MEASURE JUSTIFICATION FORM

Project Title:
End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio for Dialysis Facilities.

Project Overview:
The Centers for Medicare & Medicaid Services (CMS) has contracted with University of Michigan Kidney Epidemiology and Cost Center (UM-KECC) to evaluate the potential of including prevalent comorbidities in the SMR and SHR risk adjustment models. Motivation for this project comes from public comments expressing interest in considering the addition of more recent measures of patient health status to the risk-adjustment models, which now adjust for comorbidities at incidence. This work is part of a larger project to reevaluate the SMR and SHR measures.

Date:
Information included is current on May 10, 2016

Measure Name:
Standardized Hospitalization Ratio for Dialysis Facilities

Descriptive Information:

Measure Name (Measure Title De.2.)
Standardized Hospitalization Ratio for Dialysis Facilities

Measure Type De.1.
Outcome

Brief Description of Measure De.3.
Standardized hospitalization ratio for dialysis facility patients. This measure is calculated as a ratio but can also be expressed as a rate.

If Paired or Grouped De.4.
N/A

Subject/Topic Areas De.5.
Renal, Renal: End Stage Renal Disease (ESRD)

Crosscutting Areas De 6.
N/A

Measure Specifications:

Measure-specific Web Page S.1.
N/A

If This Is an eMeasure S.2a.
This is not an eMeasure

Data Dictionary, Code Table, or Value Sets S.2b.
See Data Dictionary/ Code Table

For Endorsement Maintenance S.3.
This form is being used for endorsement maintenance. Updates include:

- The model now adjusts for each incident comorbidity separately rather than using a comorbidity index.
- We have also modified the indicators for diabetes by consolidating the individual indicators.
- We have included adjustments for 210 prevalent comorbidities (identified through Medicare claims).

Numerator Statement S.4.
Number of inpatient hospital admissions among eligible patients at the facility during the reporting period.

Time Period for Data S.5.
At least one year

Numerator Details S.6.
The numerator is calculated through use of Medicare claims data. When a claim is made for an inpatient hospitalization, the patient is identified and attributed to a dialysis facility following rules discussed below in the denominator details. The numerator is the count of all such hospitalizations over the reporting period.

Denominator Statement S.7.
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.

Target Population Category S.8.
Populations at Risk

Denominator Details S.9.
Assignment of Patients to Facilities

UM-KECC's treatment history file provides a complete history of the status, location, and dialysis treatment modality of an ESRD patient from the date of the first ESRD service until the patient dies or the data collection cutoff date is reached. For each patient, a new record is created each time he/she changes facility or treatment modality. Each record represents a time period associated with a specific modality and dialysis facility. SIMS/CROWNWeb is the primary basis for placing patients at dialysis facilities, and dialysis claims are used as an additional source. Information regarding first ESRD service date, death and transplant is obtained from additional sources including the CMS Medical Evidence Form (Form CMS-2728), transplant data from the Organ Procurement and Transplant Network (OPTN), the Death Notification Form (Form CMS-2746) and the Social Security Death Master File.

As patients can receive dialysis treatment at more than one facility in a given year, we assign each patient day to a facility (or no facility, in some cases) based on a set of conventions described below, which largely align with those for the Standardized Mortality Ratio (SMR). We detail patient inclusion criteria, facility assignment and how to count days at risk, all of which are required for the risk adjustment model.

General Inclusion Criteria for Dialysis Patients

Though a patient's follow-up in the database can be incomplete during the first 90 days of ESRD therapy, we only include a patient's follow-up in the tabulations after that patient has received chronic renal replacement therapy for at least 90 days. Thus, hospitalizations, mortality and survival during the first 90 days of ESRD do not enter into the calculations. This minimum 90-day period also assures that most patients are eligible for Medicare, either as their primary or secondary insurer. It also excludes from analysis patients who die or recover renal function during the first 90 days of ESRD.

In order to exclude patients who only received temporary dialysis therapy, we assign patients to a facility only after they have been on dialysis there for the past 60 days. This 60 day period is used both for patients who started ESRD for the first time and for those who returned to dialysis after a transplant. That is, hospitalizations during the first 60 days of dialysis at a facility do not affect the SHR of that facility.

Identifying Facility Treatment Histories for Each Patient

For each patient, we identify the dialysis provider at each point in time. Starting with day 91 after onset of ESRD, we attribute patients to facilities according to the following rules. A patient is attributed to a facility once the patient has been treated there for the past 60 days. When a patient transfers from one facility to another, the patient continues to be attributed to the original facility for 60 days and then is attributed to the destination facility. In particular, a patient is attributed to his or her current facility on day 91 of ESRD if that facility had treated him or her for the past 60 days. If on day 91, the facility had not treated a patient for the past 60 days, we wait until the patient reaches day 60 of continuous treatment at that facility before attributing the patient to that facility. When a patient is not treated in a single facility for a span of 60 days (for instance, if there were two switches within 60 days of each other), we do not attribute that patient to any facility. Patients are removed from facilities three days prior to transplant in order to exclude the transplant hospitalization. Patients who withdrew from dialysis or recovered renal function remain assigned to their treatment facility for 60 days after withdrawal or recovery.

If a period of one year passes with neither paid dialysis claims nor SIMS information to indicate that a patient was receiving dialysis treatment, we consider the patient lost to follow-up and do not include

that patient in the analysis. If dialysis claims or other evidence of dialysis reappears, the patient is entered into analysis after 60 days of continuous therapy at a single facility.

Days at Risk for Medicare Dialysis Patients
After patient treatment histories are defined as described above, periods of follow-up in time since ESRD onset are created for each patient. In order to adjust for duration of ESRD appropriately, we define 6 time intervals with cut points at 6 months, 1 year, 2 years, 3 years and 5 years. A new time period begins each time the patient is determined to be at a different facility, or at the start of each calendar year or when crossing any of the above cut points.

Since hospitalization data tend not to be as complete as mortality data, we include only patients whose Medicare billing records include all hospitalizations. To achieve this goal, we require that patients reach a certain level of Medicare-paid dialysis bills to be included in the hospitalization statistics, or that patients have Medicare-paid inpatient claims during the period. Specifically, months within a given dialysis patient-period are used for SHR calculation when they meet the criterion of being within two months after a month with either: (a) $900+ of Medicare-paid dialysis claims OR (b) at least one Medicare-paid inpatient claim. The intention of this criterion is to assure completeness of information on hospitalizations for all patients included in the analysis.

The number of days at risk in each of these patient-ESRD facility-year time periods is used to calculate the expected number of hospital admissions for the patient during that period. The SHR for a facility is the ratio of the total number of observed hospitalizations to the total number of expected hospitalizations during all time periods at the facility. Based on a risk adjustment model for the overall national hospitalization rates, we compute the expected number of hospitalizations that would occur for each month that each patient is attributed to a given facility. The sum of all such expectations for patients and months yields the overall number of hospital admissions that would be expected given the specific patient mix and this forms the denominator of the measure.

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 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).

References:

Cook, R. and Lawless, J. The Statistical Analysis of Recurrent Events. New York: Springer. 2007.
Cox, D.R. (1972) Regression Models and Life Tables (with Discussion). J. Royal statistical Society, Series B, 34, 187-220.
Kalbfleisch, J.D. and Prentice, R. L. The Statistical Analysis of Failure Time Data. Wiley, New York, 2002.
Lawless, J. F. and Nadeau, C. Some simple and robust methods for the analysis of recurrent events, Technometrics, 37 1995, 355-364.
Lin, D.Y., Wei, L.J., Yang, I. and Ying, Z. Semi parametric regression for the mean and rate functions of recurrent events, Journal of the Royal Statistical Society Series B, 62, 2000, 771-730
Liu, D., Schaubel, D.E. and Kalbfleisch, J.D. Computationally efficient marginal models for clustered recurrent event data, University of Michigan Department of Biostatistics Technical Reports, 2010.

Denominator Exclusions (NQF Includes "Exceptions" in the "Exclusion" Field) S.10.
None.

Denominator Exclusion Details (NQF Includes "Exceptions" in the "Exclusion" Field) S.11.
N/A

Stratification Details/Variables S.12.
N/A

Risk Adjustment Type S.13.
Statistical risk model

Statistical Risk Model and Variables S.14.
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, prevalent comorbidities, 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, facility adjustment 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 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.

- Prevalent comorbidities: We identify a patient's prevalent comorbidities based on claims from the previous calendar year. The comorbidities adjusted for include those listed in data dictionary/code table (excel file).
- 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

Detailed Risk Model Specifications S.15.
See Data Dictionary/ Code Table

Type of Score S.16.
Ratio

Interpretation of Score S.17.
Better quality = Lower score

Calculation Algorithm/Measure Logic S.18.
See flowchart in appendix.

Calculation Algorithm/Measure Logic Diagram URL or Attachment S.19.
See flowchart in appendix.
s
Sampling S.20.
N/A

Survey/Patient-Reported Data S.21.
N/A

Missing Data S.22.
Patients with missing data are not excluded from the model. For the purposes of calculation, missing values for BMI are replaced with mean values for patients of similar age and identical race, sex, and cause of ESRD. Missing values for cause of ESRD are replaced with the other/unknown category. No patients were missing age, sex, or date of first ESRD treatment. Indicator variables identifying patients with missing values for cause of ESRD, comorbidities at incidence (missing CMS-2728), and BMI are also

included as covariates in the model. For 2010-2013, 3% of the patients included in the SHR model calculation were missing BMI.

Data Source S.23.
Administrative claims, Electronic Clinical Data

Data Source or Collection Instrument S.24.
Data are derived from an extensive national ESRD patient database, which is primarily based on the CMS Consolidated Renal Operations in a Web-enabled Network (CROWN) system. The CROWN data include the Renal Management Information System (REMIS), CROWNWeb facility-reported clinical and administrative data (including CMS-2728 Medical Evidence Form, CMS-2746 Death Notification Form, and CMS-2744 Annual Facility Survey Form data), the historical Standard Information Management System (SIMS) database (formerly maintained by the 18 ESRD Networks until replaced by CROWNWeb in May 2012), the National Vascular Access Improvement Initiative's Fistula First Catheter Last project (in CROWNWeb since May 2012), Medicare dialysis and hospital payment records, transplant data from the Organ Procurement and Transplant Network (OPTN), the Nursing Home Minimum Dataset, the Quality Improvement Evaluation System (QIES) Workbench, which includes data from the Certification and Survey Provider Enhanced Report System (CASPER), the Dialysis Facility Compare (DFC) and the Social Security Death Master File. The database is comprehensive for Medicare patients. Non-Medicare patients are included in all sources except for the Medicare payment records. CROWNWeb provides tracking by dialysis provider and treatment modality for non-Medicare patients. Information on hospitalizations is obtained from Part A Medicare Inpatient Claims Standard Analysis Files (SAFs), and past-year comorbidity is obtained from multiple Part A types (inpatient, home health, hospice, skilled nursing facility claims) and Part B outpatient types of Medicare Claims SAFs.

In calculating the SHR, Medicare inpatient claims that are adjacent or overlap with another claim are collapsed into one record. Specifically, if the admission date of an inpatient record is within one day of a following admission's discharge date, these adjacent inpatient records will be collapsed into one inpatient record that takes on the first admission's admission date and the following admission's discharge date. Similarly, if an inpatient record overlaps with another inpatient record, the two records are collapsed into one record where the earliest admission date between the two records becomes the new admission date and the latest discharge date between the two records becomes the new discharge date.

