrointestinal (GI): GI Bleeding, Gastrointestinal (GI): Polyps, Gastrointestinal (GI): Screening

Mortality

Measure Title	Dialysis Facility Risk-adjusted Standardized Mortality Ratio
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	Risk-adjusted standardized mortality ratio for dialysis facility patients.
Numerator	Number of deaths among eligible patients at the facility during the time period.
Denominator	Number of deaths that would be expected among eligible dialysis patients at the facility during the time period, given the mortality rate is at the national average and the patient mix at the facility.
Exclusions	None
Risk Adjustment	The SMR is based on expected mortality calculated from a Cox model (Cox, 1972; SAS Institute Inc., 2004; Kalbfleisch and Prentice, 2002; Collett, 1994). The model used is fit in two stages. The stage 1 model is a Cox model stratified by facility and adjusted for patient age, race, ethnicity, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status from previous year, patient comorbidities at incidence, calendar year and body mass index (BMI) at incidence. This model allows the baseline survival

Measure Title	Dialysis Facility Risk-adjusted Standardized Mortality Ratio
	probabilities to vary between strata (facilities), and assumes that the regression coefficients are the same across all strata. Stratification by facility at this stage avoids biases in estimating regression coefficients that can occur if the covariate distributions vary substantially across centers. The patient characteristics included in the stage 1 model as covariates are • Age: We determine each patient's age for the birth date provided in the SIMS and REMIS databases. Age is included as a piecewise continuous variable with different coefficients based on whether the patient is 0-13 years old, 14-60 years old, or 61+ years old. • Sex: We determine each patient's sex from his/her Medical Evidence Form (CMS-2728). • Race (White, Black, Asian/PI, Native American or other): We determine race from REBUS/PMMIS, the EDB(Enrollment Data Base), and SIMS. • Ethnicity (Hispanic, non-Hispanic or unknown): We determine ethnicity from his/her CMS-2728. • Diabetes as cause of ESRD: We determine each patient's primary cause of ESRD from his/her CMS-2728. • Duration of ESRD: We determine each patient's length of time on dialysis using the first service date from his/her CMS-2728, claims history (all claim types), the SIMS database and the SRTR database and categorize as less than one year, 1-2 years, 2-3 years, or 3+ years as of the period start date. • Nursing home status in previous year: Using the Nursing Home Minimum Dataset, we determine if a patient was in a nursing home the previous year. • BMI at incidence: We calculate each patient's BMI as the height and weight provided on his/her CMS 2728. BMI is included as a log-linear term. The logarithm of BMI is included as a piecewise continuous log-linear term with different coefficients based on whether the log of BMI is greater or less than 3.5. • Comorbidities at incidence: We determine each patient's comorbidities at incidence from his/her CMS-2728 namely, alcohol dependence, atherosclerotic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, congestive heart failure, diabetes (includes currently on insulin, on oral medications, without medications, and diabetic retinopathy), drug dependence, inability to ambulate, inability to transfer, malignant neoplasm, cancer, other cardiac disease, peripheral vascular disease, and tobacco use (current smoker). Each comorbidity is included as a separate indicator in the model, having a value of 1 if the patient has that comorbidity, and a value of 0 otherwise.. Another categorical indicator variable is included as a covariate in the stage 1 model to flag records where patients have at least one comorbidities. This variable has a value of 1 if the patient has at least one comorbidity and a value of 0 otherwise. • Calendar year: 2010-2013 • Missing indicator variables: Categorical indicator variables are included as covariates in the stage I

Measure Title	Dialysis Facility Risk-adjusted Standardized Mortality Ratio
	model to account for records with missing values for cause of ESRD, comorbidity at incidence(missing CMS-2728 form), and BMI. These variables have a value of 1 if the patient is missing the corresponding variable and a value of 0 otherwise. • BMI is imputed when either missing, or outside the range of [10,70) for adults or [5,70) for children. To impute BMI, we used the average values of the group of patients with similar characteristics (age, race, sex, diabetes) when data for all four of these characteristics were available. If either race or diabetes was also missing, the imputation was based on age and sex only. If either age or sex is missing, the patient is excluded from computations. • Beside main effects, two-way interaction terms between age, race, ethnicity, sex duration of ESRD and diabetes as cause of ESRD are also included: • Age*Race: Black • Ethnicity*Race: Non-White • Diabetes as cause of ESRD*Race • Diabetes as cause of ESRD*Vintage • Duration of ESRD: less than or equal to 1 year *Race • Duration of ESRD: less than or equal to 1 year* Sex • Diabetes as cause of ESRD*Sex • Sex*Race: Black Using the estimates of the regression coefficients from stage 1, we estimate the relative risk for each patient-record. The predicted value for the patient-record from stage 1 is then used as an offset in the stage 2 model, which is unstratified and includes an adjustment for the race-specific age-adjusted state population death rates. Age-adjusted population death rates (per 100,000) by state and race are obtained from the U.S. Centers for Disease Control National Center for Health Statistics. The 2014 DFR used age-adjusted death rates for 2008-10 from Table 19 of the publication Health, United States, 2013, available at http://www.cdc.gov/nchs/data/hus/hus13.pdf. Each patient typically gives rise to several patient-records. Specifically, a new patient record is defined for each calendar year and each time a patient changes facilities. The ith patient record is associated with a risk period ti, which specifies the number of days that the patient is at risk during that record. Note that each patient record corresponds to a single facility and to a single calendar year. The Cox model is applied in two stages. Stage 1 yields estimates of the coefficients (ßj) for the 56 covariates that are measured on individual patients (or patient-records). The coefficients measure the

Measure Title	Dialysis Facility Risk-adjusted Standardized Mortality Ratio
	within-facility effects for individual risk factors or comorbidities. Using these coefficients, a relative risk or predicted risk is calculated for each patient-record. Stage 2 adjusts for the differences in mortality rate at the state level. The model of this stage uses only one covariate, the log of the population death rate for that patient's race within the state where the patient is being treated. The predicted value for the patient-record from stage 1 is used as an offset in the stage 2 model and the stage 2 analysis is not stratified. The combined predicted values from stages 1 and 2, and the baseline survival curve from stage 2 of the Cox model are then used to calculate the expected number of deaths for a specific patient-record.
NQF Endorsed	Yes, #0369
Clinical Condition	Renal, Renal: End Stage Renal Disease (ESRD)

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital-level risk-standardized mortality rate (RSMR), defined as death from any cause within 30 days after the index admission date, for patients 40 and older discharged from the hospital with either a principal diagnosis of COPD or a principal diagnosis of respiratory failure with a secondary diagnosis of acute exacerbation of COPD. CMS will annually report the measure for patients who are 65 years or older, enrolled in fee-for-service (FFS) Medicare, and hospitalized in non-federal hospitals.
Numerator	The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days from the date of admission for patients 40 and older discharged from the hospital with either a principal diagnosis of COPD or a principal diagnosis of respiratory failure with a secondary diagnosis of acute exacerbation of COPD.
Denominator	This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 40 years or older. The cohort includes admissions for patients discharged from the hospital with either a principal diagnosis of COPD (see codes below) OR a principal diagnosis of respiratory failure (see codes below) WITH a secondary diagnosis of acute exacerbation of COPD (see codes below) and with a complete claims history for the 12 months prior to admission.
Exclusions	The measure excludes index admissions for patients: 1. Discharged alive on the day of admission or the following day who were not transferred; 2. With inconsistent or unknown vital status or other unreliable demographic data; 3. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission; and 4. Who were discharged against medical advice (AMA). After the above exclusions (#1-4) are applied, the measure randomly selects one index admission per

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	patient per year for inclusion in the cohort. Each episode of care must be mutually independent with the same probability of the outcome. The probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure only includes the June admission. The July admissions are excluded from the measure to avoid assigning a single death to two admissions.
Risk Adjustment	Our approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et. al., 2006). The measure employs a hierarchical logistic regression model to create a hospital level 30-day RSMR. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals (Normand & Shahian, 2007). At the patient level, the model adjusts the log-odds of mortality within 30-days of admission for age, and selected clinical covariates. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of mortality, after accounting for patient risk. Candidate and Final Risk-adjustment Variables: Candidate variables were patient-level risk-adjustors that were expected to be predictive of mortality, based on empirical analysis, prior literature, and clinical judgment, including age and indicators of comorbidity and disease severity. For each patient, covariates are obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusts for case mix differences based on the clinical status of patients at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes, and combinations of CCs as candidate variables. A file that contains a list of the ICD-9-CM codes and their groupings into CCs is attached in data field S.2b (Data Dictionary or Code Table). In addition, only comorbidities that convey information about the patient at admission or in the 12- months prior, and not complications that arise during the course of the hospitalization, are included in the risk-adjustment. Hence, we do not risk adjust for CCs that may represent adverse events of care and that are only recorded in the index admission. The final set of risk adjustment variables are:

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	Demographics Age (years above 65, continuous) Comorbidities Sleep Apnea (ICD-9 codes: 327.20, 327.21, 327.23, 327.27, 327.29, 780.51, 780.53, 780.57) History of Mechanical Ventilation (ICD-9 codes: 93.90, 96.70, 96.71, 96.72) Respirator Dependence/Respiratory Failure (CC 77-78) Cardio-Respiratory Failure and Shock (CC 79) Congestive Heart Failure (CC 80) Coronary atherosclerosis or angina (CC 83-84) Arrhythmias (CC 92-93) Vascular or Circulatory Disease (CC 104-106) Fibrosis of Lung and Other Chronic Lung Disorder (CC 109) Asthma (CC 110) Pneumonia (CC 111-113) Pleural Effusion/Pneumothorax (CC 114) Other Lung Disorders (CC 115) Metastatic Cancer and Acute Leukemia (CC 7) Lung, Upper Digestive Tract, and Other Severe Cancers (CC 8) Lymphatic, Head and Neck, Brain, and Other Major Cancers; Breast, Prostate, Colorectal and Other Cancers and Tumors; Other Respiratory and Heart Neoplasms (CC 9-11) Other Digestive and Urinary Neoplasms(CC 12) Diabetes mellitus (DM) or DM complications (CC 15-20, 119-120) Protein-calorie Malnutrition (CC 21) Disorders of Fluid/Electrolyte/Acid-Base (CC 22-23) Other Endocrine/Metabolic/Nutritional Disorders (CC 24) Other Gastrointestinal Disorders (CC 36) Osteoarthritis of Hip or Knee (CC 40) Other Musculoskeletal and Connective Tissue Disorders (CC 43)

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) following Chronic Obstructive Pulmonary Disease (COPD) Hospitalization
	Iron Deficiency and Other/Unspecified Anemias and Blood Disease (CC 47) Dementia or other specified brain disorders (CC 49-50) Drug/Alcohol Abuse, Without Dependence (CC 53) Other Psychiatric Disorders (CC 60) Hemiplegia, Paraplegia, Paralysis, Functional Disability (CC 67-69, 100-102, 177-178) Mononeuropathy, Other Neurological Conditions/Injuries (CC 76) Hypertension and Hypertensive Disease (CC 90-91) Stroke (CC 95-96) Retinal Disorders, Except Detachment and Vascular Retinopathies (CC 121) Other Eye Disorders (CC 124) Other Ear, Nose, Throat and Mouth Disorders (CC 127) Renal Failure (CC 131) Decubitus ulcer or chronic skin ulcer (CC 148-149) Other Dermatological Disorders (CC 153) Trauma (CC 154-156, 158-161) Vertebral Fractures (CC 157) Major Complications of Medical Care and Trauma (CC 164)
NQF Endorsed	Yes, #1893
Clinical Condition	Pulmonary/Critical Care, Pulmonary/Critical Care: Chronic Obstructive Pulmonary Disease (COPD), Pulmonary/Critical Care: Dyspnea

Measure Title	Hospital 30-Day Risk-Standardized Acute Myocardial Infarction (AMI) Mortality eMeasure
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	This measure estimates hospital 30-day risk-standardized mortality rates following admission for AMI using clinical information collected at presentation in an electronic health record (EHR). Mortality is defined as death from any cause within 30 days of the index admission date.
Numerator	The outcome for this measure is 30-day all-cause mortality. We define all-cause mortality as death from any cause within the 30 days after the index admission date.
Denominator	The cohort includes inpatient admissions for patients aged 65 years and older who were discharged from short-term acute care hospitals with a principal discharge diagnosis of AMI.
Exclusions	The measure excludes index admissions: 1) For patients who were discharged against medical advice (AMA) (because providers did not have the opportunity to deliver full care and prepare the patient for discharge); 2) For patients who were transferred in from another short-term acute care institution (because the death is attributed to the hospital where the patient was initially admitted); 3) With unreliable data (age >115 years); 4) That were not randomly selected from a patient's multiple qualifying AMI admissions in a year (because AMI patients may have multiple admissions in a year and the measure includes one randomly selected AMI admission per patient per year); 5) With unknown death (missing vital status) after linking to the Medicare Enrollment Database or other source of death data.
Risk Adjustment	The approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et al., 2006). For each patient, covariates are obtained from administrative data extending 12 months prior to, and including, the index admission. For all patients, information from Medicare inpatient claims, physician Part B claims and hospital outpatient claims are used for risk adjustment. For patients with an index

Measure Title	Hospital 30-Day Risk-Standardized Acute Myocardial Infarction (AMI) Mortality eMeasure
	admission in a Veterans Health Administration (VA) hospital, VA administrative data is also obtained. Inpatient claim records have data on hospitalization and include demographic information, principal and secondary diagnosis codes, and procedure codes. Diagnosis codes for comorbidities are also collected from physician and hospital outpatient files. These data are captured from the claim(s) for the index admission and from all inpatient and outpatient claims for the entire year before the patient's index acute myocardial infarction (AMI) hospitalization to be utilized in the risk-adjustment model. The VA administrative data includes 41 diagnosis and 46 procedure codes (as opposed to 25 and 25, respectively, in Centers for Medicare & Medicaid Services [CMS] administrative data). For the index hospitalization, all diagnosis and procedure codes were retained. For risk adjustment, all diagnosis and procedure codes were retained for visits prior to the index hospitalization. Only variables that convey information about patients' clinical status at the time of admission are used for the risk-adjustment, while complications that arise during the course of patients' index hospitalization are not included in the model. The final set of risk-adjustment variables included: Demographics Age 65 (years above 65, continuous) Male Cardiovascular History of percutaneous transluminal coronary angioplasty (PTCA) History of coronary artery bypass grafting (CABG) Congestive heart failure History of AMI Other acute/subacute forms of ischemic heart disease Anterior myocardial infarction Other location of myocardial infarction Chronic atherosclerosis

Measure Title	Hospital 30-Day Risk-Standardized Acute Myocardial Infarction (AMI) Mortality eMeasure
	Cardio-respiratory failure and shock Valvular and rheumatic heart disease Comorbidity Hypertension Stroke Cerebrovascular disease Renal failure Chronic obstructive pulmonary disease (COPD) Pneumonia Diabetes and diabetes mellitus (DM) complications Protein-calorie malnutrition Dementia and senility Hemiplegia, paraplegia, paralysis, functional disability Peripheral vascular disease Metastatic cancer, acute leukemia, and other severe cancers Trauma in the last year Major psychiatric disorders Chronic liver disease Hierarchical logistic regression modeling is used to calculate a hospital-specific risk-standardized mortality rate (RSMR). This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital's performance given its case-mix to an average hospital's performance with the same case-mix. Thus, a lower ratio indicates lower-than-expected mortality or better quality, and a higher ratio indicates higher-than-expected mortality or worse quality. To assess hospital performance in any reporting period, the model coefficients are re-estimated using the years of data in that period. Refer to the 2014 Measures Updates and Specifications Report. Hospital-level 30-day Risk-standardized Mortality Measures for additional information (see also the "Companion Documents" field).
NQF Endorsed	Yes, #2473

Measure Title	Hospital 30-Day Risk-Standardized Acute Myocardial Infarction (AMI) Mortality eMeasure
Clinical Condition	Cardiovascular: Acute Myocardial Infarction

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Coronary Artery Bypass Graft (CABG) Surgery
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital-level, risk-standardized mortality rate (RSMR) for patients 18 years and older discharged from the hospital following a qualifying isolated CABG procedure. Mortality is defined as death from any cause within 30 days of the procedure date of an index CABG admission. The measure was developed using Medicare Fee-for-Service (FFS) patients 65 years and older and was tested in all-payer patients 18 years and older. An index admission is the hospitalization for a qualifying isolated CABG procedure considered for the mortality outcome.
Numerator	The outcome for this measure is 30-day all-cause mortality. Mortality is defined as death for any reason within 30 days of the procedure date from the index admission for patients 18 and older discharged from the hospital after undergoing isolated CABG surgery.
Denominator	This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older. We have tested the measure in both age groups. The cohort includes admissions for patients who receive a qualifying isolated CABG procedure (see codes below) and with a complete claims history for the 12 months prior to admission. For simplicity of implementation and as testing demonstrated closely correlated patient-level and hospital-level results using models with or without age interaction terms, the only recommended modification to the measure for application to all-payer data sets is replacement of the “Age-65” variable with a fully continuous age variable. If a patient has more than one qualifying isolated CABG admission in a year, one hospitalization is randomly selected for inclusion in the measure.
Exclusions	Hospitalizations are excluded if they meet any of the following criteria. Hospitalizations for: 1) Patients with inconsistent or unknown vital status or other unreliable data. Rationale: We exclude these because the outcome cannot be adequately measured in these patients.