Data Source or Collection Instrument (Reference) S.25.
No data collection instrument provided

Level of Analysis S.26.
Facility

Care Setting S.27.
Dialysis Facility

Composite Performance Measure S.28.
N/A

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Date:

Information included is current on May 10, 2016.

Measure Name:

Standardized Hospitalization Ratio for Dialysis Facilities

Type of Measure:

Outcome

Importance:

1a—Opportunity for Improvement
1a.1. This is a Measure of

1a.2
Health Outcome – Hospitalization

1a.2.1 Rationale

2011 Submission
This was not a question on the 2011 Submission Form.

2016 Submission
Hospitalization rates remain very high in US chronic dialysis patients relative to the general population, despite a nearly 20% decline from 2005-2013. This trend in lower hospitalization is in contrast to the relatively stable hospitalization rates for the US general population over the same time period,

suggesting that dialysis providers have been somewhat successful in reducing unnecessary hospitalizations through quality of care improvements.
According to the 2015 USRDS Annual Report, approximately ½ of all dialysis patient hospitalizations continue to be caused by cardiovascular or infectious causes over that time period [1]. Recent research points to many additional opportunities to further reduce unnecessary hospitalization in this population.

Programs developed to impact dialysis provider practices have been shown to improve intermediate outcomes (reduced catheter vascular access, small solute adequacy, anemia management) and mortality, modality options, infection prevention, and dialysis organization culture [2-19]. These practice improvements have been linked to reduced hospitalizations in this population. For example, one study examined dialysis provider interventions targeting incident patients in order to improve outcomes for these patients that are at particularly high risk for

poor outcomes that can lead to higher morbidity and mortality [2]. The results suggested improved clinical outcomes in terms of the percentage of incident patients having a preferred vascular access type. In turn this has the potential to reduce hospitalization risk, along with mortality; other work on vascular access-type also supports the link between access type and hospitalization, specifically due to chronic catheter use [3].

1] United States Renal Data System. 2015 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2015.

[2] Wilson SM, Robertson JA, Chen G, Goel P, Benner DA, Krishnan M, Mayne TJ, Nissenson AR. The IMPACT (Incident Management of Patients, Actions Centered on Treatment) Program: A Quality Improvement Approach for Caring for Patients Initiating Long-term Hemodialysis. Am J Kidney Dis 60(3): 435-443, 2012

BACKGROUND: Patients beginning dialysis therapy are at risk of death and illness. The IMPACT (Incident Management of Patients, Actions Centered on Treatment) quality improvement program was developed to improve incident hemodialysis patient outcomes through standardized care.

STUDY DESIGN: Quality improvement report.

SETTING & PARTICIPANTS: Patients who started hemodialysis therapy between September 2007 and December 2008 at DaVita facilities using the IMPACT program (n = 1,212) constituted the intervention group. Propensity score-matched patients who initiated hemodialysis therapy in the same interval at DaVita facilities not using the IMPACT program (n = 2,424) made up the control group.

QUALITY IMPROVEMENT PLAN: IMPACT intervention included a structured intake process and monitoring reports; patient enrollment in a 90-day patient education program and 90-day patient management pathway.

OUTCOMES: Mean dialysis adequacy (Kt/V), hemoglobin and albumin levels, percentage of patients using preferred vascular access (arteriovenous fistula or graft), and mortality at each quarter.

RESULTS: Compared with the non-IMPACT group, the IMPACT group was associated with a higher proportion of patients dialyzing with a preferred access at 90 days (0.50 [95% CI, 0.47-0.53] vs 0.47 [95% CI, 0.45-0.49]; P = 0.1) and 360 days (0.63 [95% CI, 0.61-0.66] vs 0.48 [95% CI, 0.46-0.50]; P < 0.001) and a lower mortality rate at 90 days (24.8 [95% CI, 19.0-30.7] vs 31.9 [95% CI, 27.1-36.6] deaths/100

patient-years; P = 0.08) and 360 days (17.8 [95% CI, 15.2-20.4] vs 25.1 [95% CI, 20.7-25.2] deaths/100 patient-years; P = 0.01).

LIMITATIONS: The study does not determine the care processes responsible for the improved outcomes.

CONCLUSIONS: Intense management of incident dialysis patients with the IMPACT quality improvement program was associated with significantly decreased first-year mortality. Focused attention to the care of incident patients is an important part of a dialysis program.

[3] Vassalotti JA, Jennings WC, Beathard GA, Neumann M, Caponi S, Fox CH, Spergel LM and the Fistula First Breakthrough Initiative Community Education Committee. Fistula First Breakthrough Initiative: Targeting Catheter Last in Fistula First. Seminars Dialysis 25(3):303-310, 2012

Abstract: An arteriovenous fistula (AVF) is the optimal vascular access for hemodialysis (HD), because it is associated with prolonged survival, fewer infections, lower hospitalization rates, and reduced costs. The AVF First breakthrough initiative (FFBI) has made dramatic progress, effectively promoting the increase in the national AVF

prevalence since the program's inception from 32% in May 2003 to nearly 60% in 2011. Central venous catheter (CVC) use has stabilized and recently decreased slightly for prevalent patients (treated more than 90 days), while CVC usage in the first 90 days remains unacceptably high at nearly 80%. This high prevalence of CVC utilization suggests important specific improvement goals for FFBI. In addition to the current 66% AVF goal, the initiative should include specific CVC usage target(s), based on the KDOQI goal of less than 10% in patients undergoing HD for more than 90 days, and a substantially improved initial target from the current CVC proportion. These specific CVC targets would be disseminated through the ESRD networks to individual dialysis facilities, further emphasizing CVC avoidance in the transition from advanced CKD to chronic kidney failure, while continuing to decrease CVC by prompt conversion of CVC-based hemodialysis patients to permanent vascular access, utilizing an AVF whenever feasible.

[4] Ng LJ, Chen F, Pisoni RL, Krishnan M, Mapes D, Keen M, Bradbury BD. Hospitalization risks related to vascular access type among incident US hemodialysis patients. Nephrol Dial Transplant. 26(11):3659-66, 2011

BACKGROUND: The excess morbidity and mortality related to catheter utilization at and immediately following dialysis initiation may simply be a proxy for poor prognosis. We examined hospitalization burden related to vascular access (VA) type among incident patients who received some predialysis care.

METHODS: We identified a random sample of incident US Dialysis Outcomes and Practice Patterns Study hemodialysis patients (1996-2004) who reported predialysis nephrologist care. VA utilization was assessed at baseline and throughout the first 6 months on dialysis. Poisson regression was used to estimate the risk of all-cause and cause-specific hospitalizations during the first 6 months.

RESULTS: Among 2635 incident patients, 60% were dialyzing with a catheter, 22% with a graft and 18% with a fistula at baseline. Compared to fistulae, baseline catheter use was associated with an increased risk of all-cause hospitalization [adjusted relative risk (RR) = 1.30, 95% confidence interval (CI): 1.09-1.54] and graft use was not (RR = 1.07, 95% CI: 0.89-1.28). Allowing for VA changes over time, the risk of catheter versus fistula use was more pronounced (RR = 1.72, 95% CI: 1.42-2.08) and increased slightly for graft use (RR = 1.15, 95% CI: 0.94-1.41). Baseline catheter use was most strongly related to infection-related (RR = 1.47, 95% CI: 0.92-2.36) and VA-related hospitalizations (RR = 1.49, 95% CI: 1.06-2.11). These effects were further strengthened when VA use was allowed to vary over time (RR = 2.31, 95% CI:

1.48-3.61 and RR = 3.10, 95% CI: 1.95-4.91, respectively). A similar pattern was noted for VA-related hospitalizations with graft use. Discussion. Among potentially healthier incident patients, hospitalization risk, particularly infection and VA-related, was highest for patients dialyzing with a catheter at initiation and throughout follow-up, providing further support to clinical practice recommendations to minimize catheter placement.

[5] Block GA, Kilpatrick RD, Lowe KA, Wang W, Danese MD. CKD-Mineral and Bone Disorder and Risk of Death and Cardiovascular Hospitalization in Patients on Hemodialysis. CJASN 8:2132-2140, 2013.

BACKGROUND AND OBJECTIVES: Parathyroid hormone, calcium, and phosphate have been independently associated with cardiovascular event risk. Because these parameters may be on the same causal pathway and have been proposed as quality measures, an integrated approach to estimating event risks is needed.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: Prevalent dialysis patients were followed from August 31, 2005 to December 31, 2006. A two-stage modeling approach was used. First, the 16-month probabilities of death and composite end point of death or cardiovascular hospitalization were estimated and adjusted for potential confounders. Second, patients were categorized into 1 of 36 possible phenotypes using average

parathyroidhormone, calcium, and phosphate values over a 4-month baseline period. Associations among phenotypes and outcomes were estimated and adjusted for the underlying event risk estimated from the first model stage.

RESULTS: Of 26,221 patients, 98.5% of patients were in 22 groups with at least 100 patients and 20% of patients were in the reference group defined using guideline-based reference ranges for parathyroid hormone, calcium, and phosphate. Within the 22 most common phenotypes, 20% of patients were in groups with significantly ($P<0.05$) higher risk of death and 54% of patients were in groups with significantly higher risk of the composite end point relative to the in-target reference group. Increased risks ranged from 15% to 47% for death and from 8% to 55% for the composite. More than 40% of all patients were in the three largest groups with elevated composite end point risk (high parathyroid hormone, target calcium, and high phosphate; target high parathyroid hormone, target calcium, and high phosphate; and target high parathyroid hormone, target calcium, and target phosphate).

CONCLUSION: After adjusting for baseline risk, phenotypes defined by categories of parathyroid hormone, calcium, and phosphate identify patients at higher risk of death and cardiovascular hospitalization. Identifying common high-risk phenotypes may inform clinical interventions and policies related to quality of care.

[6] Pun PH, Horton JR, Middleton JP. Dialysate calcium concentration and the risk of sudden cardiac arrest in hemodialysis patients. CJASN 8:797-803, 2013.

BACKGROUND AND OBJECTIVES: The optimal dialysate calcium concentration to maintain normal mineralization and reduce risk of cardiovascular events in hemodialysis patients is debated. Guidelines suggest that dialysate Ca concentration should be lowered to avoid vascular calcification, but cardiac arrhythmias may be more likely to occur at lower dialysate Ca. Concurrent use of QT-prolonging medications may also exacerbate arrhythmic risk. This study examined the influence of serum Ca, dialysate Ca, and QT interval-prolonging medications on the risk of sudden cardiac arrest in a cohort of hemodialysis patients.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: This case-control study among 43,200 hemodialysis patients occurred between 2002 and 2005; 510 patients who experienced a witnessed sudden cardiac arrest were compared with 1560 matched controls. This study examined covariate-adjusted sudden cardiac arrest risk associations with serum Ca, dialysate Ca, serum dialysate Ca gradient, and prescription of QT-prolonging medications using logistic regression techniques.

RESULTS: Patients assigned to low Ca dialysate<2.5 mEq/L were more likely to be exposed to larger serum dialysate Ca gradient and had a greater fall in BP during dialysis treatment. After accounting for covariates and baseline differences, low Ca dialysate<2.5 mEq/L (odds ratio=2.00, 95% confidence interval=1.40-2.90), higher corrected serum Ca (odds ratio=1.10, 95% confidence interval=1.00-1.30), and increasing serum dialysate Ca gradient (odds ratio=1.40, 95% confidence interval=1.10-1.80) were associated with increased risk of sudden cardiac arrest, whereas there were no significant risk associations with QT-prolonging medications.