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Coronary Artery Bypass Graft (CABG) Surgery
	2) Patients who leave the hospital against medical advice (AMA) Rationale: We exclude hospitalizations for patients who are discharged AMA because providers did not have the opportunity to deliver full care and prepare the patient for discharge. 3) Patients with qualifying CABG procedures subsequent to another qualifying CABG procedure during the measurement period Rationale: CABG procedures are expected to last for several years without the need for revision or repeat revascularization. A repeat CABG procedure during the measurement period very likely represents a complication of the original CABG procedure and is a clinically more complex and higher risk surgery. We, therefore, select the first CABG admission for inclusion in the measure and exclude subsequent CABG admissions from the cohort.
Risk Adjustment	The approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et al., 2006). For each patient, covariates are obtained from administrative data extending 12 months prior to, and including, the index admission. For all patients, information from Medicare inpatient claims, physician Part B claims and hospital outpatient claims are used for risk adjustment. For patients with an index admission in a Veterans Health Administration (VA) hospital, VA administrative data is also obtained. Inpatient claim records have data on hospitalization and include demographic information, principal and secondary diagnosis codes, and procedure codes. Diagnosis codes for comorbidities are also collected from physician and hospital outpatient files. These data are captured from the claim(s) for the index admission and from all inpatient and outpatient claims for the entire year before the patient's index heart failure (HF) hospitalization to be utilized in the risk-adjustment model. The VA administrative data includes 41 diagnosis and 46 procedure codes (as opposed to 25 and 25, respectively, in Centers for Medicare & Medicaid Services [CMS] administrative data). For the index hospitalization, all diagnosis and procedure codes were retained. For risk adjustment, all diagnosis and procedure codes were retained for visits prior to the index hospitalization. Only variables that convey information about patients' clinical status at the time of admission are used for the risk-adjustment, while complications that arise during the course of patients' index hospitalization are not included in the model.

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Coronary Artery Bypass Graft (CABG) Surgery
	The final set of risk-adjustment variables included: Demographics Age 65 (years above 65, continuous) Male Cardiovascular History of percutaneous transluminal coronary angioplasty (PTCA) History of coronary artery bypass grafting (CABG) Congestive heart failure History of acute myocardial infarction (AMI) Other acute/subacute forms of ischemic heart disease Chronic atherosclerosis Cardio-respiratory failure and shock Valvular and rheumatic heart disease Comorbidity Hypertension Stroke Renal failure Chronic obstructive pulmonary disease (COPD) Pneumonia Diabetes and diabetes mellitus (DM) complications Protein-calorie malnutrition Dementia and senility Hemiplegia, paraplegia, paralysis, functional disability Peripheral vascular disease Metastatic cancer, acute leukemia, and other severe cancers Trauma in the last year Major psychiatric disorders Chronic liver disease Hierarchical logistic regression modeling is used to calculate a hospital-specific risk-standardized mortality rate (RSMR). This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital's performance given its

Measure Title	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Coronary Artery Bypass Graft (CABG) Surgery
	case-mix to an average hospital's performance with the same case-mix. Thus, a lower ratio indicates lower-than-expected mortality or better quality, and a higher ratio indicates higher-than-expected mortality or worse quality. To assess hospital performance in any reporting period, the model coefficients are re-estimated using the years of data in that period. Refer to the 2014 Measures Updates and Specifications Report. Hospital-level 30-day Risk-standardized Mortality Measures for additional information (see also the "Companion Documents" field).
NQF Endorsed	Yes, #2558
Clinical Condition	Cardiovascular, Cardiovascular: Ischemic Heart Disease, Coronary Artery Disease, Surgery: Cardiac Surgery

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital 30-day risk-standardized mortality rate (RSMR), defined as death for any cause within 30 days after the date of admission of the index admission, for patients 18 and older discharged from the hospital with a principal diagnosis of pneumonia. CMS annually reports the measure for patients who are 65 years or older and are either enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals or are hospitalized in Veterans Health Administration (VA) facilities.
Numerator	The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days of the index admission date for patients 18 and older discharged from the hospital with a principal diagnosis of pneumonia. The numerator of the risk-adjusted ratio is the predicted number of deaths within 30 days given the hospital's performance with its observed case mix. The term "predicted" describes the numerator result, which is calculated using the hospital-specific intercept term. (See details below in the 2a1.13 Statistical risk model and variables.)
Denominator	This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older. The cohort includes admissions for patients discharged from the hospital with a principal discharge

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	diagnosis of pneumonia and with a complete claims history for the 12 months prior to admission.
Exclusions	The measure excludes index admissions for patients: 1. Discharged alive on the day of admission or the following day who were not transferred; 2. With inconsistent or unknown vital status or other unreliable demographic data; 3. Enrolled in the Medicare hospice program or VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission; and 4. Who were discharged against medical advice (AMA). After the above exclusions (#1-4) are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Each episode of care must be mutually independent with the same probability of the outcome. The probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure only includes the June admission. The July admissions are excluded from the measure to avoid assigning a single death to two admissions.
Risk Adjustment	Our approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et. al., 2006). The proposed measure employs a hierarchical logistic regression model to create a hospital level 30-day RSMR. In brief, the approach simultaneously models two levels (patient and hospital) to account for the variance in patient outcomes within and between hospitals(Normand & Shahian, 2007). At the patient level, each model adjusts the log-odds of mortality within 30 days of admission for age and selected clinical covariates. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of mortality, after accounting for patient risk. See section 2a1.20. Calculation Algorithm/Measure Logic for more detail. Candidate and Final Risk-adjustment Variables: Candidate variables were patient-level risk-adjustors that were expected to be predictive of mortality, based on empirical analysis, prior literature, and clinical judgment, including age and indicators of comorbidity and disease severity. For each patient, covariates are obtained from Medicare claims

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	extending 12 months prior to and including the index admission. The model adjusts for case mix differences based on the clinical status of patients at the time of admission. We use condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes. A file which contains a list of the ICD-9-CM codes and their groupings into CCs is available at http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1182785083979. In addition, only comorbidities that convey information about the patient at that time or in the 12-months prior, and not complications that arise during the course of the hospitalization are included in the risk-adjustment. Hence, we do not risk-adjust for CCs that may represent adverse events of care and that are only recorded in the index admission. The final set of risk-adjustment variables is: **Demographic** Age-65 (years above 65, continuous) Male **Cardiovascular** History of PTCA History of CABG Congestive heart failure (CC 80) Acute Myocardial Infarction (CC 81) Unstable angina (CC 82) Chronic atherosclerosis (CC 83, 84) Cardio-respiratory failure and shock (CC 79) **Comorbidity** Hypertension (CC 89, 91) Stroke (CC 95, 96) Cerebrovascular disease (CC 97-99, 103) Renal failure (CC 131) Chronic Obstructive Pulmonary Disease (CC 108) Pneumonia (CC 111-113) Protein-calorie malnutrition (CC 21) Dementia and senility (CC 49, 50) Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178) Peripheral vascular disease (CC104, 105)

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	Metastatic cancer and acute leukemia and other severe cancers (CC 7, 8) Trauma in the last year (CC154-156, 158-162) Major psychiatric disorders (CC54-56) Chronic liver disease (CC25-27) Severe hematological disorders (CC44) Iron deficiency/anemias/blood diseases (CC47) Depression (CC 58) Parkinson's/Huntington's diseases (CC73) Seizure disorders and convulsions (CC 74) Fibrosis of lung and other chronic lung disorders (CC109) Asthma (CC 110) Vertebral fractures (CC 157)
NQF Endorsed	Yes, #0468
Clinical Condition	Pulmonary/Critical Care: Pneumonia
Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following heart failure (HF) hospitalization for patients 18 and older.
Measure Developer	Centers for Medicare & Medicaid Services
Measure Description	The measure estimates a hospital 30-day risk-standardized mortality rate (RSMR). Mortality is defined as death for any cause within 30 days after the date of admission of the index admission, for patients 18 and older discharged from the hospital with a principal diagnosis of heart failure (HF). CMS annually reports the measure for patients who are 65 years or older and are either enrolled in fee-for-service (FFS) Medicare and hospitalized in non-federal hospitals or are hospitalized in Veterans Health Administration (VA) facilities.
Numerator	The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days of the index admission date for patients 18 and older discharged from the hospital with a principal diagnosis of HF.
Denominator	This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older.

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	The cohorts include admissions for patients discharged from the hospital with a principal diagnosis of HF and with a complete claims history for the 12 months prior to admission.
Exclusions	The measure excludes index admissions for patients: 1. Discharged alive on the day of admission or the following day who were not transferred; 2. With inconsistent or unknown vital status or other unreliable demographic data; 3. Enrolled in the Medicare or VA Hospice programs any time in the 12 months prior to the index admission, including the first day of the index admission; and 4. Who were discharged against medical advice (AMA). After the above exclusions (#1-4) are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort. Each episode of care must be mutually independent with the same probability of the outcome. The probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure only includes the June admission. The July admissions are excluded from the measure to avoid assigning a single death to two admissions.
Risk Adjustment	Our approach to risk adjustment is tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et. al., 2006). The measure employs a hierarchical logistic regression model to create a hospital level 30-day RSMR. In brief, the approach simultaneously models data at the patient and hospital levels to account for the variance in patient outcomes within and between hospitals (Normand & Shahian, 2007). At the patient level, the model adjusts the log-odds of mortality within 30-days of admission for age, sex, and selected clinical covariates. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of mortality, after accounting for patient risk. Candidate and Final Risk-adjustment Variables: Candidate variables were patient-level risk-adjustors that were expected to be

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	predictive of mortality, based on empirical analysis, prior literature, and clinical judgment, including age, sex, and indicators of comorbidity and disease severity. For each patient, covariates are obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusts for case mix differences based on the clinical status of patients at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes, and combinations of CCs as candidate variables. A file that contains a list of the ICD-9-CM codes and their groupings into CCs is attached in data field S.2b (Data Dictionary or Code Table). In addition, only comorbidities that convey information about the patient at admission or in the 12- months prior, and not complications that arise during the course of the hospitalization, are included in the risk-adjustment. Hence, we do not risk adjust for CCs that may represent adverse events of care and that are only recorded in the index admission. Risk Adjustment Variables Note: CCs are condition categories or diagnostic groups that combine related sets of ICD-9-CM codes (Pope et al., 2000). For more details, please see the methodology report. Demographics Male Age-65 (years above 65, continuous) for 65 and over cohorts; or Age (years, continuous) for 18 and over cohorts. Comorbidities Congestive heart failure (CC 80) Acute myocardial infarction (CC 81) Other acute/subacute forms of ischemic heart disease (CC 82) Coronary atherosclerosis or angina (CC 83, 84) Cardio-respiratory failure and shock (CC 79) Valvular and rheumatic heart disease (CC 86) Hypertension (CC 89, 91) Stroke (CC 95, 96) Renal failure (CC 131) Chronic obstructive pulmonary disease (COPD) (CC 108)

Measure Title	Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following pneumonia hospitalization
	Pneumonia (CC 111-113) Diabetes mellitus (DM) or DM complications except proliferative retinopathy (CC 15-20, 120) Protein-calorie malnutrition (CC 21) Dementia or other specified brain disorders (CC 49, 50) Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177, 178) Vascular disease and complications (CC 104, 105) Metastatic cancer, acute leukemia and other severe cancers (CC 7, 8) Trauma in last year (CC 154-156, 158-162) Major psychiatric disorders (CC 54-56) Chronic liver disease (CC 25-27) History of CABG (ICD-9-CM V45.81, 36.10-36.16) History of PTCA (ICD-9-CM V45.82, 00.66, 36.01, 36.02, 36.05, 36.06, 36.07)
NQF Endorsed	Yes, #0229
Clinical Condition	Cardiovascular, Cardiovascular: Congestive Heart Failure

CMS Technical Expert Panel: Evaluation of Potential Prevalent Comorbidity Adjustments: Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)

September 9-10, 2015
Baltimore, MD

SCHOOL OF PUBLIC HEALTH
KECC
UNIVERSITY OF MICHIGAN

Meeting Outline

- Introductions
- Conflict of Interest
- Review of TEP Objectives
- Review of risk adjustment in SMR
  - Comorbidities from CMS ME 2728
  - Includes essentially all patients
- Review of risk adjustment in SHR
  - Comorbidities from CMS ME 2728
  - Limited to Medicare patients, due to claims availability
- Comorbidities in claims – using Hierarchical Condition Categories (HCCs)
  - Background and definition
  - Percentage of patients in a year having comorbidity (HCC)

Meeting Outline – cont.

- Refinement of comorbidity list – using HCCs
- Relationship between comorbidities and mortality
  - Using HCCs
  - Using Charlson Comorbidity Index (CCI) approach
- Relationships between comorbidities and hospitalization
  - Using HCCs
  - Using CCI approach
- Assessing facility influence on comorbidities
  - Results of TEP Comorbidity Rating Exercise
- SMR and Prevalent Comorbidities
- SHR and Prevalent Comorbidities

Meeting Outline – cont.