CONCLUSIONS: Increased risk of sudden cardiac arrest associated with low Ca dialysate and large serum dialysate Ca gradients should be considered in determining the optimal dialysate Ca prescription.

[7] Ishani A, Liu J, Wetmore JB, Lowe KA, Do T, Bradbury BD, Block GA, Collins AJ. Clinical outcomes after parathyroidectomy in a nationwide cohort of patients on hemodialysis. Clin J Am Soc Nephrol. 10(1):90-7, 2015.

BACKGROUND AND OBJECTIVES: Patients receiving dialysis undergo parathyroidectomy to improve laboratory parameters in resistant hyperparathyroidism with the assumption that clinical outcomes will also improve.

However, no randomized clinical trial data demonstrate the benefits of parathyroidectomy. This study aimed to evaluate clinical outcomes up to 1 year after parathyroidectomy in a nationwide sample of patients receiving hemodialysis.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: Using data from the US Renal Data System, this study identified prevalent hemodialysis patients aged ≥18 years with Medicare as primary payers who underwent parathyroidectomy from 2007 to 2009. Baseline characteristics and comorbid conditions were assessed in the year preceding parathyroidectomy; clinical events were identified in the year preceding and the year after parathyroidectomy. After parathyroidectomy, patients were censored at death, loss of Medicare coverage, kidney transplant, change in dialysis modality, or 365 days. This study estimated cause-specific event rates for both periods and rate ratios comparing event rates in the postparathyroidectomy versus preparathyroidectomy periods.

RESULTS: Of 4435 patients who underwent parathyroidectomy, 2.0% died during the parathyroidectomy hospitalization and the 30 days after discharge. During the 30 days after discharge, 23.8% of patients were rehospitalized; 29.3% of these patients required intensive care. In the year after parathyroidectomy, hospitalizations were higher by 39%, hospital days by 58%, intensive care unit admissions by 69%, and emergency room/observation visits requiring hypocalcemia treatment by 20-fold compared with the preceding year. Cause-specific hospitalizations were higher for acute myocardial infarction (rate ratio, 1.98; 95% confidence interval, 1.60 to 2.46) and dysrhythmia (rate ratio 1.4; 95% confidence interval1.16 to 1.78); fracture rates did not differ (rate ratio 0.82; 95% confidence interval 0.6 to 1.1).

CONCLUSIONS: Parathyroidectomy is associated with significant morbidity in the 30 days after hospital discharge and in the year after the procedure. Awareness of clinical events will assist in developing evidence-based risk/benefit determinations for the indication for parathyroidectomy.

[8] Tentori F, McCullough K, Kilpatrick RD, Bradbury BD, Robinson BM, Kerr PG, Pisoni RL. High rates of death and hospitalization follow bone fracture among hemodialysis patients. Kidney Int. 85(1):166-73, 2014.

Abstract: Altered bone structure and function contribute to the high rates of fractures in dialysis patients compared to the general population. Fracture events may increase the risk of subsequent adverse clinical outcomes. Here we assessed the incidence of post-fracture morbidity and mortality in an international cohort of 34,579 in-center hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study (DOPPS). We estimated country-specific rates of fractures requiring a hospital admission and associated length of stay in the hospital. Incidence rates of death and of a composite event of death/rehospitalization were estimated for 1 year after fracture. Overall, 3% of participants experienced a fracture. Fracture incidence varied across countries, from 12 events/1000 patient-years (PY) in Japan to 45/1000 PY in Belgium. In all countries, fracture rates were higher in the hemodialysis group compared to those reported for the general population. Median length of stay ranged from 7 to 37 days in the United States and Japan, respectively. In most countries, postfracture mortality rates exceeded 500/1000 PY and death/rehospitalization rates exceeded 1500/1000 PY. Fracture patients had higher unadjusted rates of death (3.7-fold) and death/rehospitalization (4.0-fold) compared to the overall DOPPS population. Mortality and hospitalization rates were highest in the first month after the fracture and declined thereafter. Thus, the high frequency of fractures and increased adverse outcomes following a fracture pose a significant health burden for dialysis patients. Fracture prevention strategies should be identified and applied broadly in nephrology practices.

[9] Weinhandl ED, Arneson TJ, St Peter WL. Clinical outcomes associated with receipt of integrated pharmacy services by hemodialysis patients: a quality improvement report. Am J Kidney Dis. Sep;62(3):557-67, 2013. Reducing medication-related problems and improving medication adherence in hemodialysis patients may improve clinical outcomes. In 2005, a large US dialysis organization created an integrated pharmacy program for its patients. We aimed to compare the outcomes of hemodialysis patients enrolled in this program and matched control patients.

STUDY DESIGN: Quality improvement report.

SETTING & PARTICIPANTS: Hemodialysis patients with concurrent Medicare and Medicaid eligibility who chose to receive program services and propensity score-matched controls; the propensity score was an estimated function of demographic characteristics, comorbid conditions, medication exposure, serum concentrations, and vascular access method.

QUALITY IMPROVEMENT PLAN: Program services included medication delivery, refill management, medication list reviews, telephonic medication therapy management, and prior authorization assistance.

OUTCOMES: Relative rates of death and hospitalization.

MEASUREMENTS: Survival estimates calculated with the Kaplan-Meier method; mortality hazards compared with Cox regression; hospitalization rates compared with Poisson regression.

RESULTS: In outcome models, there were 8,864 patients receiving integrated pharmacy services and 43,013 matched controls. In intention-to-treat and as-treated analyses, mortality HRs for patients

receiving integrated pharmacy services versus matched controls were 0.92 (95% CI, 0.86-0.97) and 0.79 (95% CI, 0.74-0.84), respectively. Corresponding relative rates of hospital admissions were 0.98 (95% CI, 0.95-1.01) and 0.93 (95% CI, 0.90-0.96), respectively, and of hospital days, 0.94 (95% CI, 0.90-0.98) and 0.86 (95% CI, 0.82-0.90), respectively. Cumulative incidences of disenrollment from the pharmacy program were 23.4% at 12 months and 37.0% at 24 months.

LIMITATIONS: Patients were not randomly assigned to receive integrated pharmacy services; as-treated analyses may be biased because of informative censoring by disenrollment from the pharmacy program; data regarding use of integrated pharmacy services were lacking.

CONCLUSIONS: Receipt of integrated pharmacy services was associated with lower rates of death and hospitalization in hemodialysis patients with concurrent Medicare and Medicaid eligibility. Studies are needed to measure pharmacy program use and assess detailed clinical and economic outcomes.

[10]. Weinhandl ED, Gilbertson DT, Collins AJ. Mortality, Hospitalization, and Technique Failure in Daily Home Hemodialysis and Matched Peritoneal Dialysis Patients: A¬†Matched Cohort Study. Am J Kidney Dis. 67(1):98-110, 2016.

BACKGROUND: Use of home dialysis is growing in the United States, but few direct comparisons of major clinical outcomes on daily home hemodialysis (HHD) versus peritoneal dialysis (PD) exist.

STUDY DESIGN: Matched cohort study.

SETTING & PARTICIPANTS: We matched 4,201 new HHD patients in 2007 to 2010 with 4,201 new PD patients from the US Renal Data System database.

PREDICTOR: Daily HHD versus PD.

OUTCOMES: Relative mortality, hospitalization, and technique failure.

RESULTS: Mean time from end-stage renal disease onset to home dialysis therapy initiation was 44.6 months for HHD and 44.3 months for PD patients. In intention-to-treat analysis, HHD was associated with 20% lower risk for all-cause mortality (HR, 0.80; 95% CI, 0.73-0.87), 8% lower risk for all-cause hospitalization (HR, 0.92; 95% CI, 0.89-0.95), and 37% lower risk for technique failure (HR, 0.63; 95% CI, 0.58-0.68), all relative to PD. In the subset of 1,368 patients who initiated home dialysis therapy within 6 months of end-stage renal disease onset, HHD was associated with similar risk for all-cause mortality (HR, 0.95; 95% CI, 0.80-1.13), similar risk for all-cause hospitalization (HR, 0.96; 95% CI, 0.88-1.05), and 30% lower risk for technique failure (HR, 0.70; 95% CI, 0.60-0.82). Regarding hospitalization, risk comparisons favored HHD for cardiovascular disease and dialysis access infection and PD for bloodstream infection.

LIMITATIONS: Matching unlikely to reduce confounding attributable to unmeasured factors, including residual kidney function; lack of data regarding dialysis frequency, duration, and dose in daily HHD patients and frequency and solution in PD patients; diagnosis codes used to classify admissions.

CONCLUSIONS: These data suggest that relative to PD, daily HHD is associated with decreased mortality, hospitalization, and technique failure. However, risks for mortality and hospitalization were similar with these modalities in new dialysis patients. The interaction between modality and end-stage renal disease duration at home dialysis therapy initiation should be investigated further.

[11] Rosenblum A, Wang W, Ball LK, Latham C, Maddux FW, Lacson E. Hemodialysis catheter care strategies: A cluster-randomized quality improvement initiative. Am J Kidney Dis. 63(2):259-267, 2014.

BACKGROUND: The prevalence of central venous catheters (CVCs) for hemodialysis remains high and, despite infection-control protocols, predisposes to bloodstream infections (BSIs).

STUDY DESIGN: Stratified, cluster-randomized, quality improvement initiative.

SETTING & PARTICIPANTS: All in-center patients with a CVC within 211 facility pairs matched by region, facility size, and rate of positive blood cultures (January to March 2011) at Fresenius Medical Care, North America.

QUALITY IMPROVEMENT PLAN: Incorporate the use of 2% chlorhexidine with 70% alcohol swab sticks for exit-site care and 70% alcohol pads to perform "scrub the hubs" in dialysis-related CVC care procedures compared to usual care.

OUTCOME: The primary outcome was positive blood cultures for estimating BSI rates.

MEASUREMENTS: Comparison of 3-month baseline period from April 1 to June 30 and follow-up period from August 1 to October 30, 2011.

RESULTS: Baseline BSI rates were similar (0.85 vs 0.86/1,000 CVC-days), but follow-up rates differed at 0.81/1,000 CVC-days in intervention facilities versus 1.04/1,000 CVC-days in controls ($P = 0.02$). Intravenous antibiotic starts during the follow-up period also were lower, at 2.53/1,000 CVC-days versus 3.15/1,000 CVC-days in controls ($P < 0.001$). Cluster-adjusted Poisson regression confirmed 21%-22% reductions in both ($P < 0.001$). Extended follow-up for 3 successive quarters demonstrated a sustained reduction of bacteremia rates for patients in intervention facilities, at 0.50/1,000 CVC-days (41% reduction; $P < 0.001$). Hospitalizations due to sepsis during 1-year extended follow-up were 0.19/1,000 CVC-days (0.069/CVC-year) versus 0.26/1,000 CVC-days (0.095/CVC-year) in controls (~27% difference; $P < 0.05$).

LIMITATIONS: Inability to capture results from blood cultures sent to external laboratories, underestimation of sepsis-specific hospitalizations, and potential crossover adoption of the intervention protocol in control facilities.

CONCLUSIONS: Adoption of the new catheter care procedure (consistent with Centers for Disease Control and Prevention recommendations) resulted in a 20% lower rate of BSIs and intravenous antibiotic starts, which were sustained over time and associated with a lower rate of hospitalizations due to sepsis.