- Discussion of Issues requiring TEP Advice
  - Selection of comorbidity classification system
  - Achieving consensus on inclusion of specific prevalent comorbidities as risk adjusters
  - Timing and frequency of comorbidity measurement
  - Reflecting severity in comorbidity measurement

Introductions

Name, Credentials, and Professional Role	Organizational Affiliation, City, State	Conflict of Interest Disclosure
Caroline Steward, APRN, CCRN, CNN **Advanced Practice Nurse (Hemodialysis)**	Capital Health System Trenton, NJ	None provided
Roberta Wager, MSN, RN **Renal Care Coordinator** **Member of Forum of ESRD Networks Beneficiary Council**	Fresenius Medical Care Forum of ESRD Networks Boerne, TX	None provided
Mark Mitsnefes, MD, MS **Professor of Pediatrics** **Program Director**	Cincinnati Children's Hospital Medical Center and University of Cincinnati Cincinnati, OH	None provided
Dana Miskulin, MD, MS **Staff Nephrologist** **Associate Professor of Medicine**	Tufts Medical Center Boston, MA Outcomes Monitoring Program, Dialysis Clinic Inc. Nashville, TN	Receives salary support from DCI
Jennifer Flythe, MD, MPH **Research Fellow** **Assistant Professor of Medicine**	University of North Carolina at Chapel Hill Chapel Hill, NC	Speaking honorarium from DCI.
Eduardo Lacson Jr, MD, MPH **Nephrologist**	American Society of Nephrology Lexington, MA	None provided
Lorien Dalrymple, MD, MPH **Associate Professor**	University of California, Davis Division of Nephrology Sacramento, CA	Receives research support from DCI. Husband is a physician partner at Kaiser Permanente and shareholder at TPMG. Engaged in research related to SMR and SHR.
David Gilbertson, PhD **Co-Director** **Director of Epidemiology and Biostatistics**	Chronic Disease Research Group Minneapolis, MN	CDRG receives research support from: NIH, HRSA, Amgen, DaVita, NxStage, Questcor, Keryx, Amag, Akebia, Fresenius, ZS Pharma, Peer Kidney Care Initiative.
Danielle Ward **Member of Forum of ESRD Networks Beneficiary Council** **Board Member**	Forum of ESRD Networks Network 6 Wake Forest, NC	None provided

Introductions

Name	Title and Organization	Conflicts of Interest
Jack Wheeler, PhD	Professor Emeritus, Health Management and Policy,	None
Yi Li, PhD	Director, University of Michigan - Kidney Epidemiology and Cost Center; Professor of Biostatistics	None
Joseph Messana, MD	Collegiate Professor of Nephrology and Professor of Internal Medicine	None
Claudia Dahlerus, PhD, MA	Principal Scientist, University of Michigan - Kidney Epidemiology and Cost Center	None
Kevin He, PhD	Research Assistant Professor, Biostatistics; University of Michigan - Kidney Epidemiology and Cost Center	None
Sarah Bell, MPH	Research Analyst, University of Michigan - Kidney Epidemiology and Cost Center	None
Amy Jiao, MA, MPP	Research Analyst, University of Michigan - Kidney Epidemiology and Cost Center	None
Casey Parrotte, BA	Lead Project Manager, University of Michigan - Kidney Epidemiology and Cost Center	None

TEP Objective

To provide advice on the inclusion or exclusion of prevalent comorbidities as risk adjusters in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)

NQF Measure Evaluation Criteria for Risk-Adjustment

- Risk adjustment should be based on patient factors that influence the measured outcome and present at start of care
- Measures should not be adjusted for factors related to disparities in care or the quality of care
- Comorbidity must be substantially related to the outcome being measured
- Comorbidity should not reflect quality of care by the provider/facility being evaluated

Questions for TEP

- What comorbidities should be *included* as adjustors for SMR and SHR, based on their statistical and clinical relationships to the outcomes?
- What comorbidities should be *excluded* based on the likelihood that they may be a result of facility care?

Questions for TEP (cont.)

- What data sources should we use to identify prevalent comorbidities?
  - Do the sources of data available to identify prevalent comorbidities introduce bias into the models?
  - If so, are there steps that can be taken to address this problem?
- How do we specify the length of time over which a prevalent comorbidity is measured?
  - Does the timing of prevalent comorbidity reporting introduce bias into the models?

Questions for TEP (cont.)

- Are there unintended consequences for use of prevalent comorbidities in the models?
  - What can be done to mitigate any unintended consequences?
- What measures of patient comorbidity burden are missing from currently available data that are important to collect?

Current SMR and SHR Models

Current Risk Adjusters

Risk Adjustment in SMR

- Current SMR model adjustments
  - patient age, race, ethnicity, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status, comorbidities at incidence (2728), BMI at incidence, calendar year, and age-adjusted population death rates by state and race
- Predictive power: C-Statistic 0.68
- Includes all patients, Medicare and non-Medicare
  - 2011 analyses include 531,442 patients in 6299 dialysis facilities

Risk Adjustment in SHR

- Current SHR model adjustments
  - patient age, sex, diabetes as cause of ESRD, duration of ESRD, nursing home status, comorbidities at incidence (2728), BMI at incidence, and calendar year
- Predictive power: C-statistic 0.60
- Excludes non-Medicare patients since Medicare claims hospital data available for Medicare patients only
  - For example, 2011 analyses include 392,544 patients in 6,202 dialysis facilities

Approaches to Classifying Comorbidities

Approaches to Classifying Comorbidities

- Considered three approaches to classifying comorbidity conditions
  - ***CMS ESRD Hierarchical Condition Categories (HCC)***
  - ***Charlson Comorbidity Index (CCI)***
  - AHRQ Clinical Classification Software (CCS)
- Analyses presented here apply CMS HCC Grouper, and Charlson Comorbidity Index for classifying comorbidities
- Both CMS HCCs and CCI have wide acceptability as sources for comorbidity risk adjusters

CMS HCCs

- Background: CMS HCCs Developed for determining capitated payments to Medicare Advantage (MA) Plans based on patient risk profile
- Derivation of HCCs: ICD-9 codes aggregated into ~ 805 diagnostic groups
  - Diagnostic groups → 189 Condition Categories (CC)

CMS HCCs

- Lower numbered CC indicates greater clinical severity and impact on cost
- Hierarchy applied to risk model
  - Patients coded into CC with most severe manifestation among those related diseases (Pope et al 2011; Levy et al 2006)
- Data source: HCCs derived from hospital and physician diagnoses codes (inpatient and outpatient)

CMS HCCs

- CMS uses separate risk model to determine payment for ESRD patients enrolled in MA plans
  - Dialysis patients (new to ESRD and prevalent); transplant patients; patients with functioning graft
  - 87 HCCs identified as most predictive of disease burden and cost for ESRD beneficiaries (Levy et al 2006)
- ESRD HCCs subset of 189 CMS HCCs
  - Our analyses use these 87 HCCs from 2014

CMS HCCs

- Evaluation by Pope et al (2011) demonstrate predictive of cost and CCs identify clinically relevant groups of conditions
- HCCs used for risk adjustment in other assessments of comorbidity burden
  - Hospital Wide Readmission Ratio
  - In-Center-HD CAHPS: defining sampling frame for respondents based on comorbidity burden

2014 ESRD HCCs Comorbidities from Medicare Claims

- Used Medicare claims (all provider types)
- Patient considered to have a particular HCC if there was a claim with one of the ICD-9 codes in the HCC during the prior 12 months
  - Required patient to have had Medicare coverage for at least 6 months of the prior 12 month period to make HCC determination
  - Sensitivity analysis: compared frequency of HCC on at least 1 versus 2 claims to classify patient as having that HCC

Frequency of ESRD HCCs in Medicare Patients According to Claims

HCC	HCC Label	HCC based on at least 1 claim*	HCC based on at least 2 claims*
19	Diabetes without Complication	56.8	51.4
23	Other Significant Endocrine and Metabolic Disorders	47.6	42.9
85	Congestive Heart Failure	43.6	38.0
18	Diabetes with Chronic Complications	42.0	37.3
108	Vascular Disease	36.3	29.8
140	Unspecified Renal Failure	29.1	22.9
96	Specified Heart Arrhythmias	24.3	20.2
111	Chronic Obstructive Pulmonary Disease	22.2	17.8
176	Complications of Specified Implanted Device or Graft	20.8	17.3
84	Cardio-Respiratory Failure and Shock	17.5	14.0
75	Polyneuropathy	17.2	12.7
2	Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	16.1	14.8
48	Coagulation Defects and Other Specified Hematological Disorders	13.3	9.0
141	Nephritis	12.9	7.9
161	Chronic Ulcer of Skin, Except Pressure	12.0	10.1
100	Ischemic or Unspecified Stroke	9.5	7.4
52	Dementia Without Complication	9.2	6.5
87	Unstable Angina and Other Acute Ischemic Heart Disease	8.9	6.7
21	Protein-Calorie Malnutrition	8.6	4.9
122	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	7.9	6.9

* 2010 Medicare claims. Top 20 most frequently reported ESRD HCCs in claims

Comorbidity Selection Method Based on Statistical Relationships

Using 2014 ESRD HCCs

Comorbidity Selection Method ESRD HCCs

Goal:

- Identify subset of comorbidities based on their ability to predict response variables (mortality, hospitalization)

Statistical challenges:

- Number of predictors is large and it is infeasible to search through all possible subsets
- Traditional forward or backward selection procedures do not take proper account of the multiple testing issues
- Traditional selection procedures do not account for search process and estimated standard errors from chosen model are not valid

Comorbidity Selection Method ESRD HCCs

Method: Adaptive Lasso (Zhang and Lu, 2007)

- Shrinks small coefficients to zero using penalized partial likelihood
- Can be regarded as an automatic implementation of best-subset selection
- Based on stratified Cox models: stratified on facilities
- Select comorbidities, with adjustment for currently used variables
- Using 2013 data to select variables

Comorbidity Selection Method ESRD HCCs

Alternative Method: Boosting (He et al., 2015)

- Given the inclusion of current predictors, we aim to find new predictors to add to the mix
- The Boosting algorithm iteratively detects predictors along which the partial likelihood would ascend most rapidly
- Stability selection to improve the performance of variable selection
- Identify variables selected with higher probabilities when Boosting is performed on random sample of observations

SMR with ESRD HCCs

HCCs Predictive of Mortality using Lasso and Boosting Methods: Fit to SMR

- 70 HCCs selected by Lasso and Boosting Method, using 2013 data.
- Re-fit SMR and added the HCCs predictive of mortality, using 2011 data
- 49 of 70 were statistically significant
- C-statistic: 0.719 compared to 0.679 for current model with incident comorbidities only
- C-stat suggests better predictive power in re-fitted SMR with the added HCCs compared to current SMR

HCCs Predictive of Mortality using Lasso and Boosting Method: Fit to SMR (1)

HCC	HCC Label	Coefficient	P-value
1	HIV/AIDS	0.26	<.0001
2	Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	0.14	<.0001
6	Opportunistic Infections	0.13	<.0001
8	Metastatic Cancer and Acute Leukemia	0.65	<.0001
9	Lung and Other Severe Cancers	0.31	<.0001
10	Lymphoma and Other	0.20	<.0001
11	Colorectal, Bladder, and Other Cancers	0.001	0.95
12	Breast, Prostate, and Other Cancers and Tumors	-0.02	0.38
17	Diabetes with Acute Complications	0.13	<.0001
19	Diabetes without Complication	-0.02	0.17
21	Protein-Calorie Malnutrition	0.23	<.0001
22	Morbid Obesity	-0.04	0.03
23	Other Significant Endocrine and Metabolic Disorders	-0.13	<.0001
27	End-Stage Liver Disease	0.25	<.0001
28	Cirrhosis of Liver	0.33	<.0001
29	Chronic Hepatitis	0.04	0.09
33	Intestinal Obstruction/Perforation	0.12	<.0001
34	Chronic Pancreatitis	0.08	0.05

HCCs Predictive of Mortality using Lasso and Boosting Method: Fit to SMR (2)

HCC	HCC Label	Coefficient	P-value
39	Bone/Joint/Muscle Infections/Necrosis	-0.06	0.001
46	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	0.12	<.0001
47	Disorders of Immunity	0.11	0.0004
48	Coagulation Defects and Other Specified Hematological Disorders	0.15	<.0001
51	Dementia With Complications	0.08	0.0002
52	Dementia Without Complication	0.16	<.0001
54	Drug/Alcohol Psychosis	0.03	0.28
55	Drug/Alcohol Dependence	0.17	<.0001
57	Schizophrenia	-0.003	0.94
58	Major Depressive, Bipolar, and Paranoid Disorders	0.05	0.0008
70	Quadriplegia	-0.04	0.38
72	Spinal Cord Disorders/Injuries	0.02	0.55
74	Cerebral Palsy	0.22	0.03
75	Polyneuropathy	0.009	0.40
77	Multiple Sclerosis	-0.12	0.06
78	Parkinson's and Huntington's Diseases	0.01	0.63
79	Seizure Disorders and Convulsions	0.08	<.0001
80	Coma, Brain Compression/Anoxic Damage	0.16	<.0001

HCCs Predictive of Mortality using Lasso and Boosting Method: Fit to SMR (3)

HCC	HCC Label	Coefficient	P-value
83	Respiratory Arrest	0.12	0.0009
84	Cardio-Respiratory Failure and Shock	0.18	<.0001
85	Congestive Heart Failure	0.31	<.0001
86	Acute Myocardial Infarction	0.23	<.0001
87	Unstable Angina and Other Acute Ischemic Heart Disease	0.03	0.02
96	Specified Heart Arrhythmias	0.20	<.0001
99	Cerebral Hemorrhage	0.07	0.03
100	Ischemic or Unspecified Stroke	0.05	<.0001
103	Hemiplegia/Hemiparesis	0.05	0.009
106	Atherosclerosis of the Extremities with Ulceration or Gangrene	0.18	<.0001
107	Vascular Disease with Complications	0.03	0.05
108	Vascular Disease	0.08	<.0001
111	Chronic Obstructive Pulmonary Disease	0.14	<.0001
112	Fibrosis of Lung and Other Chronic Lung Disorders	0.07	<.0001
114	Aspiration and Specified Bacterial Pneumonias	0.12	<.0001
115	Pneumococcal Pneumonia, Empyema, Lung Abscess	0.006	0.80
122	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	-0.07	<.0001
134	Dialysis Status	0.03	0.05

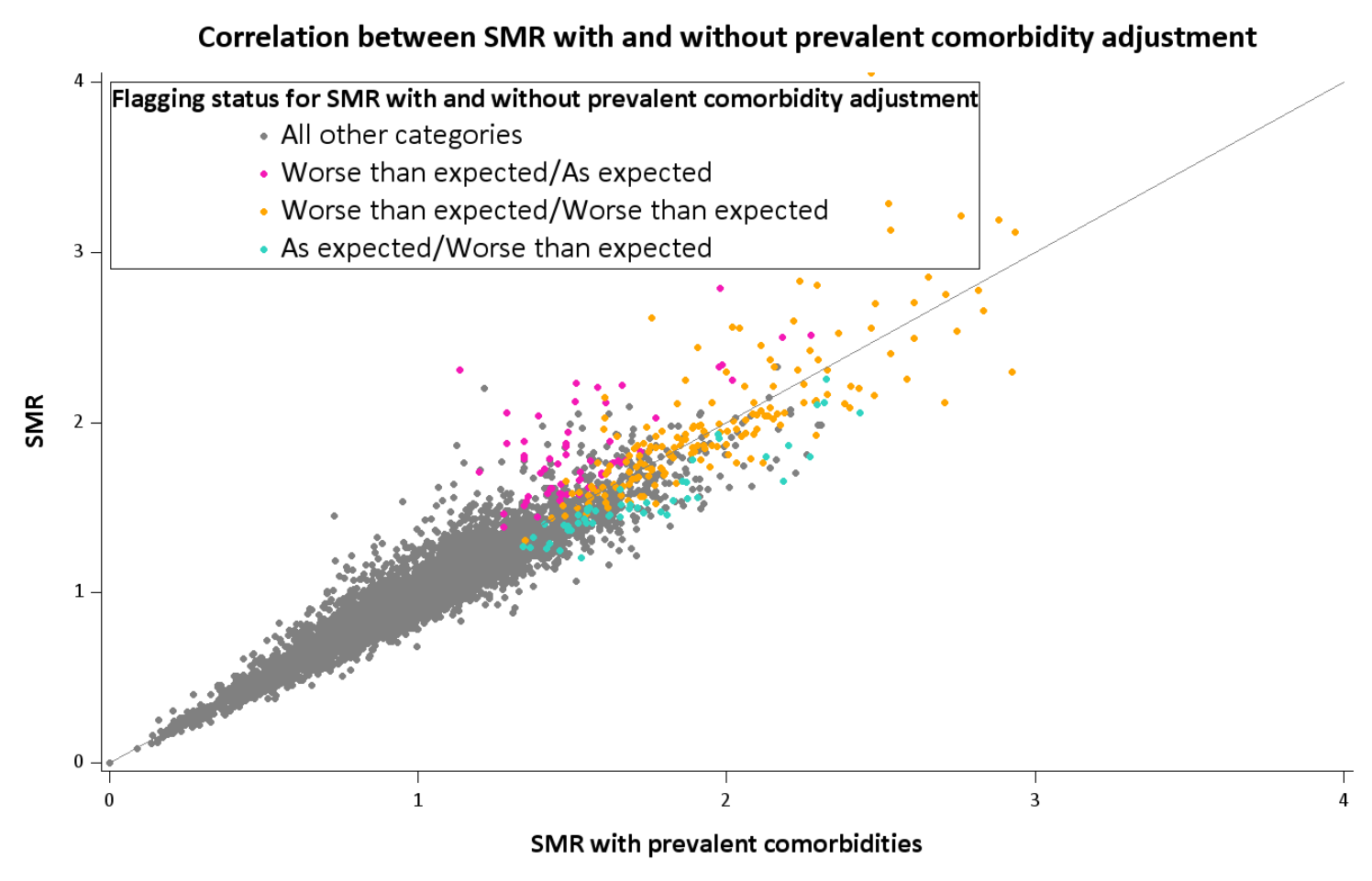
HCCs Predictive of Mortality using Lasso and Boosting Method: Fit to SMR (4)