[12] Patel PR, Kallen AJ. Bloodstream infection prevention in ESRD: Forging a pathway for success. Am J Kidney Dis. 63(2):180-182, 2014

Introduction: There should be little doubt regarding the importance of infections in the hemodialysis patient population. For years, the US Renal Data System has reported increasing hospitalization rates for all infectious diagnoses and for bacteremia/sepsis in patients treated with hemodialysis.[1] In 2011, the Centers for Disease Control and Prevention (CDC) reported that although the burden of central line–associated bloodstream infections (BSIs) in hospitalized patients had declined nationally, the estimated burden of central line–associated BSIs in people treated with outpatient hemodialysis was substantial, possibly reaching 37,000 in 2008.[2] Soon after, the US Department of Health and Human Services released their National Action Plan to Prevent Healthcare-Associated Infections (HAIs) for End Stage

Renal Disease (ESRD) Facilities.[3] The Action Plan, which was developed by the Federal Steering Committee for the Prevention of HAIs in ESRD Facilities with dialysis community stakeholder input, highlighted BSIs as a top priority for national prevention efforts.

[13] Gilbertson DT, Guo H, Arneson TJ, Collins AJ. The association of pneumococcal vaccination with hospitalization and mortality in hemodialysis patients. Nephrol Dial Transplant. Sept;26(9):2934-9, 2011.

BACKGROUND: Few studies have examined the effectiveness of pneumococcal vaccination (alone or with influenza vaccination) in improving hemodialysis patient outcomes. We aimed to describe vaccination rates between 2003-2005 and to study the effects on outcomes.

METHODS: For 118,533 prevalent patients who initiated hemodialysis ≥90 days before 1 November 2003, had Medicare Part A and Part B and were aged ≥18 years, and alive through 31 October 2005, Cox proportional hazards models were used to assess pneumococcal vaccination effects on subsequent hospitalization and mortality, adjusting for demographics and comorbidity.

RESULTS: The 21% of patients who received vaccinations were older; a higher proportion were white, with diabetes as cause of end-stage renal disease and more comorbidity. Pneumococcal vaccination was associated with a statistically significant decreased mortality hazard [hazard ratio (HR) 0.94, 95% confidence interval (CI) 0.90-0.98], cardiac death (HR 0.91, 95% CI 0.85-0.97) and hospitalization for bacteremia/viremia/septicemia (HR 0.95, 95% CI 0.91-1.00). The mortality hazard was 0.73 (95% CI 0.68-0.78) for patients who received pneumococcal and influenza vaccinations.

CONCLUSIONS: The small but significant association between pneumococcal vaccination and lower mortality risk was seen despite factors associated with poor outcomes in patients most likely to be vaccinated. Pneumococcal and influenza vaccines may have beneficial synergistic effects. Hemodialysis patients may benefit from revaccination more frequently than the recommended 5-year intervals.

[14] Dalrymple LS, Mu Y, Nguyen DV, Romano PS, Chertow GM, Grimes B, Kaysen GA, Johansen KL. CJASN 10:2170-2180, 2015.

BACKGROUND AND OBJECTIVES: Infection-related hospitalizations have increased dramatically over the last 10 years in patients receiving in-center hemodialysis. Patient and dialysis facility characteristics associated with the rate of infection-related hospitalization were examined, with consideration of the region of care, rural-urban residence, and socioeconomic status.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: The US Renal Data System linked to the American Community Survey and Rural-Urban Commuting Area codes was used to examine factors associated with hospitalization for infection among Medicare beneficiaries starting in-center hemodialysis between 2005 and 2008. A Poisson mixed effects model was used to examine the associations among patient and dialysis facility characteristics and the rate of infection-related hospitalization.

RESULTS: Among 135,545 Medicare beneficiaries, 38,475 (28%) had at least one infection-related hospitalization. The overall rate of infection-related hospitalization was 40.2 per 100 person-years. Age ≥85 years old, cancer, chronic obstructive pulmonary disease, inability to ambulate or transfer, drug dependence, residence in a care facility, serum albumin <3.5 g/dl at dialysis initiation, and dialysis initiation with an access other than a fistula were associated with a ≥20% increase in the rate of infection-related hospitalization. Patients residing in isolated small rural compared with urban areas had lower rates of hospitalization for infection (rate ratio, 0.91; 95% confidence interval, 0.86 to 0.97), and rates of hospitalization for infection varied across the ESRD networks. Measures of socioeconomic status

(at the zip code level), total facility staffing, and the composition of staff (percentage of nurses) were not associated with the rate of hospitalization for infection.

CONCLUSIONS: Patient and facility factors associated with higher rates of infection-related hospitalization were identified. The findings from this study can be used to identify patients at higher risk for infection and inform the design of infection prevention strategies.

[15] Gilbertson DT, Wetmore JB. Infections Requiring Hospitalization in Patients on Hemodialysis CJASN 10:2101-2103, 2015.

Introduction: Although the past decade has witnessed significant improvements in survival or patients receiving hemodialysis (HD) (1), hospitalization rates, particularly for infection, have not improved commensurately. Notable lack of progress is evident regarding hospitalizations for bacteremia/septicemia and pulmonary infections, such as pneumonia and influenza (2). For bacteremia/septicemia, first–year (incident) admission rates showed a 39% relative increase between 2003 and 2010 from 12.9% to 18.0%. Similarly, admission rates for prevalent patients increased 36% from 8.6% to 11.6%. Pneumonia/influenza hospitalization rates also did not improve between 2003 and 2010; although first–year admission rates decreased slightly (from 10.2% to 9.0%), rates for prevalent patients increased from 8.3% to 9.0%.

[16] Arneson TJ, Liu J, Qiu Y, Gilbertson DT, Foley RN, Collins AJ. Hospital treatment for fluid overload in the Medicare hemodialysis population. Clin J Am Soc Nephrol.(6):1054-63, 2010.

BACKGROUND AND OBJECTIVES: Fluid overload in hemodialysis patients sometimes requires emergent dialysis, but the magnitude of this care has not been characterized. This study aimed to estimate the magnitude of fluid overload treatment episodes for the Medicare hemodialysis population in hospital settings, including emergency departments.

DESIGN, SETTING, PARTICIPANTS, & MEASUREMENTS: Point-prevalent hemodialysis patients were identified from the Centers for Medicare and Medicaid Renal Management Information System and Standard Analytical Files. Fluid overload treatment episodes were defined by claims for care in inpatient, hospital observation, or emergency

department settings with primary discharge diagnoses of fluid overload, heart failure, or pulmonary edema, and dialysis performed on the day of or after admission. Exclusion criteria included stays >5 days. Cost was defined as total Medicare allowable costs for identified episodes. Associations between patient characteristics and episode occurrence and cost were analyzed.

RESULTS: For 25,291 patients (14.3%), 41,699 care episodes occurred over a mean follow-up time of 2 years: 86% inpatient, 9% emergency department, and 5% hospital observation. Heart failure was the primary diagnosis in 83% of episodes, fluid overload in 11%, and pulmonary edema in 6%. Characteristics associated with more frequent events included age <45 years, female sex, African-American race, causes of ESRD other than diabetes, dialysis duration of 1 to 3 years, fewer dialysis sessions per week at baseline, hospitalizations during baseline, and most comorbid conditions. Average cost was $6,372 per episode; total costs were approximately $266 million.

CONCLUSIONS: Among U.S. hemodialysis patients, fluid overload treatment is common and expensive. Further study is necessary to identify prevention opportunities.

[17] Erickson KF, Winkelmayer WC, Chertow GM, Bhattacharya J. Physician visits and 30-day hospital readmissions in patients receiving hemodialysis. J Am Soc Nephrol 25:2079-2087, 2014.

Abstract: A focus of health care reform has been on reducing 30-day hospital readmissions. Patients with ESRD are at high risk for hospital readmission. It is unknown whether more monitoring by outpatient providers can reduce hospital readmissions in patients receiving hemodialysis. In nationally representative cohorts of patients in the United States receiving in-center hemodialysis between 2004 and 2009, we used a quasi-experimental (instrumental variable) approach to assess the relationship between frequency of visits to patients receiving hemodialysis following hospital discharge and the probability of rehospitalization. We then used a multivariable regression model and published hospitalization data to estimate the cost savings and number of hospitalizations that could be prevented annually with additional provider visits to patients in the month following hospitalization. In the main cohort (n=26,613), one additional provider visit in the month following hospital discharge was estimated to reduce the absolute probability of 30-day hospital readmission by 3.5% (95% confidence interval, 1.6% to 5.3%). The reduction in 30-day hospital readmission ranged from 0.5% to 4.9% in an additional four cohorts tested, depending on population density around facilities, facility profit status, and patient Medicaid eligibility. At current Medicare reimbursement rates, the effort to visit patients one additional time in the month following hospital discharge could lead to 31,370 fewer hospitalizations per year, and $240 million per year saved. In conclusion, more frequent physician visits following hospital discharge are estimated to reduce rehospitalizations in patients undergoing hemodialysis. Incentives for closer outpatient monitoring following hospital discharge could lead to substantial cost savings.

[18] Kliger AS. Maintaining safety in the dialysis facility. CJASN 10:688-695, 2015.

Abstract: Errors in dialysis care can cause harm and death. While dialysis machines are rarely a major cause of morbidity, human factors at the machine interface and suboptimal communication among caregivers are common sources of error. Major causes of potentially reversible adverse outcomes include medication errors, infections, hyperkalemia, access-related errors, and patient falls. Root cause analysis of adverse events and "near misses" can illuminate care processes and show system changes to improve safety. Human factors engineering and simulation exercises have strong potential to define common clinical team purpose, and improve processes of care. Patient observations and their participation in error reduction increase the effectiveness of patient safety efforts.
[19] Nissenson AR. Improving outcomes for ESRD patients: Shifting the quality paradigm. CJASN 9:430-434, 2014.

Abstract: The availability of life-saving dialysis therapy has been one of the great successes of medicine in the past four decades. Over this time period, despite treatment of hundreds of thousands of patients, the overall quality of life for patients with ESRD has not substantially improved. A narrow focus by clinicians and regulators on basic indicators of care, like dialysis adequacy and anemia, has consumed time and resources but not resulted in significantly improved survival; also, frequent hospitalizations and dissatisfaction with the care experience continue to be seen. A new quality paradigm is needed to help guide clinicians, providers, and regulators to ensure that patients' lives are improved by the technically complex and costly therapy that they are receiving. This paradigm can be envisioned as a quality pyramid: the foundation is the basic indicators (outstanding performance on these indicators is necessary but not sufficient to drive the primary outcomes). Overall, these basics are being well managed currently, but there remains an excessive focus on them, largely because of publically reported data and regulatory requirements. With a strong foundation, it is now time to focus on the more complex intermediate clinical outcomes-fluid management, infection control, diabetes management,

medication management, and end-of-life care among others. Successfully addressing these intermediate outcomes will drive improvements in the primary outcomes, better survival, fewer hospitalizations, better patient experience with the treatment, and ultimately, improved quality of life. By articulating this view of quality in the ESRD program (pushing up the quality pyramid), the discussion about quality is reframed, and also, clinicians can better target their facilities in the direction of regulatory oversight and requirements about quality. Clinicians owe it to their patients, as the ESRD program celebrates its 40th anniversary, to rekindle the aspirations of the creators of the program, whose primary goal was to improve the lives of the patients afflicted with this devastating condition.

1a.3. — Linkage

1a.3.1. Source of Systematic Review
N/A

1a.4. — Clinical Practice Guideline Recommendation

1a.4.1. Guideline Citation
N/A

1a.4.2. Specific Guideline
N/A

1a.4.3. Grade
N/A

1a.4.4. Grades and Associated Definitions
N/A

1a.4.5. Methodology Citation
N/A

1a.4.6. Quantity, Quality, and Consistency
N/A

1a.5. — United States Preventative Services Task Force Recommendation

1a.5.1. Recommendation Citation
N/A

1a.5.2. Specific Recommendation
N/A

1a.5.3. Grade
N/A

1a.5.4. Grades and Associated Definitions
N/A

1a.5.5. Methodology Citation
Complete Section 1a.7

1a.6.—Other Systematic Review of the Body of Evidence

1a.6.1. Review Citation
N/A

1a.6.2. Methodology Citation
Complete Section 1a.7

1a.7.—Findings from Systematic Review of Body of the Evidence Supporting the Measure

1a.7.1. Specifics Addressed in Evidence Review
N/A

1a.7.2. Grade
N/A

1a.7.3. Grades and Associated Definitions
N/A

1a.7.4. Time Period
N/A

1a.7.5. Number and Type of Study Designs
N/A

1a.7.6. Overall Quality of Evidence
Certainty or confidence in the estimates of effect particularly in relation to study factors such as design flaws, imprecision due to small numbers, indirectness of studies to the measure focus or target population).

1a.7.7. Estimates of Benefit
N/A

1a.7.8. Benefits Over Harms
N/A

1a.7.9. Provide for Each New Study
N/A

1a.8. — Other Source of Evidence

1a.8.1. Process Used
N/A

1a.8.2. Citation
N/A

1b.—Evidence to Support Measure Focus

1b.1. Rationale
Hospitalization rates are an important indicator of patient morbidity and quality of life. On average, dialysis patients are admitted to the hospital nearly twice a year and spend an average of 11.2 days in the hospital per year [1]. Hospitalizations account for approximately 40 percent of total Medicare expenditures for ESRD patients [1]. Measures of the frequency of hospitalization have the potential to help efforts to control escalating medical costs, and to play an important role in identifying potential problems and helping facilities provide cost-effective health care.

1b.2. Performance Scores
Standardized hospitalization admission rates vary widely across facilities. For example, for 2014, the SHR Admissions varied from 0.07 to 2.92. The mean value was 0.99 and the SD was 0.27. The data used to calculate these rates is limited to those facilities with at least 5 patient years at risk (reflecting how the measure is currently calculated on DFC).

Distribution of the SHR, 2011-2014:
2011: Facilities = 5386, Mean SHR = .99, Standard Error = .28, 10th = .66, 25th = .80, 50th = .96, 75th = 1.14, 90th = 1.33
2012: Facilities = 5568, Mean SHR = .99, Standard Error = .28, 10th = .66, 25th = .81, 50th = .97, 75th = 1.15, 90th = 1.34

2013: Facilities = 5700, Mean SHR = .99, Standard Error = .27, 10th = .68, 25th = .81, 50th = .97, 75th = 1.15, 90th = 1.33
2014: Facilities = 5857, Mean SHR = .99, Standard Error = .27, 10th = .68, 25th = .82, 50th = .97, 75th = 1.14, 90th = 1.32

1b.3. Summary of Data Indicating Opportunity
N/A

1b.4. Disparities
Race and ethnicity have been shown to be predictors of hospitalization. Using data from 2013, it is observed that white and black patients are hospitalized at similar rates (both SHRs = 1.01). Native American and Asian/Pacific Islander patients are hospitalized at lower rates than would be expected (SHR = 0.90 and 0.84, respectively). Also, Hispanic patients had slightly lower than expected hospitalization rates (SHR = 0.98), while non-Hispanic and patients of unknown ethnicity were hospitalized at the same rate (both SHRs = 1.00). While there are differences across the race and ethnicity groups, the results suggest no clear disparities in outcomes and that it would not be appropriate to adjust for these factors.

Refer to Risk Adjustment section (2b4) for further analyses on race, ethnicity, sex and socioeconomic status.

1b.5. Disparities
N/A

1c.—High Priority

1c.1. Demonstrated High-Priority Aspect of Health Care

Affects large numbers, High resource use, Severity of illness

1c.3. Epidemiologic or Resource Use Data

Hospitalization rates are an important indicator of patient morbidity and quality of life. On average, dialysis patients are admitted to the hospital twice a year and spend an average of 11.2 days in the hospital per year [1]. Hospitalizations account for approximately 40 percent of total Medicare expenditures for ESRD patients [1]. Measures of the frequency of hospitalization have the potential to help efforts to control escalating medical costs, and to play an important role in identifying potential problems and helping facilities provide cost-effective health care.
At the end of 2013 there were 661,648 patients being dialyzed, of which 117,162 were new (incident) ESRD patients [1]. In 2013, total Medicare costs for the ESRD program were $30.9 billion, a 1.6% increase from 2012 [1]. Correspondingly, hospitalization costs for ESRD patients are very high with Medicare costs of over $10.3 billion in 2013.

Hospitalization measures have been in use in the Dialysis Facility Reports (formerly Unit-Specific Reports) since 1995. The Dialysis Facility Reports are used by the dialysis facilities and ESRD Networks for quality improvement,
and by ESRD state surveyors for monitoring and surveillance. In particular, the SHR for Admissions is used by ESRD state surveyors in conjunction with other standard criteria for prioritizing and selecting facilities to survey and has been found to be predictive of citations in the past (ESRD State Outcomes List). The SHR is also a public reporting measure on the Centers for Medicare and Medicaid Services (CMS) Dialysis Facility Compare website.

As noted above, hospitalization among dialysis patients is common and accounts for a large fraction of Medicare expenditures for ESRD beneficiaries. The Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicators (PQIs) has identified several diagnoses where timely and effective ambulatory care can significantly reduce hospitalization. These diagnoses represent hospitalizations that might be prevented with effective ambulatory care including but not limited to dialysis facilities. We identified the PQIs most common for ESRD patients and compared the frequency of those diagnoses for the ESRD population to that of the general Medicare population in the fee-for-service system. Based on clinical input we identified several other diagnoses common among dialysis patients that may be preventable through the delivery of appropriate dialysis care [2]. Our analysis showed that compared to the general Medicare population, ESRD patients were hospitalized at higher rates for the following potentially preventable conditions as defined by AHRQ PQIs: diabetes with long term complications (16 times the rate of the general Medicare population), lower extremity amputation (22 times), and diabetes with short term complications (22 times). Applying the ESRD-specific potentially preventable conditions, ESRD patients were hospitalized at a higher rate for the following: complications of device/implant/graft (ESRD-related only) (13 times), septicemia (except in labor) (7 times) and fluid and electrolyte disorder (8 times). Since for most dialysis patients the dialysis facility is the principal source of ambulatory care and may even be considered by some as their medical home, it is reasonable to expect that high quality care by the dialysis facility could reduce the very high rate of hospitalizations among dialysis patients. Further, the facility-level correlation between the hospitalization rate for potentially preventable hospitalizations and that for all hospitalizations (the SHR) was found in this study to be high (0.84 for facilities with more than 20 patient years). This result provides further evidence that facilities have opportunities to reduce hospitalizations through appropriate dialysis care [2].

A 2015 Technical Expert Panel closely reviewed comorbidities related to hospitalization and provided an assessment of each and the likelihood whether they were related to facility care. This assessment process and the results are further described in the risk adjustment section below.

1c.4. Citations

[1] United States Renal Data System. 2015 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2015.
[2] Wheeler J, Hirth R, Meyer K, Messana JM. Exploring preventable hospitalizations of dialysis patients. J Am Soc Nephrol 22, 2011.
[3] Erickson KF, Winkelmayer WC, Chertow GM, Bhattacharya J. Physician visits and 30-day hospital readmissions in patients receiving hemodialysis. J Am Soc Nephrol 25, 2014 (published online before print).
[4] Arora P, Kausz AT, Obrador GT, Ruthazer R, Khan S, Jenuleson CS, Meyer KB, Pereira BJ. Hospital utilization among chronic dialysis patients. J Am Soc Nephrol 11: 740 –746, 2000.
[5] Piraino B. Staphylococcus aureus infections in dialysis patients: focus on prevention. ASAIO J 46(6): S13-S17, 2000.
[6] Dalrymple LS, Johansen KL, Romano PS, Chertow GM, Mu Y, Ishida JH, Grimes B, Kaysen GA, Nguyen DV. Comparison of hospitalization rates among for-profit and nonprofit dialysis facilities. Clin J Am Soc Nephrol 9, 2014 (published online before print).

1c.5. Patient-Reported Outcome Performance Measure (PRO-PM)

N/A

Scientific Acceptability:

1.—Data Sample Description

1.1. What Type of Data was Used for Testing?

Administrative Claims, Administrative Claims, Clinical Database/Registry, Clinical Database/Registry

1.2. Identify the Specific Dataset

Data are derived from an extensive national ESRD patient database, which is primarily based on the CMS Consolidated Renal Operations in a Web-enabled Network (CROWN) system. The CROWN data include the Renal Management Information System (REMIS), CROWNWeb facility-reported clinical and administrative data (including

CMS-2728 Medical Evidence Form, CMS-2746 Death Notification Form, and CMS-2744 Annual Facility Survey Form data), the historical Standard Information Management System (SIMS) database (formerly maintained by the 18 ESRD Networks until replaced by CROWNWeb in May 2012), the National Vascular Access Improvement Initiative's Fistula First Catheter Last project (in CROWNWeb since May 2012), Medicare dialysis and hospital payment records, transplant data from the Organ Procurement and Transplant Network (OPTN), the Nursing Home Minimum Dataset, the Quality Improvement Evaluation System (QIES) Workbench, which includes data from the Certification and Survey Provider Enhanced Report System (CASPER), the Dialysis Facility Compare (DFC) and the Social Security Death Master File.

The database is comprehensive for Medicare patients. Non-Medicare patients are included in all sources except for the Medicare payment records. CROWNWeb provides tracking by dialysis provider and treatment modality for non-Medicare patients. Information on hospitalizations is obtained from Part A Medicare Inpatient Claims Standard Analysis Files (SAFs), and past-year comorbidity is obtained from multiple Part A types (inpatient, home health, hospice, skilled nursing facility claims) and Part B outpatient types of Medicare Claims SAFs.

1.3. What are the Dates of the Data Used in Testing?

Calendar years 2010 through 2013

1.4. What Levels of Analysis Were Tested?

Hospital/Facility/Agency

1.5. How Many and Which Measured Entities Were Included in the Testing and Analysis?

For each year of the four years from 2010-2013 there were 5,406, 5,582, 5,708 and 5,863 facilities, respectively.

1.6. How Many and Which Patients Were Included in the Testing and Analysis?

Medicare dialysis patients were included in the testing and analysis for each of the four years from 2010-2013 of which there were 377,675, 387,249, 396,167 and 403,337 patients, respectively.

1.7. Sample Differences, if Applicable

N/A

1.8 What were the patient-level sociodemographic (SDS) variables that were available and analyzed in the data or sample used?

Patient level:

- Employment status 6 months prior to ESRD
- Sex
- Race
- Ethnicity
- Medicare coverage*

**Assessed at the start of time at risk based on calendar year and facility assignment. Medicare coverage in the model was defined as:*
1. Medicare as primary and Medicaid
2. Medicare as primary and NO Medicaid
3. Medicare as secondary or Medicare HMO

Data on patient level SDS/SES factors obtained from Medicare claims and administrative data.