HCC	HCC Label	Coefficient	P-value
135	Acute Renal Failure	-0.005	0.65
137	Chronic Kidney Disease, Severe (Stage 4)	-0.12	<.0001
138	Chronic Kidney Disease, Moderate (Stage 3)	-0.06	0.0003
139	Chronic Kidney Disease, Mild or Unspecified (Stages 1-2 or Unspecified)	-0.002	0.88
140	Unspecified Renal Failure	-0.003	0.77
157	Press ure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone	0.03	0.31
158	Pressure Ulcer of Skin with Full Thickness Skin Loss	0.04	0.07
159	Pressure Ulcer of Skin with Partial Thickness Skin Loss	0.04	0.10
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage	0.15	<.0001
161	Chronic Ulcer of Skin, Except Pressure	0.17	<.0001
167	Major Head Injury	0.03	0.29
169	Vertebral Fractures without Spinal Cord Injury	0.15	<.0001
170	Hip Fracture/Dislocation	0.06	0.003
173	Traumatic Amputations and Complications	-0.07	0.002
188	Artificial Openings for Feeding or Elimination	-0.05	0.02
189	Amputation Status, Lower Limb/Amputation Complications	0.15	<.0001
	Patients with <6 months of Medicare coverage in prior year	0.46	<.0001

SMR with HCCs selected using Lasso/Boosting
Flagging Compared with Current SMR

		Current SMR Model		
		Better than Expected	As Expected	Worse than Expected
SMR Model including HCCs selected using Lasso/Boosting	Better than Expected	128 (2.4%)	41 (0.8%)	0 (0%)
	As Expected	53 (0.8%)	4763 (90.5%)	60 (1.1%)
	Worse than Expected	0 (0%)	49 (0.9%)	169 (3.2%)
*Kappa statistic: 0.7299 (p-value <0.0001), 2011 data				

SMR Model with HCCs selected using Lasso/Boosting: Correlation with Current SMR



SHR with ESRD HCCs

Predictive HCCs using Lasso and Boosting Methods: Fit to SHR

- 70 HCCs selected by Lasso and Boosting Method, using 2013 data
- Re-fit SHR and added the selected HCCs, using 2011 data
- 65 of 70 were statistically significant
- C-statistic: 0.66 compared to 0.60 for current model with incident comorbidities only
- C-stat suggests better predictive power in RE-fitted SHR with the added HCCs compared to current SHR

Predictive HCCs using Lasso and Boosting Methods: Fit to SHR (1)

HCC	HCC Label	Coefficient	P-value
1	HIV/AIDS	0.21	<0.0001
10	Lymphoma and Other Cancers	0.10	<0.0001
100	Ischemic or Unspecified Stroke	0.04	<0.0001
106	Atherosclerosis of the Extremities with Ulceration or Gangrene	0.05	<0.0001
107	Vascular Disease with Complications	0.06	<0.0001
108	Vascular Disease	0.07	<0.0001
111	Chronic Obstructive Pulmonary Disease	0.18	<0.0001
112	Fibrosis of Lung and Other Chronic Lung Disorders	0.08	<0.0001
114	Aspiration and Specified Bacterial Pneumonias	-0.008	0.27
122	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	-0.08	<0.0001
135	Acute Renal Failure	0.12	<0.0001
137	Chronic Kidney Disease, Severe (Stage 4)	-0.04	<0.0001
138	Chronic Kidney Disease, Moderate (Stage 3)	-0.03	<0.0001
141	Nephritis	0.12	<0.0001
158	Pressure Ulcer of Skin with Full Thickness Skin Loss	-0.02	0.049
159	Pressure Ulcer of Skin with Partial Thickness Skin Loss	0.01	0.31

Predictive HCCs using Lasso and Boosting Methods: Fit to SHR (2)

HCC	HCC Label	Coefficient	P-value
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage	-0.03	0.0001
161	Chronic Ulcer of Skin, Except Pressure	0.06	<0.0001
167	Major Head Injury	0.03	0.007
169	Vertebral Fractures without Spinal Cord Injury	0.08	<0.0001
17	Diabetes with Acute Complications	0.16	<0.0001
170	Hip Fracture/Dislocation	0.004	0.60
186	Major Organ Transplant or Replacement Status	0.11	<0.0001
188	Artificial Openings for Feeding or Elimination	0.02	0.02
189	Amputation Status, Lower Limb/Amputation Complications	0.04	<0.0001
19	Diabetes without Complication	0.08	<0.0001
2	Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	0.14	<0.0001
21	Protein-Calorie Malnutrition	0.09	<0.0001
22	Morbid Obesity	0.04	<0.0001
23	Other Significant Endocrine and Metabolic Disorders	-0.15	<0.0001
27	End-Stage Liver Disease	0.18	<0.0001
28	Cirrhosis of Liver	0.11	<0.0001
29	Chronic Hepatitis	0.08	<0.0001

Predictive HCCs using Lasso and Boosting Methods: Fit to SHR (3)

HCC	HCC Label	Coefficient	P-value
33	Intestinal Obstruction/Perforation	0.14	<0.0001
34	Chronic Pancreatitis	0.29	<0.0001
35	Inflammatory Bowel Disease	0.07	<0.0001
39	Bone/Joint/Muscle Infections/Necrosis	0.02	0.001
40	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	0.08	<0.0001
46	Severe Hematological Disorders	0.13	<0.0001
47	Disorders of Immunity	0.07	<0.0001
48	Coagulation Defects and Other Specified Hematological Disorders	0.11	<0.0001
52	Dementia Without Complication	0.006	0.24
54	Drug/Alcohol Psychosis	0.16	<0.0001
55	Drug/Alcohol Dependence	0.35	<0.0001
57	Schizophrenia	0.07	<0.0001
58	Major Depressive, Bipolar, and Paranoid Disorders	0.10	<0.0001
6	Opportunistic Infections	0.14	<0.0001
75	Polyneuropathy	0.12	<0.0001

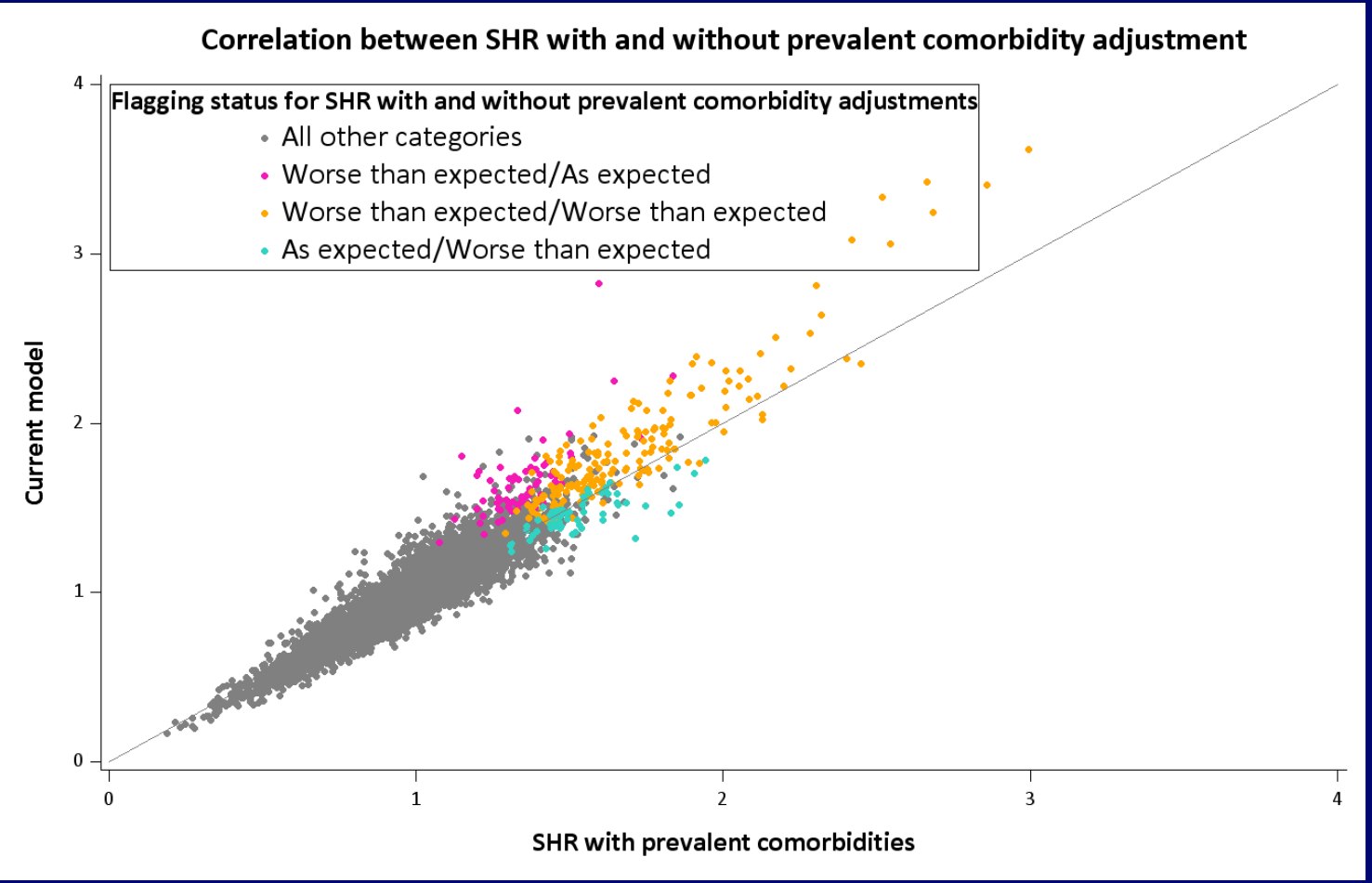
Predictive HCCs using Lasso and Boosting Methods: Fit to SHR (4)

HCC	HCC Label	Coefficient	P-value
79	Seizure Disorders and Convulsions	0.15	<0.0001
8	Metastatic Cancer and Acute Leukemia	0.20	<0.0001
80	Coma, Brain Compression/Anoxic Damage	-0.02	0.13
82	Respirator Dependence/Tracheostomy Status	-0.10	<0.0001
84	Cardio-Respiratory Failure and Shock	0.17	<0.0001
85	Congestive Heart Failure	0.30	<0.0001
86	Acute Myocardial Infarction	0.10	<0.0001
87	Unstable Angina and Other Acute Ischemic Heart Disease	0.11	<0.0001
88	Angina Pectoris	0.10	<0.0001
9	Lung and Other Severe Cancers	0.09	<0.0001
96	Specified Heart Arrhythmias	0.09	<0.0001
	Patients with <6 months of Medicare coverage in prior year	0.80	<0.0001

SHR with HCCs selected using Lasso/Boosting: Flagging Compared with Current SHR

		Current SHR Model		
SHR Model with HCCs selected using Lasso/Boosting		Better than Expected	As Expected	Worse than Expected
	Better than Expected	31 (0.6%)	34 (0.6%)	0 (0%)
	As Expected	15 (0.3%)	5,173 (92.9%)	68 (1.2%)
	Worse than Expected	0 (0%)	59 (1.1%)	188 (3.4%)
*Kappa statistic: 0.6992 (p-value <0.0001)				

SHR with HCCs selected using Lasso/Boosting
Correlation with Current SHR



Application of Charlson Comorbidity Index (CCI)

Charlson Comorbidity Index and Prevalent Comorbidities

- Charlson Comorbidity Index (CCI)
  - Developed in 1987
  - Weighted index based on 19 comorbidities
  - General medical population based on small cohort (~550 patients admitted to NY hospital)
  - Validated in 10-year longitudinal cohort study of 694 women with breast cancer (New Haven Yale hospital)
  - CCI predictive of mortality longitudinally

CCI and Prevalent Comorbidities

- Beddhu et al (2000) applied CCI to predict mortality, hospitalization, and cost in the ESRD population
- Performed well in predicting clinical outcomes and costs

CCI and Prevalent Comorbidities

- Application of CCI by Beddhu et al did not assess whether included conditions could be the result of care
- Application of CCI in SMR and SHR
  - Did not assess whether conditions in CCI a result of care
- Used CCI weighting and scoring method
- Assessed model performance using the CCI

Charlson Index Comorbidities

1. Used 2012 data and fit a Cox regression model to first generate relative risks (RR) for all comorbidities from Medicare claims
2. Assigned weights as follows:
   - Conditions with RR < 1.2 *dropped*
   - RR $\geq$ 1.2 < 1.5 assigned weight of 1
   - RR $\geq$ 1.5 < 2.5 weight of 2
   - RR $\geq$ 2.5 < 3.5 weight of 3;
   - No conditions had RR $\geq$3.5
3. Used weights to calculate the index then re-fit the model with the index using 2011 data

Charlson Comorbidity Index
SMR

Charlson Index Comorbidities: Relative Risks for Mortality and Weights

Charlson Comorbidities	RR	P-value	weight
1 Myocardial infarction	1.25	<.0001	1
2 Congestive heart failure	1.47	<.0001	1
3 Peripheral vascular disease	1.29	<.0001	1
4 Cerebrovascular disease	1.10	<.0001	0
5 Dementia	1.32	<.0001	1
6 Chronic pulmonary disease	1.18	<.0001	0
7 Rheumatologic disease	1.15	<.0001	0
8 Peptic ulcer disease	1.30	<.0001	1
9 Mild liver disease	1.44	<.0001	1
10 Diabetes	1.03	0.015	0
11 Diabetes with chronic complications	1.04	0.003	0
12 Hemiplegia or paraplegia	1.28	<.0001	1
13 Any malignancy, including leukemia and lymphoma	1.12	<.0001	0
14 Moderate or severe liver disease	1.58	<.0001	2
15 Metastatic solid tumor	2.04	<.0001	2
16 AIDS	1.48	<.0001	1
Patients with <6 months of Medicare coverage in prior year	1.87	<.0001	n/a