Proxy/Area level: ZIP code level – Area Deprivation Index (ADI) elements from Census data:

- Unemployment rate (%)
- Median family income (rescaled as (income-60,000)/10,000)
- Income disparity
- Families below the poverty level (%)
- Single-parent households w/ children <18 (%)

- Home ownership rate (%)
- Median home value (rescaled as (homevalue-200,000)/100,000)
- Median monthly mortgage (rescaled as (mortgage-1,500)/1,000)
- Median gross rent (rescaled as (rent-900)/1,000)
- Population (aged 25+) with <9 years of education (%)
- Population (aged 25+) without high school diploma (%)

2a.2—Reliability Testing

2a2.1. Level of Reliability Testing

Performance Measure Score

2a2.2. Method of Reliability Testing

2011 Submission

Reliability of the Standardized Hospital Ratio for Admissions was assessed using data on hospitalizations among ESRD patients over a three year period of 2006-2008 for 4338 dialysis centers. Data for the hospitalization measures are derived from an extensive national ESRD patient database, which is largely derived from the Standard Information Management System (SIMS) database maintained by the 18 ESRD Networks, the CMS Annual Facility Survey (Form CMS-2744), Medicare dialysis and hospital payment records, the CMS Medical Evidence Form (Form CMS-2728), transplant data from the Organ Procurement and Transplant Network (OPTN), the Death Notification Form (Form CMS-2746), the Nursing Home Minimum Dataset, and the Social Security Death Master File. The database is comprehensive for Medicare patients. Information on hospitalizations is obtained from Medicare Inpatient Claims Standard Analysis Files (SAFs).

To assess reliability, we assessed the degree to which the measures were consistent year to year. If one looks at two adjacent time intervals, one should expect that a reliable measure will exhibit correlation over these periods since large changes in patterns affecting the measure should not occur for most centers over shorter periods. Year to year variability in the SHR values was assessed across the years 2006, 2007 and 2008 based on the 4338 dialysis centers for which an SHR is reported in the 2010 DFRs.

2016 Submission

The reliability of the SHR was assessed using data among Medicare ESRD dialysis patients during 2010-2013. If the measure were a simple average across individuals in the facility, the usual approach for determining measure reliability would be a one-way analysis of variance (ANOVA), in which the between and within facility variation in the measure is determined. The inter-unit reliability (IUR) measures the proportion of the total variation of a measure that is attributable to the between-facility variation. The SHR, however, is not a simple average and we instead estimate the IUR using a bootstrap approach, which uses a resampling scheme to estimate the within facility variation that cannot be directly estimated by ANOVA. A small IUR (near 0) reveals that most of the variation of the measures between facilities is driven by random noise, indicating the measure would not be a good characterization of the differences among facilities, whereas a large IUR (near 1) indicates that most of the variation between facilities is due to the real difference between facilities.

Here we describe our approach to calculating IUR. Let $T_1,\ldots,T_N$ be the SHR for these facilities. Within each facility, select at random and with replacement B bootstrap samples. Our numerical experiments reveal

that B=100 is sufficient. That is, if the ith facility has n_i subjects, randomly draw with replacement n_i subjects from those in the same facility, find their corresponding SHR_i and repeat the process B (say, 100) times. Thus, for the ith facility, we have bootstrapped SHRs of T_{i1}^*,…, T_{i200}^*. Let S_i^* be the sample variance of this bootstrap sample. From this it can be seen that

$$s_{t,w}^2 = \frac{\sum_{i=1}^{N}[(n_i - 1)S_i^{*2}]}{\sum_{i=1}^{N}(n_i - 1)}$$

is a bootstrap estimate of the within-facility variance in the SHR, namely, $\sigma_{t,w}^2$. Calling on formulas from the one way analysis of variance, an estimate of the overall variance of T_i is

$$s_t^2 = \frac{1}{n'(N-1)} \sum_{i=1}^{N} n_i (T_i - \bar{T})^2$$

where

$$\bar{T} = \sum n_i T_i / \sum n_i$$

is the weighted mean of the observed SHR and

$$n' = \frac{1}{N-1} \left(\sum n_i - \sum n_i^2 \Big/ \sum n_i \right)$$

is approximately the average facility size (number of patients per facility). Note that s_t^2 is the total variation of SHR and is an estimate of $\sigma_b^2 + \sigma_{t,w}^2$, where σ_b^2 is the between-facility variance, the true signal reflecting the differences across facilities. Thus, the estimated IUR, which is defined by

$$IUR = \frac{\sigma_b^2}{\sigma_b^2 + \sigma_{t,w}^2}$$

can be estimated with $(s_t^2 - s_{t,w}^2)/s_t^2$.

The SHR calculation only included facilities with at least 5 patient years at risk.

2a2.3. Statistical Results from Reliability Testing

2011 Submission

The correlation between SHR admissions across adjacent years (2006 versus 2007 and 2007 vs 2008) was approximately 0.67 indicating that centers with large or small SHR tended to have larger or smaller SHR on the following year. These correlations were highly significant. Similarly, there was persistence in SHRs that were significant from year to year. For example, there were 4.3% of facilities that had significant evidence of a true SHR of at least 1.2 in 2006. Of those that were significantly larger than 1.2 in 2006, 1.8/4.3 = 42% were again significantly larger than 1.2 in 2007. Of those that were not significant in 2006, only 2.5% were found to be significantly larger than 1.2 in 2007.

The measure is based on complete data and is not subject to judgment or rater variability. Hence the measures of inter-rater variability are not relevant here.

2016 Submission

Overall, we found that IURs for the one-year SHRs have a range of 0.70-0.72 across the years 2010, 2011, 2012 and 2013, which indicates that over two-thirds of the variation in the one-year SHR can be attributed to the between-facility differences and less than one-third to within-facility variation.

Table 1: IUR for one-year SHR, Overall and by Facility Size, 2010-2013

	2010		2011		2012		2013	
Facility Size (Number of patients)	**IUR**	**N**	**IUR**	**N**	**IUR**	**N**	**IUR**	**N**
All	0.72	5407	0.71	5583	0.70	5709	0.70	5864
Small (<=50)	0.54	1864	0.51	1921	0.48	1977	0.46	2028
Medium (51–87)	0.65	1702	0.63	1785	0.58	1825	0.57	1930
Large (>=88)	0.81	1841	0.81	1877	0.81	1907	0.82	1906

2a2.4. Interpretation

2011 Submission

This was not a question on the 2011 Submission Form.

2016 Submission

This value of IUR indicates a high degree of reliability. When stratified by facility size, we find that, as expected, larger facilities have greater IUR.

2b2—Validity Testing

2b2.1. Level of Validity Testing

Performance Measure Score, Empirical Validity Testing, Systematic Assessment of Face Validity of Performance Measure Score Indicator

2b2.2. Method of Validity Testing

2011 Submission

Validity of the Standardized Hospital Ratio for Admissions was assessed using data on hospitalizations as well as other quality measures among ESRD patients over a three year period of 2006-2008. We examined the validity of the measure by examining its covariability with other measures of quality as well as by examining the relationship of the overall hospitalization measure with measures that were more directly focused on specific causes.

We have assessed the validity of the measure through various comparisons of this measure with other quality measures in use. Also, hospitalization measures were reviewed by a TEP in 2007 and overall measures based on admissions and on days were recommended for inclusion in the Dialysis Facility reports. In addition, hospitalization is a major cost factor in the management of ESRD patients as noted earlier, so there is here a very strong case for face validity of the SHR admissions measure.

2016 Submission

We have assessed the validity of the measure through various comparisons of this measure with other quality measures in use, using Spearman correlations.

The measure is also maintained on face validity. Hospitalization measures were reviewed by a TEP in 2007 and overall measures based on admissions and on days were recommended for inclusion in the Dialysis Facility Reports. In 2015, a TEP was held specifically to consider prevalent comorbidity adjustments for inclusion in the measure. The TEP's recommendations are reflected in the risk adjustment methodology. In addition, hospitalization is a major cost factor in the management of ESRD patients as noted earlier, further establishing a very strong case for face validity of the SHR admissions measure.

2b2.3. Statistical Results from Validity Testing

2011 Submission

The SHR Admissions measure is correlated with the Standardized Mortality Ratio (SMR) over the three year cohort (r=0.40) and in individual years r was approximately equal to 0.33, both correlations being highly significant. In addition, SHR Admissions is negatively correlated in each of the three year with percent of patients in the facility with AV Fistula (r=-0.27, -0.23, -0.21). Thus higher values of SHR are associated with lower usage of AV Fistulas. On the other hand, SHR admissions is positively correlated with catheter use (r=0.24, 0.23, 0.22), indicating that higher values of SHR are associated with increased use of catheters. These correlations are all highly significant ($p<0.001$). The SHR Admissions is also found to be negatively correlated (r=-0.10, $p<0.0001$) with the percent of patients with URR>65, again in the direction expected.

The SHR Admissions is an overall measure of hospital use and is comprised of many different causes or reasons for hospitalization. The TEP considered the possibility of devising cause specific SHRs, but recommended the use of overall SHR measures due to various reasons including the lack of clear research to indicate what causes should be selected as indicative of poor ESRD care and issues associated with inter-rater reliability in assessing cause of hospitalization. The TEP reached a strong consensus that the overall measures should give a reliable and valid measure that would typically be related to quality of care. We have some crude measures of cause of hospitalization which we have taken to assess the relationship between the overall measure and cause specific components. These measures are useful in assessing the overall SHR measures, but we caution that the cause specific hospitalizations have not been tested or validated at this time. The overall SHR Admissions is strongly correlated with the SHR for cause specific hospitalizations. The correlation with Septicemia is r=0.44, with Chronic Heart Failure is r=0.55 and with an overall measure including Septicemia and a collection of coronary causes is r=0.66. Thus the overall hospitalization rate also correlates strongly with causes that are commonly thought to be potentially related to poor quality of care.

2016 Submission

The SHR Admissions measure is correlated with the Standardized Mortality Ratio (SMR) for each individual year from 2010-2013, where Spearman's correlation coefficient ranged from 0.27 to 0.30, with all four correlations being highly significant ($p<0.0001$). Also for each year from 2011-2013, the SHR was correlated with the Standardized Readmission Ratio (SRR) (Spearman's rho=0.54, 0.50, 0.48; $p<0.0001$).

In addition, SHR Admissions is negatively correlated in each of the four years with percent of patients in the facility with AV Fistula (Spearman's rho= -0.12, -0.15, -0.12, -0.13). Thus higher values of SHR are associated with lower usage of AV Fistulas. Further, SHR admissions is positively correlated in each of

the four years with percent of patients with catheter >= 90 days (Spearman's rho=0.21, 0.21, 0.18, 0.16), indicating that higher values of SHR are associated with increased use of catheters. These correlations are all highly significant (p<0.001). For each year of 2010 through 2013, the SHR Admissions is also found to be negatively correlated with the percent of hemodialysis patients with Kt/V>=1.2, again in the direction expected (Spearman's rho= -0.11, -0.13, -0.10,-0.11; p<0.0001). Lower SHRs are associated with a higher percentage of patients receiving adequate dialysis dose.

2b2.4. Interpretation

2011 Submission

This was not a question on the 2011 Submission Form.

2016 Submission

The SHR correlates with outcomes, processes of care, and causes of hospitalization that are commonly thought to be potentially related to poor quality of care. Higher hospitalization was associated with higher facility mortality rates; and similarly with higher readmissions. We found higher values of SHR are associated with lower usage of AV Fistulas, higher catheter use, and suboptimal dialysis adequacy.
The 2007 TEP considered the possibility of developing cause specific SHRs, but recommended the use of all-cause SHR measures due to various reasons including the lack of clear research to indicate what causes (i.e., reason for admission) should be selected as valid indicators of poor ESRD care, and issues associated with inter-rater reliability in assessing cause of hospitalization. The TEP reached a strong consensus that the all-cause measure would be reliable and valid and the measure would typically be related to quality of care. We have some crude measures of cause of hospitalization which we have used to assess the relationship between the all-cause measure and cause specific components. These measures are useful in assessing the overall SHR measures, but we caution that the cause specific hospitalizations have not been tested or validated at this time. All correlations are in the expected direction and highly significant, (p<0.0001). Thus these preliminary analyses show that the overall hospitalization rate also correlates with specific causes that are commonly thought to be potentially related to poor quality of care. In 2015, a TEP was held specifically to consider prevalent comorbidity adjustments for inclusion in this measure (and SMR). The TEP's recommendations are reflected in the risk adjustment methodology.