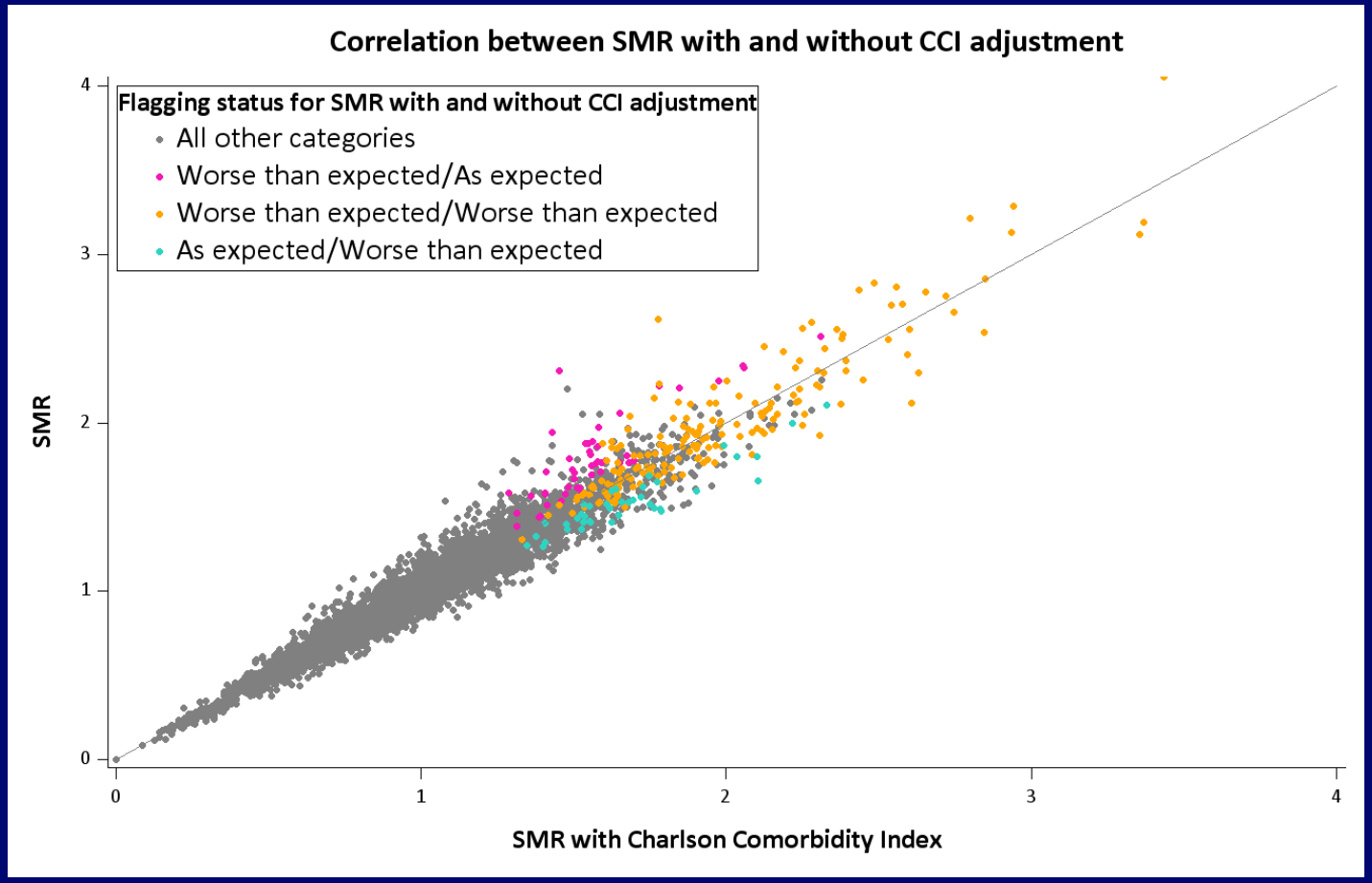
* 2012 data

SMR with CCI
Flagging Compared to Current SMR

		Current SMR Model		
		Better than Expected	As Expected	Worse than Expected
SMR Model with CCI	Better than Expected	139 (2.6%)	35 (0.7%)	0 (0%)
	As Expected	42 (0.8%)	4778 (90.8%)	48 (0.9%)
	Worse than Expected	0	40 (0.8%)	181 (3.4%)

*Kappa statistic: 0.7825 (p-value <0.0001), 2011 data

Current SMR Compared with SMR with CCI Adjustment



Charlson Comorbidity Index
SHR

Charlson Index Comorbidities: Relative Risks for Hospitalization and Weights

Charlson Comorbidities	RR	P-value	weight
1 Myocardial infarction	1.24	<.0001	1
2 Congestive heart failure	1.41	<.0001	1
3 Peripheral vascular disease	1.16	<.0001	0
4 Cerebrovascular disease	1.10	<.0001	0
5 Dementia	1.01	0.0726	0
6 Chronic pulmonary disease	1.26	<.0001	1
7 Rheumatologic disease	1.19	<.0001	0
8 Peptic ulcer disease	1.45	<.0001	1
9 Mild liver disease	1.23	<.0001	1
10 Diabetes	1.09	<.0001	0
11 Diabetes with chronic complications	1.08	<.0001	0
12 Hemiplegia or paraplegia	1.12	<.0001	0
13 Any malignancy, including leukemia and lymphoma	1.05	<.0001	0
14 Moderate or severe liver disease	1.39	<.0001	1
15 Metastatic solid tumor	1.27	<.0001	1
16 AIDS	1.33	<.0001	1
Patients with <6 months of Medicare coverage in prior year	2.90	<.0001	n/a

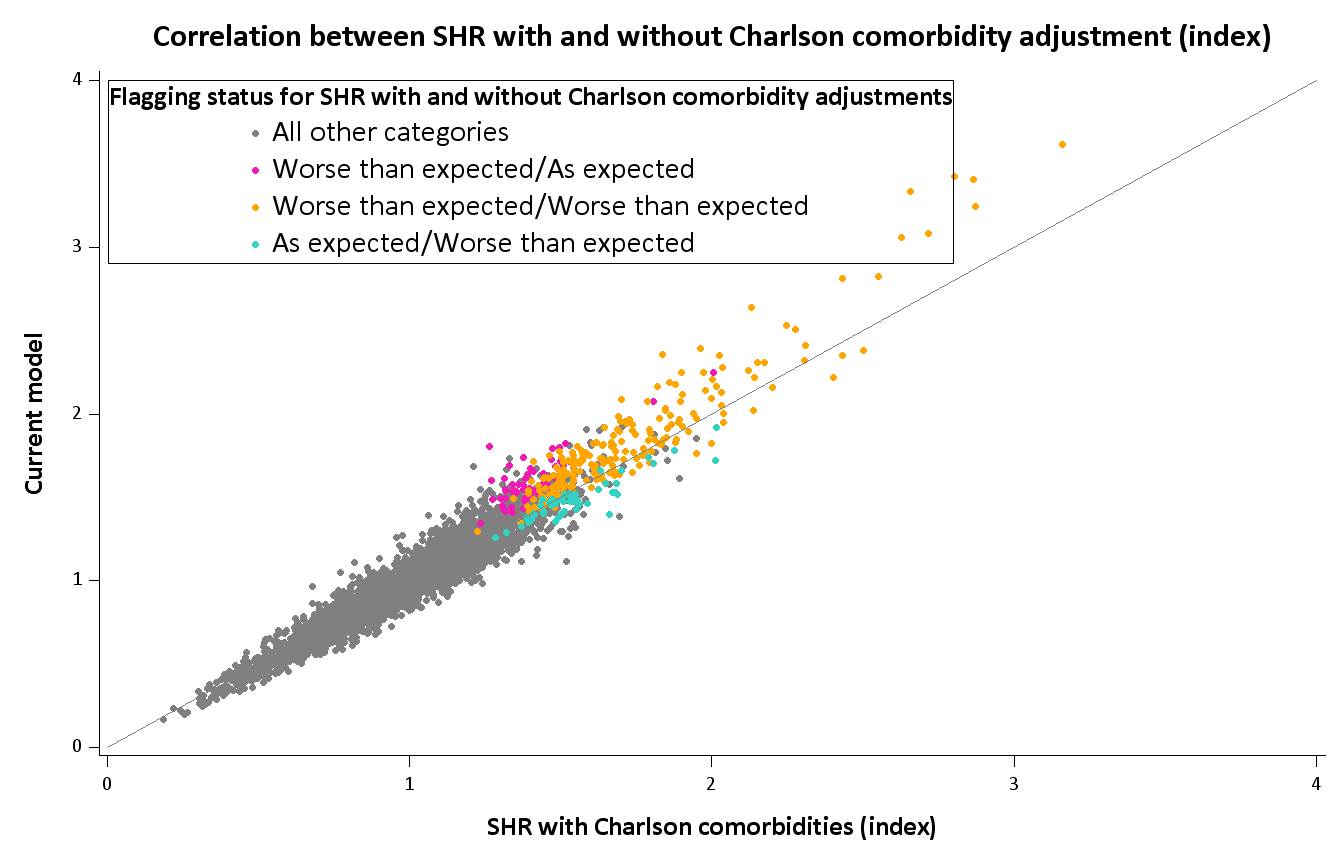
*2012 data

SHR with CCI Flagging Compared to Current SHR

		Current SHR Model		
		Better than Expected	As Expected	Worse than Expected
SHR with CCI	Better than Expected	29 (0.5%)	17 (0.3%)	9 (0%)
	As Expected	17 (0.3%)	5,199 (93.4%)	56 (1%)
	Worse than Expected	0 (0%)	50 (0.9%)	200 (3.6%)

*Kappa statistic for models with the CCI is 0.7544 (p-value <0.0001)

Current SHR Compared with SHR with CCI Adjustment

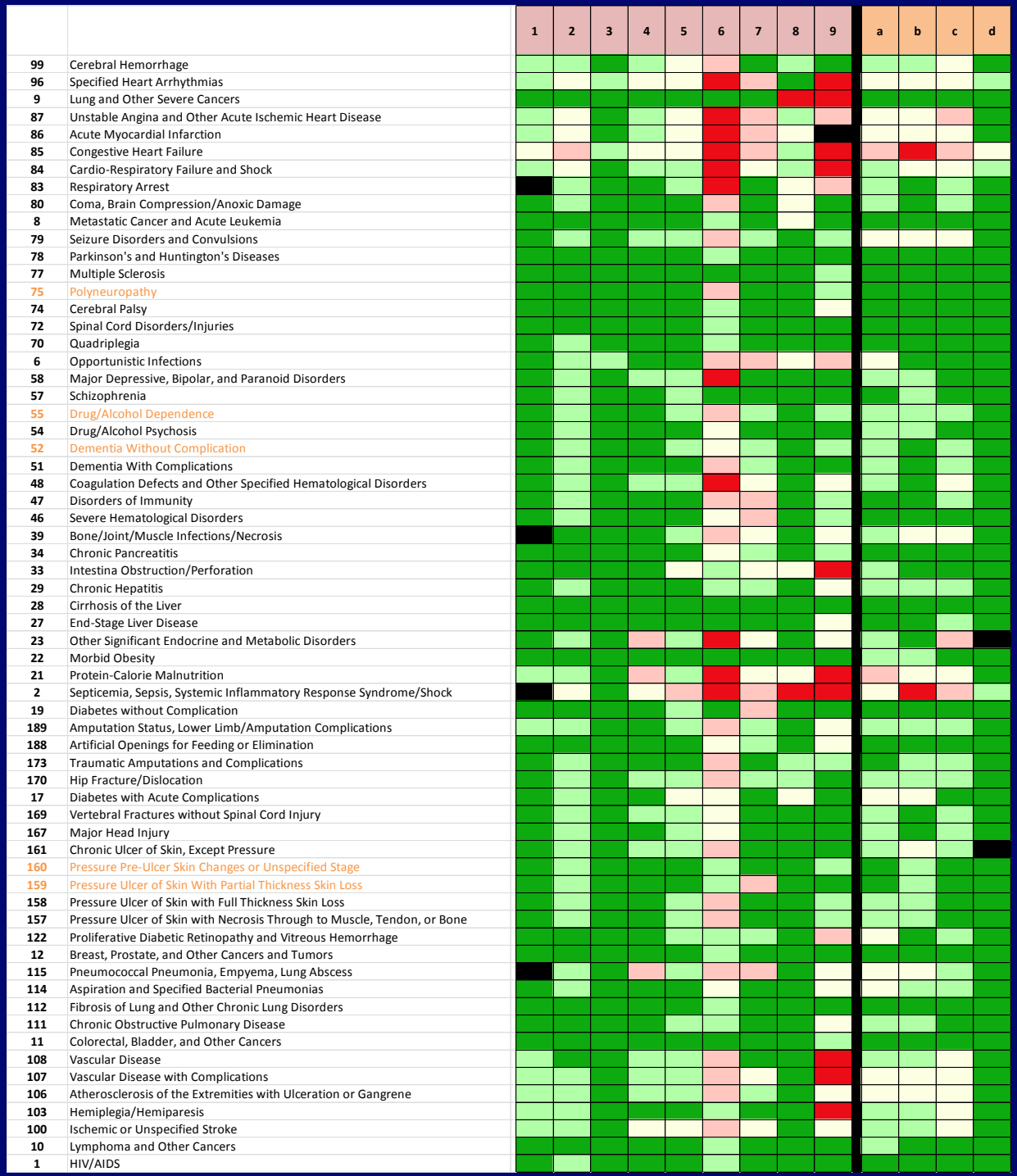


Assessing Facility Influence on Comorbidities

Assessing Whether Prevalent Comorbidities are a Result of Care

- Second requirement for a comorbidity as a risk-adjuster: It is not the result of facility care
- Assessing the extent of potential facility influence on existence of comorbidities
- UM-KECC nephrologists results
- TEP results (heat maps)
- Discussion and consensus building

Comorbidity Rating Exercise



Key

- =1 Very likely not a result of care
- =1.5-2 Likely not a result of facility care
- =3 Neutral
- =3.5-4 Likely a result of facility care
- =5 Very likely a result of facility care
- Multiple or conditional responses

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Lowest Tertile Summary Scores For Comorbidity Category Attribution to Dialysis Facility Care

			1	2	3	4	5	6	7	8	9	a	b	c	d
28	Cirrhosis of the Liver	9													
22	Morbid Obesity	9													
78	Parkinson's and Huntington's Diseases	10													
77	Multiple Sclerosis	10													
72	Spinal Cord Disorders/Injuries	10													
12	Breast, Prostate, and Other Cancers and Tumors	10													
112	Fibrosis of Lung and Other Chronic Lung Disorders	10													
11	Colorectal, Bladder, and Other Cancers	10													
10	Lymphoma and Other Cancers	10													
70	Quadriplegia	10.5													
57	Schizophrenia	10.5													
1	HIV/AIDS	10.5													
27	End-Stage Liver Disease	11													
54	Drug/Alcohol Psychosis	11.5													
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage	11.5													
8	Metastatic Cancer and Acute Leukemia	12													
74	Cerebral Palsy	12													
75	Polyneuropathy	13													
34	Chronic Pancreatitis	13													
19	Diabetes without Complication	13													
167	Major Head Injury	13													
111	Chronic Obstructive Pulmonary Disease	13													

Highest Tertile Summary Scores For Comorbidity Category Attribution to Dialysis Facility Care

			1	2	3	4	5	6	7	8	9	a	b	c	d
85	Congestive Heart Failure	31													
2	Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	30													
96	Specified Heart Arrhythmias	28													
87	Unstable Angina and Other Acute Ischemic Heart Disease	26													
84	Cardio-Respiratory Failure and Shock	25													
21	Protein-Calorie Malnutrition	25													
86	Acute Myocardial Infarction	22.5													
6	Opportunistic Infections	22													
23	Other Significant Endocrine and Metabolic Disorders	21.5													
100	Ischemic or Unspecified Stroke	21.5													
107	Vascular Disease with Complications	21.5													
115	Pneumococcal Pneumonia, Empyema, Lung Abscess	21													
33	Intestina Obstruction/Perforation	20													
48	Coagulation Defects and Other Specified Hematological Disorders	19.5													
83	Respiratory Arrest	19													
108	Vascular Disease	19													
106	Atherosclerosis of the Extremities with Ulceration or Gangrene	18.5													
189	Amputation Status, Lower Limb/Amputation Complications	18													
99	Cerebral Hemorrhage	18													
79	Seizure Disorders and Convulsions	18													
9	Lung and Other Severe Cancers	17													
170	Hip Fracture/Dislocation	17													