2b3—Exclusion Analysis

2b3.1. Method of Testing Exclusion

N/A

2b3.2. Statistical Results from Testing Exclusion

N/A

2b3.3. Interpretation

N/A

2b4—Risk Adjustment or Stratification

2b4.1. Method of controlling for differences

Statistical risk model with **229** risk factors

2b4.2. Rationale why Risk Adjustment is not Needed

N/A

2b4.3. Conceptual, Clinical, and Statistical Methods

The risk adjustment is based on a Cox or relative risk model. The adjustment is made for patient age, sex, diabetes, duration of ESRD, nursing home status, BMI at incidence, comorbidities at incidence, a set of prevalent comorbidities, and calendar year. In this model, covariates are taken to act multiplicatively on the admission rate and the adjustment model is fitted with facility defining strata so as to provide valid estimates even if the distribution of adjustment variables differs across facilities. Relevant references are Cox (1972), Kalbfleisch and Prentice (2002), Lawless and Nadeau (1995), Lin et al. (2000), Cook and Lawless (2007) and Liu, Schaubel and Kalbfleisch (2010). All analyses are done using SAS.
In general, adjustment factors for the SHR were selected based on several considerations. As noted above, we began with a large set of patient characteristics, including demographics, comorbidities at ESRD incidence, a set of prevalent comorbidities, and other characteristics. Factors considered appropriate were then investigated with statistical models, including interactions between sets of adjusters, to determine if they were related to hospitalizations. Factors related to the SHR were also evaluated for face validity before being included. Finally, SDS/SES factors were evaluated based on appropriateness (whether related to disparities in care), empirical association with the outcome, and as supported in published literature.

First, in 2007, a Technical Expert Panel was convened; the TEP provided advice on various aspects of the SHR, including adjustment factors. The 2007 Hospitalization TEP felt that facility characteristics are generally not appropriate for use as adjusters, but should be evaluated for their potential as proxies for patient characteristics. They also recommended that facility market characteristics, such as local hospital utilization rates, should not be considered as risk adjusters.

More recently, there has been great interest among dialysis care providers and other stakeholders in adjusting for more current (prevalent) comorbidities to reflect the current health status of dialysis patients, and specifically inclusion of conditions associated with hospitalization. In response CMS contracted with UM-KECC to convene a Technical Expert Panel (TEP) in September 2015 to consider the addition of prevalent comorbidity risk adjustment. The summary report for the TEP can be found here: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/TechnicalExpertPanels.html. 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 Condition Categories (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 and/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 listed below.

Consideration of SDS/SES risk factors

The relationship among patient level SDS, socioeconomic disadvantage and health care utilization such as hospitalization is well-established in the general population and has received considerable attention over the years. (AHRQ Reports, 2011; 2012; 2013; 2014; 2015). The likelihood of hospitalization is related to socioeconomic disadvantage through differences in health status, insurance coverage, and access to quality primary care (Basu et al, 2012; Blustein et al, 1998). Further, individual and market or area-level measures of deprivation have been shown to contribute independently to preventable hospitalizations (Moy et al, 2013).

Health care outcomes and utilization are associated with area-level income and residential segregation, but particularly so for racial minorities (Williams, 2006 ; Williams and Collins, 2001). This suggests the interplay of patient level (race) and area level SES factors related to lower income, neighborhood poverty, segregation, levels of educational attainment, and unemployment levels that jointly influence key health outcomes related to morbidity (Williams 2006; Williams and Collins, 2001; AHRQ, 2008). Within the dialysis population area-level SES are associated with poor outcomes (Almachraki et al 2016); while patient level factors such as race are predictive of differences in certain clinical outcomes by race. (Yan et al 2014; Whittle et al 1991). In a study of first year hemodialysis patients, patients of Hispanic ethnicity had lowest all-cause hospital length of stay compared to whites, while patients of black race had intermediate all-cause hospital admissions that was lower relative to whites but higher than Hispanic patient, with differences observed across certain age groups (Yan et al, CJASN 2014). Moreover the study authors found that infection-related hospitalizations were significantly higher for black and Hispanic patients compared to non-Hispanic whites. These associations could indicate certain facility level practices related to effective infection control and prevention may unevenly impact patients of black race and Hispanic ethnicity (Yan et al CJASN 2014 p7).

Insurance status is also related to health outcomes but this has not been studied extensively within the dialysis population as it relates to hospitalization, though the association has been documented in

studies of the general dual Medicare and Medicaid population. Dual eligibles typically have greater comorbidity burden, face access to care barriers which in turn drive higher hospital utilization (Jiang et al, 2010; Moon and Shin,2006; Wright et al., 2015).

Maintaining employment is a challenge for dialysis patients which in turn can influence well-being and may have a proximal impact on outcomes such as hospitalization (Curtin et al, AJKD 1996).
Given these observed linkages we tested these patient- and area-level SDS/SES variables based on the conceptual relationships as described above and demonstrated in the literature, as well as the availability of data for the analyses. Measures of area-level socioeconomic deprivation are included as individual components from the Area Deprivation Index (Singh, 2003).

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2b4.4a. Statistical Results

Table 2a. Model Coefficients, Data Years 2010–2013.

Covariate	Coefficient	P-value
Comorbidities at start of ESRD		
At least one of the comorbidities listed below	0.08624	<.0001
Atherosclerotic heart disease	0.04999	<.0001
Other cardiac disease	0.04395	<.0001
Diabetes*	-0.02026	<.0001
Congestive heart failure	0.04269	<.0001
Inability to ambulate	0.02042	<.0001
Chronic obstructive pulmonary disease	0.05646	<.0001
Inability to transfer	0.02401	<.0001
Malignant neoplasm, cancer	0.04102	<.0001

Covariate	Coefficient	P-value
Peripheral vascular disease	0.04104	<.0001
Cerebrovascular disease, CVA, TIA	0.01904	<.0001
Tobacco use (current smoker)	0.08539	<.0001
Alcohol dependence	0.01285	0.036
Drug dependence	0.17361	<.0001
No Medical Evidence (CMS-2728) Form	0.15316	<.0001
Cause of ESRD		
Diabetes	0.03848	<.0001
Missing	-0.03547	<.0001
Sex: Female	0.07156	<.0001
Age		
0-14	0.48884	<.0001
15-24	0.13135	<.0001
25-44	-0.0678	<.0001
45-59	-0.065	<.0001
60-74	Reference	
75+	0.10178	<.0001
BMI		
Log BMI	-0.15032	<.0001
BMI missing	0.01656	0.0002
Calendar year		
2010	Reference	
2011	-0.02546	<.0001
2012	-0.12676	<.0001
2013	-0.16265	<.0001
In nursing home the previous year	0.20788	<.0001
Diabetes as cause of ESRD X time on ESRD interaction term		
91 days-6 months	Reference	

Covariate	Coefficient	P-value
6 months-1 year	0.03417	<.0001
1-2 years	0.01166	0.0737
2-3 years	0.00139	0.8356
3-5 years	-0.01549	0.0147
5+ years	-0.06398	<.0001
Cause of ESRD: diabetes X sex: female interaction term	-0.02622	<.0001
Age X diabetes as cause of ESRD interaction term		
0-14	-0.93749	<.0001
15-24	0.16727	<.0001
25-44	0.15502	<.0001
45-59	0.05013	<.0001
60-74	Reference	
75+	-0.03426	<.0001
Age X female sex interaction term		
0-14	-0.13038	0.0002
15-24	0.24562	<.0001
25-44	0.12877	<.0001
45-59	0.03139	<.0001
60-74	Reference	
75+	-0.00664	0.0685

*The diabetes indicator includes all diabetes comorbidities on CMS-2728 and diabetes as cause of ESRD

Table 2b. Prevalent Comorbidity Coefficients, Data Years 2010–2013.

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Sarcoidosis	135	0.0624	<.0001
Malign neopl prostate	185	-0.03133	<.0001
Malign neopl thyroid	193	-0.04837	0.0087
Oth severe malnutrition	262	0.0382	<.0001
Chr airway obstruct NEC	496	0.1908	<.0001
Postinflam pulm fibrosis	515	0.11769	<.0001
Malignant neopl rectum	1541	0.1335	<.0001

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Mal neo liver, primary	1550	0.12225	<.0001
Mal neo upper lobe lung	1623	0.08088	<.0001
Mal neo bronch/lung NOS	1629	0.13617	<.0001
Malig neo bladder NOS	1889	0.10792	<.0001
Malig neopl kidney	1890	0.02548	0.0004
Secondary malig neo lung	1970	0.17282	<.0001
Second malig neo liver	1977	0.38071	<.0001
Secondary malig neo bone	1985	0.29043	<.0001
Malignant neoplasm NOS	1991	0.13518	<.0001
Protein-cal malnutr NOS	2639	0.10345	<.0001
Dis urea cycle metabol	2706	0.06036	0.0002
Senile dementia uncomp	2900	-0.02563	0.0001
Drug withdrawal	2920	0.26748	<.0001
Mental disor NEC oth dis	2948	0.04058	<.0001
Cereb degeneration NOS	3319	0.08582	<.0001
Aut neuropthy in oth dis	3371	0.02621	<.0001
Grand mal status	3453	0.01548	0.1722
Anoxic brain damage	3481	-0.03408	0.0008
Cerebral edema	3485	0.09181	<.0001
Idio periph neurpthy NOS	3569	0.09859	<.0001
Neuropathy in diabetes	3572	0.04133	<.0001
Intermed coronary synd	4111	0.2052	<.0001
Angina pectoris NEC/NOS	4139	0.12568	<.0001
Prim pulm hypertension	4160	-0.01251	0.0316
Chr pulmon heart dis NEC	4168	0.15189	<.0001
Prim cardiomyopathy NEC	4254	0.16394	<.0001
Cardiomyopath in oth dis	4258	0.16331	<.0001
Atriovent block complete	4260	0.02671	0.0001
Parox ventric tachycard	4271	0.09607	<.0001
Parox tachycardia NOS	4272	0.06145	<.0001
Subdural hemorrhage	4321	0.03408	0.0004
Aortic atherosclerosis	4400	0.09852	<.0001
Lower extremity aneurysm	4423	0.10898	<.0001
Periph vascular dis NOS	4439	0.09731	<.0001
Stricture of artery	4471	0.00238	0.6534
Oth inf vena cava thromb	4532	0.2153	<.0001
Emphysema NEC	4928	0.05787	<.0001
Bronchiectas w/o ac exac	4940	0.06175	<.0001
Food/vomit pneumonitis	5070	0.05726	<.0001
Lung involv in oth dis	5178	0.17403	<.0001