			1	2	3	4	5	6	7	8	9	a	b	c	d	
28	Cirrhosis of the Liver	9														4
78	Parkinson's and Huntington's Diseases	10														4
77	Multiple Sclerosis	10														4
72	Spinal Cord Disorders/Injuries	10														4
12	Breast, Prostate, and Other Cancers and Tumors	10														4
112	Fibrosis of Lung and Other Chronic Lung Disorders	10														4
11	Colorectal, Bladder, and Other Cancers	10														4
70	Quadriplegia	10.5														4
1	HIV/AIDS	10.5														4
8	Metastatic Cancer and Acute Leukemia	12														4
74	Cerebral Palsy	12														4
75	Polyneuropathy	13														4
34	Chronic Pancreatitis	13														4
19	Diabetes without Complication	13														4
188	Artificial Openings for Feeding or Elimination	14														4
46	Severe Hematological Disorders	15.5														4
9	Lung and Other Severe Cancers	17														4
10	Lymphoma and Other Cancers	10														5
57	Schizophrenia	10.5														5
27	End-Stage Liver Disease	11														5
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage	11.5														5
159	Pressure Ulcer of Skin With Partial Thickness Skin Loss	13.5														5
47	Disorders of Immunity	16.5														5
33	Intestina Obstruction/Perforation	20														5
22	Morbid Obesity	9														6
54	Drug/Alcohol Psychosis	11.5														6
167	Major Head Injury	13														6
111	Chronic Obstructive Pulmonary Disease	13														6
51	Dementia With Complications	13.5														6
169	Vertebral Fractures without Spinal Cord Injury	13.5														6
52	Dementia Without Complication	14.5														6
173	Traumatic Amputations and Complications	14.5														6
158	Pressure Ulcer of Skin with Full Thickness Skin Loss	14.5														6
157	Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone	14.5														6
80	Coma, Brain Compression/Anoxic Damage	15														6
58	Major Depressive, Bipolar, and Paranoid Disorders	15.5														6
83	Respiratory Arrest	19														6
6	Opportunistic Infections	22														6

SMR and Prevalent Comorbidities

Three versions of SMR, reflecting different sets of prevalent comorbidities

- To demonstrate conceptual approach
- Next step: re-estimate SMR with TEP results

SMR and Prevalent Comorbidities (1)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
1	HIV/AIDS	0.322	<.0001	0.304	<.0001	0.272	<.0001
6	Opportunistic Infections					0.246	<.0001
8	Metastatic Cancer and Acute Leukemia	0.745	<.0001	0.681	<.0001	0.675	<.0001
9	Lung and other severe cancer	0.397	<.0001	0.361	<.0001	0.330	<.0001
10	Lymphoma and Other Cancers			0.237	<.0001	0.2276	<.0001
11	Colorectal, Bladder, and Other Cancers	0.018	0.3946	0.013	0.5353	0.008	0.7037
12	Breast, Prostate, and Other Cancers and Tumors	0.015	0.3679	-0.005	0.7724	-0.017	0.3361
19	Diabetes without Complication	0.169	<.0001	0.132	<.0001	0.084	<.0001
22	Morbid Obesity					0.001	0.9512
27	End-Stage Liver Disease			0.368	<.0001	0.341	<.0001
28	Cirrhosis of the Liver	0.622	<.0001	0.430	<.0001	0.412	<.0001
33	Intestinal Obstruction/Perforation			0.252	<.0001	0.219	<.0001
34	Chronic Pancreatitis	0.217	<.0001	0.183	<.0001	0.150	<.0001
46	Severe Hematological Disorders	0.290	<.0001	0.229	<.0001	0.208	<.0001
47	Disorders of Immunity			0.190	<.0001	0.172	<.0001

*2011 data

SMR and Prevalent Comorbidities (2)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff	P-value	Coeff	P-value	Coeff	P-value
51	Dementia With Complications					0.097	<.0001
52	Dementia Without Complication					0.238	<.0001
54	Drug/Alcohol Psychosis					0.129	<.0001
57	Schizophrenia			0.120	0.0014	-0.005	0.8804
58	Major Depressive, Bipolar, and Paranoid Disorders					0.097	<.0001
70	Quadriplegia	0.269	<.0001	0.098	0.0391	0.011	0.8031
72	Spinal Cord Disorders/Injuries	0.206	<.0001	0.12	<.0001	0.032	0.2655
74	Cerebral Palsy	0.307	0.0023	0.239	0.0175	0.251	0.0127
75	Polyneuropathy	0.194	<.0001	0.138	<.0001	0.100	<.0001
77	Multiple Sclerosis	0.006	0.9193	-0.047	0.4672	-0.118	0.0726
78	Parkinson's and Huntington's Diseases	0.114	<.0001	0.082	0.0047	0.016	0.5764
80	Coma, Brain Compression/Anoxic Damage					0.336	<.0001
83	Respiratory Arrest					0.335	<.0001

SMR and Prevalent Comorbidities (3)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff	P-value	Coeff	P-value	Coeff	P-value
111	Chronic Obstructive Pulmonary Disease					0.299	<.0001
112	Fibrosis of Lung and Other Chronic Lung Disorders	0.371	<.0001	0.325	<.0001	0.218	<.0001
157	Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone					0.095	0.0027
158	Pressure Ulcer of Skin with Full Thickness Skin Loss					0.144	<.0001
159	Pressure Ulcer of Skin with Partial Thickness Skin Loss			0.10	<.0001	0.06	0.0022
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage			0.474	<.0001	0.344	<.0001
167	Major Head Injury					0.140	<.0001
169	Vertebral Fractures without Spinal Cord Injury					0.18	<.0001
173	Traumatic Amputations and Complications					0.188	<.0001
188	Artificial Openings for Feeding or Elimination	0.296	<.0001	0.145	<.0001	0.055	0.0077
--	Flag for not having 6 months of Medicare coverage	0.127	<.0001	0.168	<.0001	0.264	0.0066

SMR C-Statistics

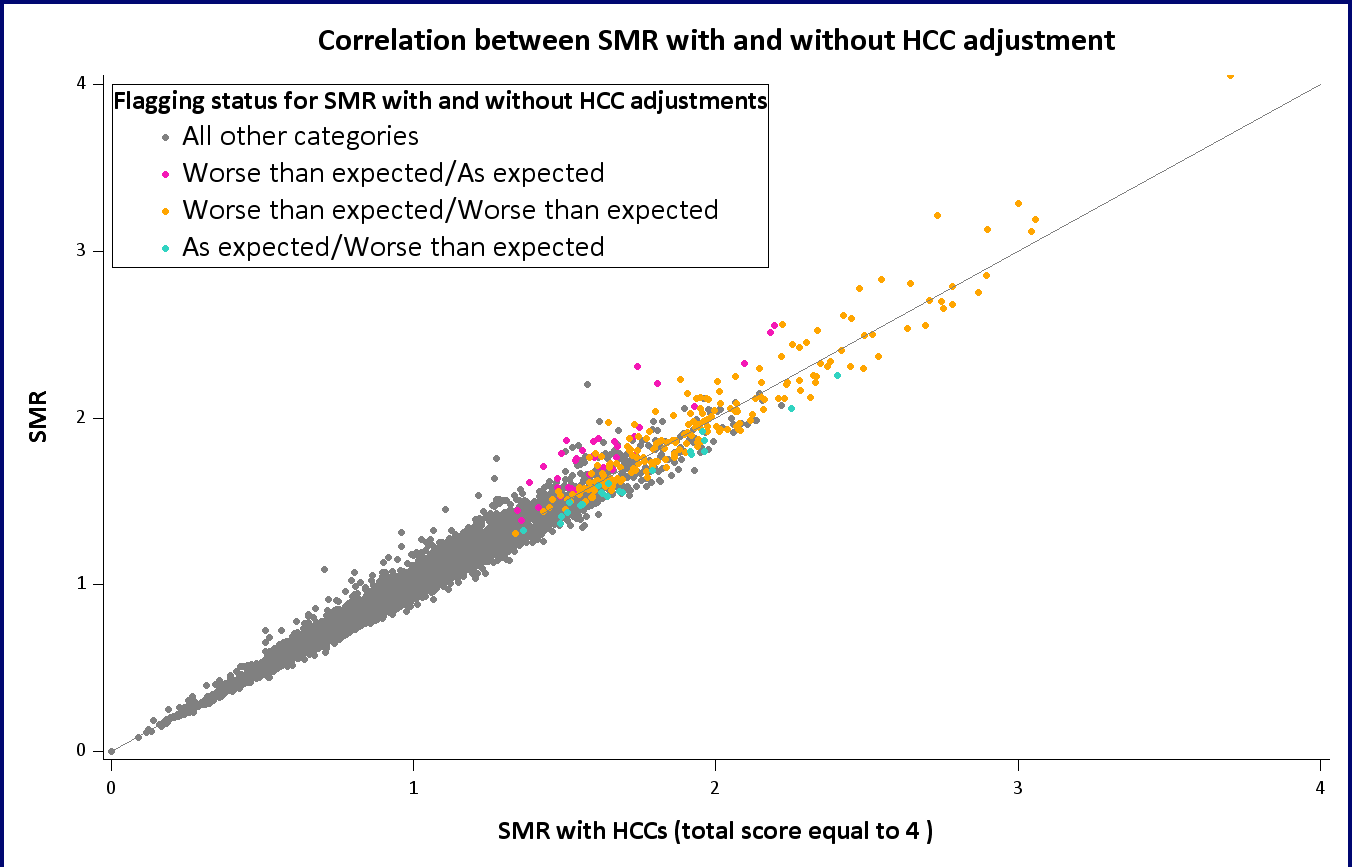
SMR Model	C-Statistic
Current model without prevalent comorbidities	0.68
Model including HCCs with score = 4 (17)	0.69
Model including HCCs with score ≤5 (24)	0.70
Model including HCCs with score ≤6 (38)	0.71
Model including all HCC selected (70)	0.72

Flagging: SMR and Prevalent Comorbidities

		Current SMR Model		
		Better than Expected	As Expected	Worse than Expected
SMR including HCCs with score =4	Better than Expected	154(2.9%)	27(0.5%)	0
	As Expected	27(0.5%)	4803(91.2%)	36(0.7%)
	Worse than Expected	0	23(0.4%)	193(3.7%)
SMR including HCCs with score ≤5	Better than Expected	142(2.7%)	30(0.6%)	0
	As Expected	39(0.7%)	4799(91.2%)	33(0.6%)
	Worse than Expected	0	24(0.5%)	196(3.7%)
SMR including HCCs with score ≤6	Better than Expected	135(2.6%)	34(0.7%)	0
	As Expected	46(0.9%)	4787(91.0%)	43(0.8%)
	Worse than Expected	0	32(0.6%)	186(3.5%)

*Kappa statistics for models including HCCs with score =4, score ≤5 and ≤6: 0.8514, 0.8333 and 0.7938, respectively (p-value <0.0001 for all comparisons)

Current SMR and SMR with Prevalent Comorbidities



SHR and Prevalent Comorbidities

Three versions of SHR, reflecting different sets of prevalent comorbidities

- To demonstrate conceptual approach
- Next step: re-estimate SHR with TEP results

SHR and Prevalent Comorbidities (1)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
1	HIV/AIDS	0.2979	<0.0001	0.2843	<0.0001	0.2472	<0.0001
10	Lymphoma and Other Cancers			0.1400	<0.0001	0.1340	<0.0001
11	Colorectal, Bladder, and Other Cancers	0.0521	<0.0001	0.0380	<0.0001	0.0270	0.001
111	Chronic Obstructive Pulmonary Disease					0.3392	<0.0001
112	Fibrosis of Lung and Other Chronic Lung Disorders	0.3545	<0.0001	0.3251	<0.0001	0.2238	<0.0001
12	Breast, Prostate, and Other Cancers and Tumors	0.0092	0.1782	-0.0033	0.6324	-0.0095	0.1669
157	Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone					0.0372	0.0067
158	Pressure Ulcer of Skin with Full Thickness Skin Loss					0.0356	0.0004
159	Pressure Ulcer of Skin with Partial Thickness Skin Loss			0.0531	<0.0001	0.0366	0.0002
160	Pressure Pre-Ulcer Skin Changes or Unspecified Stage			0.1714	<0.0001	0.1038	<0.0001
167	Major Head Injury					0.1109	<0.0001
169	Vertebral Fractures without Spinal Cord Injury					0.1258	<0.0001

*2011 data

SHR and Prevalent Comorbidities (2)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
173	Traumatic Amputations and Complications					0.0786	<0.0001
188	Artificial Openings for Feeding or Elimination	0.2302	<0.0001	0.1386	<0.0001	0.0860	<0.0001
19	Diabetes without Complication	0.2568	<0.0001	0.2382	<0.0001	0.1934	<0.0001
22	Morbid Obesity					0.0971	<0.0001
27	End-Stage Liver Disease			0.3024	<0.0001	0.2790	<0.0001
28	Cirrhosis of the Liver	0.4089	<0.0001	0.2468	<0.0001	0.2186	<0.0001
33	Intestina Obstruction/Perforation			0.2749	<0.0001	0.2411	<0.0001
34	Chronic Pancreatitis	0.5057	<0.0001	0.4655	<0.0001	0.4088	<0.0001
46	Severe Hematological Disorders	0.3147	<0.0001	0.2664	<0.0001	0.2379	<0.0001
47	Disorders of Immunity			0.2113	<0.0001	0.1842	<0.0001
51	Dementia With Complications					-0.1086	<0.0001
52	Dementia Without Complication					0.0938	<0.0001
54	Drug/Alcohol Psychosis					0.3384	<0.0001
57	Schizophrenia			0.2226	<0.0001	0.0997	<0.0001

SHR and Prevalent Comorbidities (3)

HCC	HCC Label	Score 4		Score 5		Score 6	
		Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
58	Major Depressive, Bipolar, and Paranoid Disorders					0.1871	<0.0001
6	Opportunistic Infections					0.2646	<0.0001
70	Quadriplegia	0.1371	<0.0001	0.0676	0.0003	0.0358	0.0583
72	Spinal Cord Disorders/Injuries	0.1364	<0.0001	0.1011	<0.0001	0.0448	<0.0001
74	Cerebral Palsy	0.1640	<0.0001	0.1359	<0.0001	0.1376	<0.0001
75	Polyneuropathy	0.2818	<0.0001	0.2587	<0.0001	0.2150	<0.0001
77	Multiple Sclerosis	0.1699	<0.0001	0.1408	<0.0001	0.1011	<0.0001
78	Parkinson's and Huntington's Diseases	0.1523	<0.0001	0.1325	<0.0001	0.0936	<0.0001
8	Metastatic Cancer and Acute Leukemia	0.2880	<0.0001	0.2389	<0.0001	0.2285	<0.0001
80	Coma, Brain Compression/Anoxic Damage					0.1466	<0.0001
83	Respiratory Arrest					0.1746	<0.0001
9	Lung and Other Severe Cancers	0.1746	<0.0001	0.1430	<0.0001	0.1106	<0.0001
--	Patients with <6 months of Medicare coverage in prior year	0.5375	<0.0001	0.5665	<0.0001	0.6551	<0.0001

SHR C-Statistics

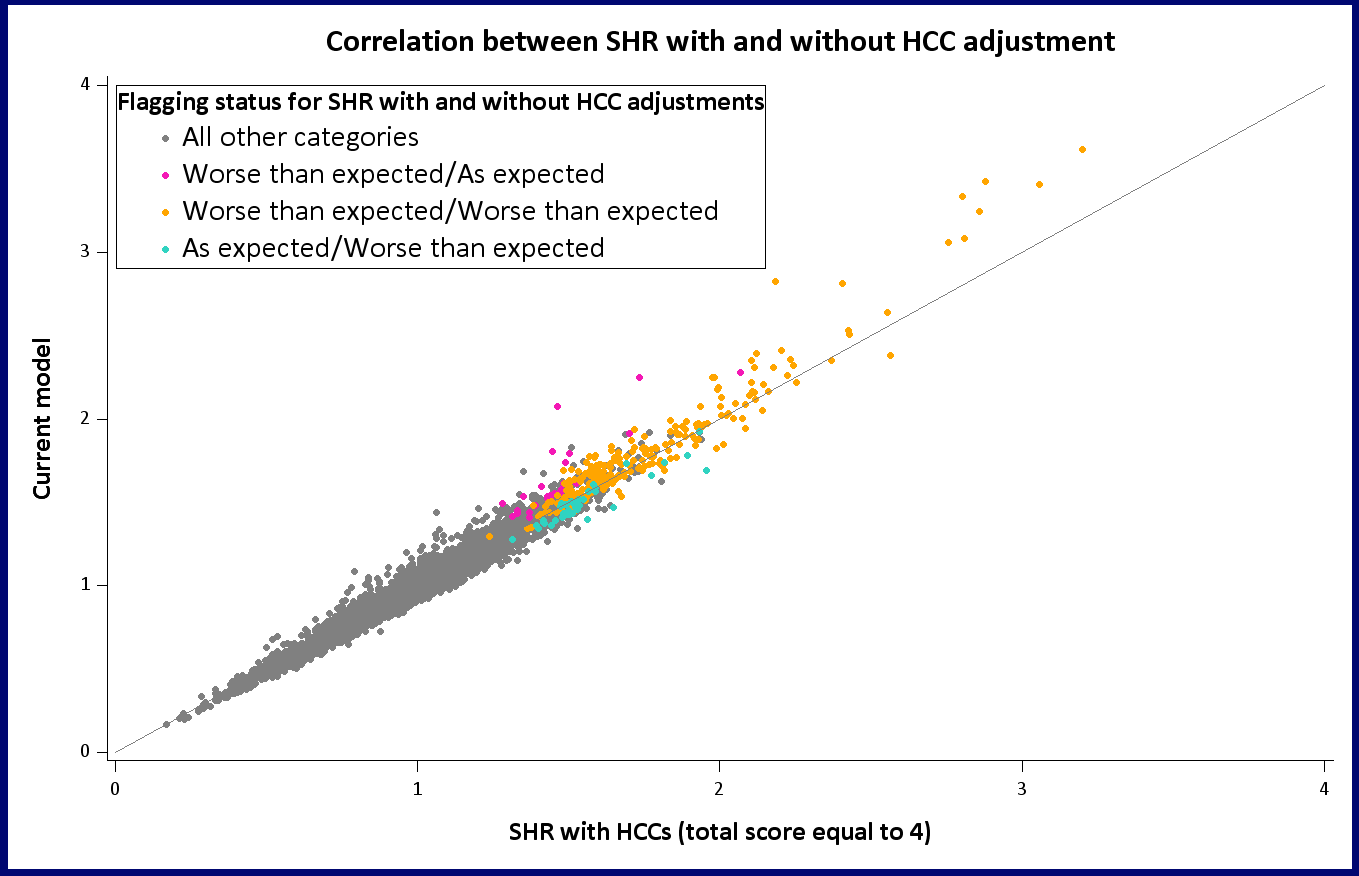
SHR Model	C-Statistic
Current model without prevalent comorbidities	0.60
Model including HCCs with score = 4 (17)	0.62
Model including HCCs with score ≤5 (24)	0.63
Model including HCCs with score ≤6 (38)	0.64
Model including all HCC selected (70)	0.66

Flagging: SHR and Prevalent Comorbidities

		Current SHR Model		
		Better than Expected	As Expected	Worse than Expected
SHR including HCCs with score =4	Better than Expected	41 (0.7%)	14 (0.3%)	0
	As Expected	5 (0.1%)	5,213 (93.6%)	27 (0.5%)
	Worse than Expected	0	39 (0.7%)	229 (4.1%)
SHR including HCCs with score ≤5	Better than Expected	41 (0.7%)	14 (0.3%)	0
	As Expected	5 (0.1%)	5,206 (93.5%)	29 (0.5%)
	Worse than Expected	0	46 (0.8%)	227 (4.1%)
SHR including HCCs with score ≤6	Better than Expected	36 (0.7%)	20 (0.4%)	0
	As Expected	10 (0.2%)	5,199 (93.4%)	42 (0.7%)
	Worse than Expected	0	47 (0.8%)	214 (3.8%)

*Kappa statistics for models including HCCs with score =4, score ≤5 and ≤6: 0.8571, 0.8431 and 0.7981, respectively (p-value <0.0001 for all comparisons)

Flagging: SHR and Prevalent Comorbidities



Issues Requiring TEP Advice

- Selection of comorbidity classification system
- Inclusion of specific prevalent comorbidities as risk adjusters
- Sources of data for comorbidity measurement
- Timing and frequency of comorbidity measurement
- Reflecting severity in comorbidity measurement

Impact of When Comorbidities are Measured

Timing of Comorbidity Measurement

- Effect on assessment of whether comorbidities are a result of facility care

Severity of Comorbidity

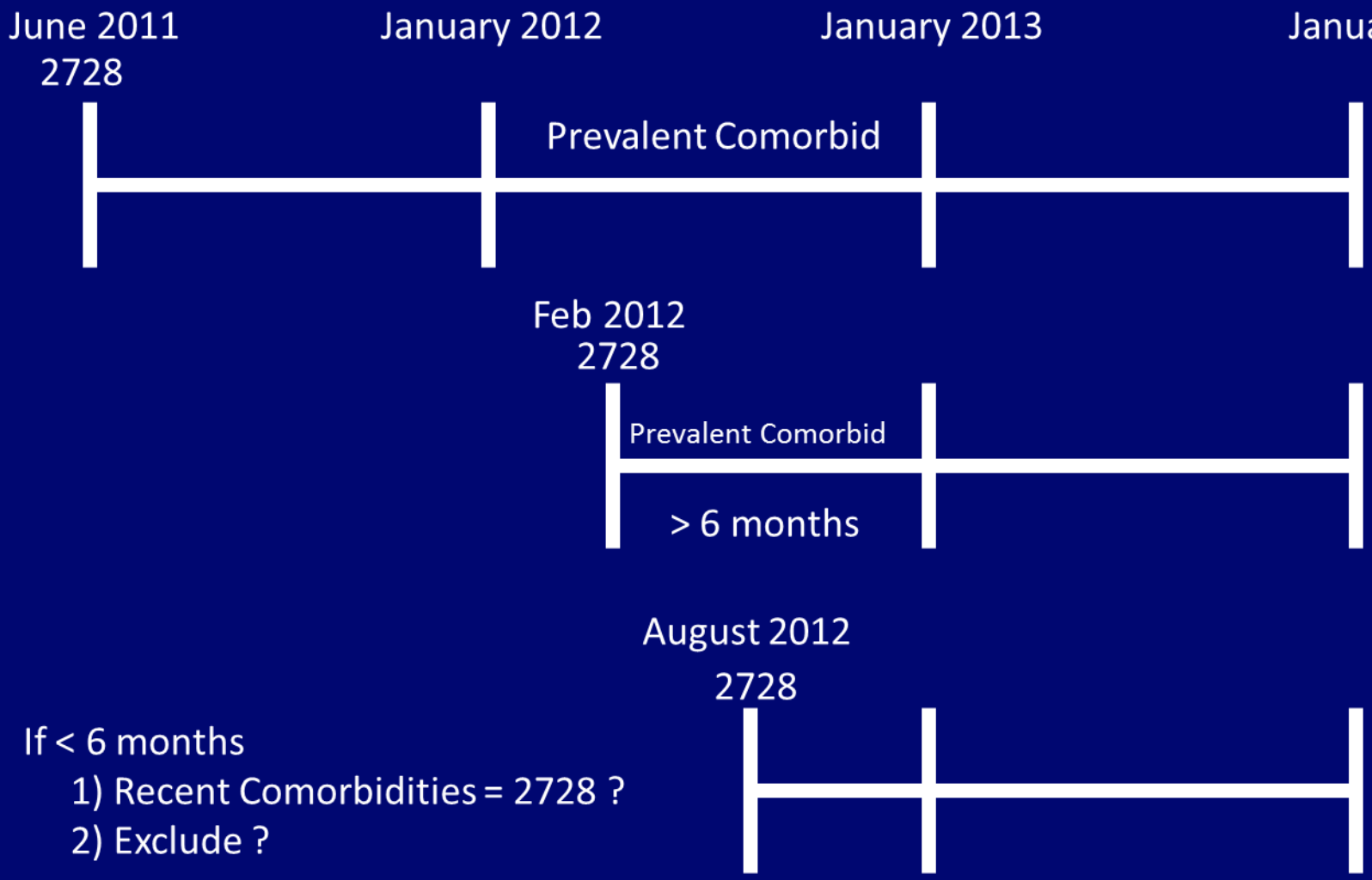
- Effect on strength of relation to outcome
  - Gilbertson et al.
- Measured by source of claims
  - Gilbertson et al.
- Measured by frequency of claims by condition over specified time period

CMS Technical Expert Panel

ESRD Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)

DAY 2

Look-Backs: Calendar Year 2013 SMR



If < 6 months

1) Recent Comorbidities = 2728 ?
2) Exclude ?

Heart Failure is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 3
- Disagree – should be adjusted for - 6
- No vote - 0

Septicemia is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 7
- Disagree – should be adjusted for - 2
- No vote - 0

Specified Heart Arrhythmias is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 1
- Disagree – should be adjusted for - 8
- No vote - 0

Lymphoma and Other Cancers is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 0
- Disagree – should be adjusted for - 9
- No vote - 0

Cirrhosis of the Liver is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 0
- Disagree – should be adjusted for - 9
- No vote - 0

Morbid Obesity is a result of facility care and should not be adjusted for

- Agree – should not be adjusted for - 0
- Disagree – should be adjusted for - 9
- No vote - 0

Recap of Recommendations

Next Steps

- Re-estimation of SMR and SHR based on TEP recommendations from this meeting
- Reporting results to TEP for consideration
- Seeking consensus on final recommendations

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End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR)
Post-TEP Teleconference Call #1 Minutes
December 7, 2015 1:00-3:00pm (ET)

TEP Members	UM-KECC	CMS
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Introduction

UM-KECC welcomed everyone to the Post-TEP End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR) conference call, and thanked the TEP members for their time. The purpose of this call was to review analyses completed subsequent to the in-person TEP meeting in September and attempt to achieve consensus regarding three specific questions, listed below.

Presentation Overview and Objectives (UM-KECC)

UM-KECC outlined the questions for TEP discussion and displayed the comorbidity scoring sheet analyses with seven out of eight TEP responses. The questions requiring TEP advice included:

1) Which prevalent comorbidities that appear in Medicare claims are not likely the result of facility care and hence should be included as risk-adjusters in the SMR and SHR?
2) What should be the length of the lookback period for prevalent comorbidity identification (one or two years)?
3) What should be the requirement for defining a prevalent comorbidity (any one claim versus either two outpatient claims or one inpatient claim)?

Discussion of Comorbidities not Resulting from Dialysis Care (242 ICD-9 Codes)

UM-KECC provided a context for review of the results of surveying the TEP members on likelihood that a comorbidity results from facility care. For inclusion as a risk adjuster, the NQF guidelines specify that a

condition not be the result of facility care. The TEP survey found there was a large set of ICD-9 comorbidities identified by the TEP rating that were designated as not likely the result of facility care and therefore as candidates for risk adjustment.

Depending on the definition of consensus, there is a substantial difference regarding the inclusion of comorbidity risk adjustment. UM-KECC offered the TEP two different definitions of consensus, a simple majority definition, or a two-thirds majority. The two-thirds majority is a more stringent approach with respect for comorbidity inclusion for risk adjustment. One TEP member asked if UM-KECC had deviated from the HCC method. UM-KECC explained that the comorbidities within the HCCs had at least 0.1% frequency, which consisted of 555 ICD-9 codes. UM-KECC then subjected those codes to the expanded Lasso statistical analysis to identify which codes had a statistical relationship to either mortality or hospitalization. From that methodology, a subset of 242 comorbidities were selected for the TEP to consider for risk adjustment.

UM-KECC provided a clarification regarding the spreadsheet, stating that UM-KECC combined the categories “unlikely” and “very unlikely” the result of facility care, and “likely” and “very likely” the result of facility care. UM-KECC suggested the category “may or may not be related to facility care” could be included in the “likely” and “very likely” the result of facility care grouping based upon NQF requirements for risk adjustment.

One TEP member expressed concern that a methodology discussion was taking place reflecting upon the results of the survey. The TEP member’s opinion was there seems to be a value judgement included, and there is now an imbalance of three categories against two. Furthermore, the TEP member stated a majority consensus is a better option versus a two-thirds consensus. UM-KECC noted that the response, “may or may not be the result of facility care”, does not provide any assurance a condition is not a result of facility care. UM-KECC suggested that in order to meet the criteria of NQF, there should be a clear consensus that a condition is unlikely or very unlikely the result of facility care to be included as a risk adjuster.

A TEP member suggested the group reevaluate the individual diagnoses, after they are grouped into clinically meaningful groups. The rationale is several diagnoses reflect similar conditions. Adjusting for some and not for others may not make sense. The TEP chair added that failure to reflect similar diagnoses in the risk-adjustment model could also provide potential gaming opportunities.

UM-KECC highlighted the two-thirds majority consensus regarding 187 diagnoses are not likely the result of facility care, and there does not seem to be ambivalence about those 187. UM-KECC asked the TEP if there is any disagreement that those 187 comorbidities should definitely be included; The TEP members present on the call unanimously agreed those 187 comorbidities should indeed be included for risk adjustment. As a result, the discussion focused on what action to take regarding the remaining 55 comorbidities. UM-KECC stated at this point, out of the 55 remaining comorbidities, 28 would be excluded from risk adjustment based on a majority consensus; however, it is possible some comorbidities would shift when grouping based on overarching disease. The TEP chair suggested a vote be held regarding which definition be used in how to classify the remaining comorbidities, and there was a unanimous TEP recommendation that a simple majority score for the 55 comorbidities should define consensus.

Discussion of the Length of the Lookback Period for Comorbidity Identification

UM-KECC shifted the discussion to the length of the lookback period for comorbidity identification. The relevant analyses, which the TEP had received prior to the meeting, were displayed for information.

The TEP chair asked how patients who have not been on dialysis for less than one year, and, subsequently, do not have a full year of data are handled. The TEP chair also stated if one looks at the strength of the associations, those that seem significantly stronger are among the shorter lookback period. UM-KECC responded that, in the analyses displayed, if a patient has more than six months of Medicare claims, this is judged to be sufficient comorbidity identification. If not, the model contains an indicator indicating missing comorbidities.

One TEP member asked UM-KECC if the baseline comorbidities (from CMS Form 2728) were included when formulating the models; UM-KECC answered yes. This approach was based on discussion at the in-person TEP. The TEP acknowledged the C-statistics do not have much variation between a one-year and two-year lookback period. One TEP member recently had a research publication regarding the lookback period, and UM-KECC's analyses parallels the TEP member's findings. For a one-year compared to a two-year lookback, these findings are: (1) fewer comorbidities identified and (2) stronger relationship between a comorbidity and mortality or hospitalization.

A TEP member asked what happens if there is not the minimum required time for the lookback. UM-KECC explained an analytic method is currently being explored, which could account for patients for whom UM-KECC has less than a year's worth of data; this method essentially uses a missing data statistical concept. UM-KECC's goal with this model is to include as many patients as possible and to save as much data is possible. The TEP noted that, in general, stronger p-values are present for a one-year lookback period. Partially for this reason, the TEP members in attendance unanimously voted to use a one-year lookback period.

Discussion of Claims Types and Numbers Necessary to Identify Existence of Comorbidity

The group then reviewed the number and type of claim required to identify the existence of a comorbidity. The relevant analyses, which the TEP had received prior to the meeting, were displayed for information.

Option one is to use one-inpatient claim or two-outpatient claims, and option two is to use any claim type. UM-KECC noted the higher comorbidity frequencies if one claim, as opposed to multiple claims, is required. Again, the TEP noted that the C-statistics were very similar.

One TEP member asked to clarify the difference between option one and option two regarding outpatient claims. UM-KECC explained that with option two all outpatient claims types are treated the same, and any two, including outpatient hospital claims and physician claims, occurring at least twice within the lookback period are sufficient for comorbidity identification.

One TEP member expressed a concern that CKD ICD-9 diagnoses are included in the analyses and asked if this could confound the model. UM-KECC replied that the two options were used to compare the models. All comorbidities found to be statistically significant from the Lasso variable selection method were included and no exclusions were made regarding the HCC groups. However, reflecting this

concern, UM-KECC offered to re-run the analyses, eliminating the CKD diagnoses. The TEP agreed to exclude ICD-9 codes 134-140 and have UM-KECC rerun the analyses to inform final consideration of both this issue and the lookback period.

UM-KECC asked the TEP if any type of claim vs. a more stringent definition of one-inpatient or two-outpatient claims would be appropriate. One TEP member stated the inpatient claim often leads to diagnoses that are more severe and one of the reasons why two outpatient claims weigh equally with that.

The majority of the TEP expressed ambivalence regarding option-one versus option-two. The TEP Chair suggested the TEP take a vote with three-options: 1) one-inpatient claim or two-outpatient claims, 2) any type of claims, and 3) abstain their vote. Six out of seven TEP members voted in favor of one-inpatient or two-outpatient claims, while one TEP member officially abstained from voting.

Public Comments

The following public comment was transcribed verbatim from the teleconference recording:
Susan Senich (North Central Kidney Dialysis): "On the first hour in your discussion with your spreadsheet, you have ICD-9 codes on there. Are you going to have to redo this for ICD-10 codes? I believe ICD-10 codes are on the 2728 now."

In response to the public comment, UM-KECC responded with the following:
Joseph Messana (UM-KECC): "Thank you for the comment. Hopefully you can appreciate the fact that there is not a critical mass of ICD-10 codes in the Medicare claims yet, so none of our analyses could be done with ICD-10 codes. There are accepted crosswalks for ICD-9 to ICD-10, so in order to move forward with informing the TEP discussion, we were required to use ICD-9 codes, just because of their availability and the historical claims. A transition from ICD-9 to ICD-10 would definitely be a part of implementation."

Closing Remarks and Next Steps

UM-KECC thanked the TEP members for their time and expertise and provided closing remarks for the TEP meeting including a review of the work the TEP and UM-KECC will be doing in the next week. UM-KECC stated next steps include completing additional analyses with the remaining 55 comorbidities and checking the sensitivity analyses informing the look back period and the frequency of claims requirement. The results of these analyses will be redistributed to the TEP within a few days.

SMR/SMR TEP Teleconference Call #2

University of Michigan Kidney Epidemiology and Cost Center

(UM-KECC)

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Agenda

1. Discussion of comorbidities not resulting from dialysis care (224 ICD-9 codes).
2. Discussion of the length of the lookback period for comorbidity identification.
    a. Advantages and disadvantages for 1 year.
    b. Advantages and disadvantages for 2 years.
3. Discussion of claims types and numbers necessary to identify the existence of comorbidity.
    a. Any claim within lookback period.
    b. At least 1 inpatient claim or 2 outpatient claims within lookback period.
4. Public Comments
5. Summary and next steps.

Analyses

1. Which prevalent comorbidities that appear in Medicare claims are not likely the result of facility care and hence should be included as risk adjusters in the SMR and SHR?

2. What should be the lookback period for observing a comorbidity in the claims? Should it be one year or two years?

3. What should be the requirement for defining a prevalent comorbidity (any one claim, versus either 2 outpatient claims or 1 inpatient claim)?

Question 1

Which prevalent comorbidities that appear in Medicare claims are not likely the result of facility care and hence should be included as risk adjusters in the SMR and SHR?

Question 2

What should be the lookback period for observing a comorbidity in the claims? Should it be one year or two years?

Question 3

What should be the requirement for defining a prevalent comorbidity (any one claim, versus either 2 outpatient claims or 1 inpatient claim)?

Identification of Prevalent Comorbidities Used as Risk Adjusters

CMS contracted with UM-KECC to convene a Technical Expert Panel (TEP) in September 2015 to consider the addition of prevalent comorbidities as risk adjusters in the calculation of the Standardized Mortality Ratio (SMR) and Standardized Hospitalization Ratio (SHR). The TEP was charged with evaluating the potential of including prevalent comorbidities in the SMR and SHR risk adjustment models. Specific objectives included: (1) review of the comorbidity adjustment (determined at ESRD incidence) in the current NQF endorsed SMR and SHR measures; and (2) consideration of what, if any, prevalent comorbidities would be appropriate to include in each measure. In developing its recommendations, the TEP was asked to apply the criteria for risk-adjusters developed by the National Quality Forum (NQF): (1) Risk adjustment should be based on patient factors that influence the measured outcome and are present at the start of care; (2) Measures should not be adjusted for factors related to disparities in care or the quality of care; (3) Risk adjustment factors must be substantially related to the outcome being measured; (4) Risk adjustment factors should not reflect quality of care by the provider/facility being evaluated.

Reflecting these criteria, the TEP evaluated a list of prevalent comorbidities derived through the following process. First, the ESRD Hierarchical Comorbidity Conditions (ESRD-HCCs) were used as a starting point to identify ICD-9 diagnosis codes related to dialysis care. Those individual ICD-9 conditions that comprised the respective ESRD HCCs, with a prevalence of at least 0.1% in the patient population, were then selected for analysis to determine their statistical relationship to mortality or hospitalization. This step resulted in 555 diagnoses comorbidities (out of over 3000 ICD-9 diagnosis codes in the ESRD-HCCs). Next, an adaptive lasso variable selection method was applied to these 555 diagnoses to identify those with a statistically significant relationship to mortality and/or hospitalization ($p<0.05$). This process identified 242 diagnoses. The TEP members then scored each of these diagnoses as follows:

1. Very likely the result of dialysis facility care
2. Likely the result of dialysis facility care
3. May or may not be the result of dialysis facility care
4. Unlikely to be the result of dialysis facility care
5. Very likely not the result of dialysis facility care

This scoring exercise aimed at identifying a set of prevalent comorbidities not likely the result of facility care and therefore potentially appropriate as risk adjusters for SHR and SMR. The TEP established that comorbidities scored as “unlikely” or “very unlikely the result of facility care” by at least half of TEP members (simple majority) were judged as

appropriate for inclusion as risk-adjusters. This process resulted in 210 conditions as risk adjustors. The TEP further recommended that: (1) comorbidities for inclusion as risk-adjusters in a particular year should be present in Medicare claims in the preceding calendar year; and (2) determination of a prevalent comorbidity required at least two outpatient claims or one inpatient claim. The set of prevalent comorbidities recommended by the TEP for inclusion as risk-adjusters is presented in Appendix G. These comorbidities are reflected in the risk-adjustment methodology and model results for SHR and SMR.

ICD-9	Description
135	Sarcoidosis
185	Malign neopl prostate
193	Malign neopl thyroid
262	Oth severe malnutrition
496	Chr airway obstruct NEC
515	Postinflam pulm fibrosis
1541	Malignant neopl rectum
1550	Mal neo liver, primary
1623	Mal neo upper lobe lung
1629	Mal neo bronch/lung NOS
1889	Malig neo bladder NOS
1890	Malig neopl kidney
1970	Secondary malig neo lung
1977	Second malig neo liver
1985	Secondary malig neo bone
1991	Malignant neoplasm NOS
2639	Protein-cal malnutr NOS
2706	Dis urea cycle metabol
2900	Senile dementia uncomp
2920	Drug withdrawal
2948	Mental disor NEC oth dis
3319	Cereb degeneration NOS
3371	Aut neuropthy in oth dis
3453	Grand mal status
3481	Anoxic brain damage
3485	Cerebral edema
3569	Idio periph neurpthy NOS
3572	Neuropathy in diabetes
4111	Intermed coronary synd
4139	Angina pectoris NEC/NOS
4160	Prim pulm hypertension
4168	Chr pulmon heart dis NEC
4254	Prim cardiomyopathy NEC
4258	Cardiomyopath in oth dis
4260	Atriovent block complete
4271	Parox ventric tachycard
4272	Parox tachycardia NOS
4321	Subdural hemorrhage
4400	Aortic atherosclerosis
4423	Lower extremity aneurysm
4439	Periph vascular dis NOS
4471	Stricture of artery
4532	Oth inf vena cava thromb
4928	Emphysema NEC
4940	Bronchiectas w/o ac exac

5070	Food/vomit pneumonitis
5178	Lung involv in oth dis
5559	Regional enteritis NOS
5569	Ulceratve colitis unspcf
5571	Chr vasc insuff intest
5601	Paralytic ileus
5609	Intestinal obstruct NOS
5712	Alcohol cirrhosis liver
5715	Cirrhosis of liver NOS
5722	Hepatic encephalopathy
5723	Portal hypertension
5728	Oth sequela, chr liv dis
5771	Chronic pancreatitis
7078	Chronic skin ulcer NEC
7100	Syst lupus erythematosus
7101	Systemic sclerosis
7140	Rheumatoid arthritis
7149	Inflamm polyarthrop NOS
7202	Sacroiliitis NEC
7854	Gangrene
7994	Cachexia
8082	Fracture of pubis-closed
8088	Pelvic fracture NOS-clos
8208	Fx neck of femur NOS-cl
8970	Amput below knee, unilat
8971	Amputat bk, unilat-compl
8972	Amput above knee, unilat
8974	Amputat leg, unilat NOS
11284	Candidal esophagitis
20280	Oth lymp unsp xtrndl org
20300	Mult mye w/o achv rmson
20410	Ch lym leuk wo achv rmsn
23871	Essntial thrombocythemia
23872	Low grde myelody syn les
23875	Myelodysplastic synd NOS
25000	DMII wo cmp nt st uncntr
25002	DMII wo cmp uncntrld
25010	DMII keto nt st uncntrld
25012	DMII ketoacd uncontrold
25013	DMI ketoacd uncontrold
25022	DMII hprosmlr uncontrold
25040	DMII renl nt st uncntrld
25041	DMI renl nt st uncntrld
25050	DMII ophth nt st uncntrl
25053	DMI ophth uncntrld
25060	DMII neuro nt st uncntrl
25061	DMI neuro nt st uncntrld

25062	DMII neuro uncntrld
25063	DMI neuro uncntrld
25070	DMII circ nt st uncntrld
25071	DMI circ nt st uncntrld
25072	DMII circ uncntrld
25080	DMII oth nt st uncntrld
25081	DMI oth nt st uncntrld
25082	DMII oth uncntrld
25083	DMI oth uncntrld
25541	Glucocorticoid deficient
27739	Amyloidosis NEC
27789	Metabolism disorder NEC
27801	Morbid obesity
27803	Obesity hypovent synd
28260	Sickle cell disease NOS
28411	Antin chemo indcd pancyt
28419	Other pancytopenia
28800	Neutropenia NOS
28803	Drug induced neutropenia
28981	Prim hypercoagulable st
29020	Senile delusion
29040	Vascular dementia,uncomp
29410	Dementia w/o behav dist
29411	Dementia w behavior dist
29420	Demen NOS w/o behv dstrb
29590	Schizophrenia NOS-unspec
29620	Depress psychosis-unspec
29630	Recurr depr psychos-unsp
29633	Recur depr psych-severe
29680	Bipolar disorder NOS
29689	Bipolar disorder NEC
29690	Episodic mood disord NOS
30390	Alcoh dep NEC/NOS-unspec
30393	Alcoh dep NEC/NOS-remiss
30400	Opioid dependence-unspec
30401	Opioid dependence-contin
30490	Drug depend NOS-unspec
34540	Psymotr epil w/o int epi
34590	Epilep NOS w/o intr epil
35981	Critical illness myopthy
36202	Prolif diab retinopathy
36205	Mod nonprolf db retinoph
36207	Diabetic macular edema
40291	Hyp ht dis NOS w ht fail
41071	Subendo infarct, initial
41080	AMI NEC, unspecified
41090	AMI NOS, unspecified

41189	Ac ischemic hrt dis NEC
41519	Pulm embol/infarct NEC
42731	Atrial fibrillation
42732	Atrial flutter
42781	Sinoatrial node dysfunct
43411	Crbl emblsm w infrct
43491	Crbl art ocl NOS w infrc
44020	Athscl extrm ntv art NOS
44021	Ath ext ntv at w claudct
44022	Ath ext ntv at w rst pn
44023	Ath ext ntv art ulcrtion
44101	Dsct of thoracic aorta
44389	Periph vascular dis NEC
45119	Deep phlebitis-leg NEC
45341	Ac DVT/emb prox low ext
45350	Ch DVT/embl low ext NOS
45351	Ch DVT/embl prox low ext
45375	Ch emblsm subclav veins
45382	Ac DVT/embl up ext
45384	Ac emblsm axillary veins
45386	Ac embl internl jug vein
45387	Ac embl thorac vein NEC
45621	Esoph varice oth dis NOS
49121	Obs chr bronc w(ac) exac
49122	Obs chr bronc w ac bronc
49320	Chronic obst asthma NOS
49322	Ch obst asth w (ac) exac
51851	Ac resp flr fol trma/srg
51852	Ot pul insuf fol trm/srg
51882	Other pulmonary insuff
51883	Chronic respiratory fail
51884	Acute & chronc resp fail
53642	Gastrostomy comp - mech
56032	Fecal impaction
70703	Pressure ulcer, low back
70704	Pressure ulcer, hip
70705	Pressure ulcer, buttock
70710	Ulcer of lower limb NOS
70715	Ulcer other part of foot
70719	Ulcer oth part low limb
71100	Pyogen arthritis-unspec
71106	Pyogen arthritis-l/leg
73000	Ac osteomyelitis-unspec
73007	Ac osteomyelitis-ankle
73008	Ac osteomyelitis NEC
73024	Osteomyelitis NOS-hand
73027	Osteomyelitis NOS-ankle

73313	Path fx vertebrae
73342	Aseptic necrosis femur
73349	Asept necrosis bone NEC
78001	Coma
78039	Convulsions NEC
82009	Fx femur intrcaps NEC-cl
82100	Fx femur NOS-closed
99664	React-indwell urin cath
99683	Compl heart transplant
V08	Asymp hiv infectn status
V421	Heart transplant status
V427	Liver transplant status
V4283	Trnspl status-pancreas
V441	Gastrostomy status
V442	Ileostomy status
V443	Colostomy status
V446	Urinostomy status NEC
V4611	Respirator depend status
V4972	Status amput othr toe(s)
V4975	Status amput below knee
V4976	Status amput above knee
V551	Atten to gastrostomy
V5867	Long-term use of insulin
V8541	BMI 40.0-44.9, adult