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Regional enteritis NOS	5559	0.17154	<.0001
Ulceratve colitis unspcf	5569	0.06821	<.0001
Chr vasc insuff intest	5571	0.15765	<.0001
Paralytic ileus	5601	0.10245	<.0001
Intestinal obstruct NOS	5609	0.10671	<.0001
Alcohol cirrhosis liver	5712	0.05621	<.0001
Cirrhosis of liver NOS	5715	0.20344	<.0001
Hepatic encephalopathy	5722	0.17945	<.0001
Portal hypertension	5723	0.20086	<.0001
Oth sequela, chr liv dis	5728	0.14523	<.0001
Chronic pancreatitis	5771	0.38153	<.0001
Chronic skin ulcer NEC	7078	0.07843	<.0001
Syst lupus erythematosus	7100	0.24781	<.0001
Systemic sclerosis	7101	0.12899	<.0001
Rheumatoid arthritis	7140	0.10921	<.0001
Inflamm polyarthrop NOS	7149	0.02641	0.1369
Sacroiliitis NEC	7202	0.16649	<.0001
Gangrene	7854	0.05466	<.0001
Cachexia	7994	0.14375	<.0001
Fracture of pubis-closed	8082	0.06248	<.0001
Pelvic fracture NOS-clos	8088	-0.01048	0.4819
Fx neck of femur NOS-cl	8208	-0.02685	<.0001
Amput below knee, unilat	8970	-0.10393	<.0001
Amputat bk, unilat-compl	8971	-0.10582	<.0001
Amput above knee, unilat	8972	-0.08573	<.0001
Amputat leg, unilat NOS	8974	-0.077	<.0001
Candidal esophagitis	11284	0.1985	<.0001
Oth lymp unsp xtrndl org	20280	0.14363	<.0001
Mult mye w/o achv rmson	20300	0.19204	<.0001
Ch lym leuk wo achv rmsn	20410	0.25565	<.0001
Essntial thrombocythemia	23871	0.10421	<.0001
Low grde myelody syn les	23872	0.14376	<.0001
Myelodysplastic synd NOS	23875	0.17806	<.0001
DMII wo cmp nt st uncntr	25000	0.11986	<.0001
DMII wo cmp uncntrld	25002	0.02111	<.0001
DMII keto nt st uncntrld	25010	0.03729	<.0001
DMII ketoacd uncontrold	25012	0.13424	<.0001
DMI ketoacd uncontrold	25013	0.25355	<.0001
DMII hprosmlr uncontrold	25022	0.12376	<.0001
DMII renl nt st uncntrld	25040	0.0746	<.0001

ICD-9 Description	ICD-9 Code	Coefficient	P-value
DMI renl nt st uncntrld	25041	0.04644	<.0001
DMII ophth nt st uncntrl	25050	0.00743	0.0064
DMI ophth uncntrld	25053	0.05823	<.0001
DMII neuro nt st uncntrl	25060	0.05824	<.0001
DMI neuro nt st uncntrld	25061	0.04909	<.0001
DMII neuro uncntrld	25062	0.07612	<.0001
DMI neuro uncntrld	25063	0.13715	<.0001
DMII circ nt st uncntrld	25070	-0.04017	<.0001
DMI circ nt st uncntrld	25071	-0.05298	<.0001
DMII circ uncntrld	25072	-0.02251	<.0001
DMII oth nt st uncntrld	25080	0.08205	<.0001
DMI oth nt st uncntrld	25081	0.02286	0.0002
DMII oth uncntrld	25082	0.03781	<.0001
DMI oth uncntrld	25083	0.00729	0.3939
Glucocorticoid deficient	25541	0.17576	<.0001
Amyloidosis NEC	27739	0.15827	<.0001
Metabolism disorder NEC	27789	0.21983	<.0001
Morbid obesity	27801	0.07927	<.0001
Obesity hypovent synd	27803	-0.05432	<.0001
Sickle cell disease NOS	28260	0.71791	<.0001
Antin chemo indcd pancyt	28411	0.10449	0.0005
Other pancytopenia	28419	0.1945	<.0001
Neutropenia NOS	28800	0.16551	<.0001
Drug induced neutropenia	28803	0.14431	<.0001
Prim hypercoagulable st	28981	0.18562	<.0001
Senile delusion	29020	-0.11382	<.0001
Vascular dementia,uncomp	29040	-0.00174	0.8249
Dementia w/o behav dist	29410	0.01212	0.0613
Dementia w behavior dist	29411	-0.02334	0.0177
Demen NOS w/o behv dstrb	29420	0.04516	<.0001
Schizophrenia NOS-unspec	29590	0.15532	<.0001
Depress psychosis-unspec	29620	0.17524	<.0001
Recurr depr psychos-unsp	29630	0.08526	<.0001
Recur depr psych-severe	29633	0.07789	<.0001
Bipolar disorder NOS	29680	0.19198	<.0001
Bipolar disorder NEC	29689	0.08524	<.0001
Episodic mood disord NOS	29690	0.07786	<.0001
Alcoh dep NEC/NOS-unspec	30390	0.16788	<.0001
Alcoh dep NEC/NOS-remiss	30393	0.07322	<.0001
Opioid dependence-unspec	30400	0.25245	<.0001

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Opioid dependence-contin	30401	0.18003	<.0001
Drug depend NOS-unspec	30490	0.27902	<.0001
Psymotr epil w/o int epi	34540	-0.08114	<.0001
Epilep NOS w/o intr epil	34590	0.19176	<.0001
Critical illness myopthy	35981	-0.09196	<.0001
Prolif diab retinopathy	36202	-0.08631	<.0001
Mod nonprolf db retinoph	36205	-0.07697	<.0001
Diabetic macular edema	36207	-0.0601	<.0001
Hyp ht dis NOS w ht fail	40291	0.03839	<.0001
Subendo infarct, initial	41071	0.18348	<.0001
AMI NEC, unspecified	41080	0.03986	0.0367
AMI NOS, unspecified	41090	-0.03149	<.0001
Ac ischemic hrt dis NEC	41189	0.11644	<.0001
Pulm embol/infarct NEC	41519	0.13237	<.0001
Atrial fibrillation	42731	0.13302	<.0001
Atrial flutter	42732	0.08346	<.0001
Sinoatrial node dysfunct	42781	-0.00923	0.0206
Crbl emblsm w infrct	43411	0.01754	0.0772
Crbl art ocl NOS w infrc	43491	0.07113	<.0001
Athscl extrm ntv art NOS	44020	0.00141	0.6632
Ath ext ntv at w claudct	44021	0.04379	<.0001
Ath ext ntv at w rst pn	44022	0.09607	<.0001
Ath ext ntv art ulcrtion	44023	0.02268	<.0001
Dsct of thoracic aorta	44101	0.23712	<.0001
Periph vascular dis NEC	44389	0.01881	0.0012
Deep phlebitis-leg NEC	45119	0.00269	0.7906
Ac DVT/emb prox low ext	45341	0.12676	<.0001
Ch DVT/embl low ext NOS	45350	0.12558	<.0001
Ch DVT/embl prox low ext	45351	0.09937	<.0001
Ch emblsm subclav veins	45375	0.17741	<.0001
Ac DVT/embl up ext	45382	0.08862	<.0001
Ac emblsm axillary veins	45384	0.10835	<.0001
Ac embl internl jug vein	45386	0.16307	<.0001
Ac embl thorac vein NEC	45387	0.13445	<.0001
Esoph varice oth dis NOS	45621	0.19764	<.0001
Obs chr bronc w(ac) exac	49121	0.16393	<.0001
Obs chr bronc w ac bronc	49122	0.11419	<.0001
Chronic obst asthma NOS	49320	0.10527	<.0001
Ch obst asth w (ac) exac	49322	0.10999	<.0001
Ac resp flr fol trma/srg	51851	-0.04255	0.0003

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Ot pul insuf fol trm/srg	51852	-0.0827	0.0003
Other pulmonary insuff	51882	0.13098	<.0001
Chronic respiratory fail	51883	0.0293	<.0001
Acute & chronc resp fail	51884	0.02507	<.0001
Gastrostomy comp - mech	53642	0.10042	<.0001
Fecal impaction	56032	0.09744	<.0001
Pressure ulcer, low back	70703	0.0362	<.0001
Pressure ulcer, hip	70704	0.09173	<.0001
Pressure ulcer, buttock	70705	0.00396	0.4043
Ulcer of lower limb NOS	70710	0.01138	0.0098
Ulcer other part of foot	70715	0.04066	<.0001
Ulcer oth part low limb	70719	0.03358	<.0001
Pyogen arthritis-unspec	71100	0.03922	0.0151
Pyogen arthritis-l/leg	71106	0.11218	<.0001
Ac osteomyelitis-unspec	73000	-0.04005	0.0005
Ac osteomyelitis-ankle	73007	-0.03799	<.0001
Ac osteomyelitis NEC	73008	-0.01851	0.102
Osteomyelitis NOS-hand	73024	0.05835	0.0001
Osteomyelitis NOS-ankle	73027	-0.03107	<.0001
Path fx vertebrae	73313	0.1329	<.0001
Aseptic necrosis femur	73342	0.20291	<.0001
Asept necrosis bone NEC	73349	0.17431	<.0001
Coma	78001	0.02143	0.1083
Convulsions NEC	78039	0.10277	<.0001
Fx femur intrcaps NEC-cl	82009	0.03652	0.0079
Fx femur NOS-closed	82100	-0.05632	<.0001
React-indwell urin cath	99664	0.15093	<.0001
Compl heart transplant	99683	0.02305	0.3552
Asymp hiv infectn status	V08	0.37403	<.0001
Heart transplant status	V421	0.26702	<.0001
Liver transplant status	V427	0.16234	<.0001
Trnspl status-pancreas	V4283	0.14978	<.0001
Gastrostomy status	V441	0.02184	0.0173
Ileostomy status	V442	0.12312	<.0001
Colostomy status	V443	0.13378	<.0001
Urinostomy status NEC	V446	0.33981	<.0001
Respirator depend status	V4611	-0.02597	0.001
Status amput othr toe(s)	V4972	0.031	<.0001
Status amput below knee	V4975	0.02473	<.0001
Status amput above knee	V4976	0.01774	0.0036

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Atten to gastrostomy	V551	-0.03053	0.0012
Long-term use of insulin	V5867	0.12534	<.0001
BMI 40.0-44.9, adult	V8541	0.03116	<.0001
Less than 6 months of Medicare eligible claims in the previous calendar year		0.73799	<.0001

Most of the coefficient estimates for the prevalent comorbidities are positive and statistically significant, but several do not obtain statistical significance. The very large number of clinical factors in the model expectedly generates substantial multicollinearity among the covariates, likely resulting in some unexpected results in the direction of the coefficient sign and levels of statistical significance. Inclusion of this set of prevalent comorbidities reflects the consensus of the TEP that adjustment for all of these prevalent comorbidities, in addition to incident comorbidities, is important to reflect the current health condition of the patient in risk adjustment.

2b4.4b. Statistical Results for SDS factors

The tables below show the parameter estimates for patient- and area-level SDS/SES variables based on a Cox model for hospital admissions that included these variables along with the original covariates adjusted for in SHR.

Table 3a. Comparing coefficients between sensitivity models with and without SDS/SES adjustors, 2010-2013: Model coefficients

	Baseline SHR			SDS/SES-adjusted SHR	
Covariate	**Coefficient**	**P-value**		**Coefficient**	**P-value**
Medicare coverage*					
Medicare primary + Medicaid	NA	NA		0.07628	<.0001
Medicare primary + no Medicaid	NA	NA		Reference	-
Medicare secondary/HMO	NA	NA		0.97671	<.0001
Employment status 6 months prior to ESRD					
Unemployed	NA	NA		Reference	-
Employed	NA	NA		0.05164	<.0001
Other/Unknown	NA	NA		0.02001	<.0001
Race					
White	NA	NA		Reference	-
Native American/Alaskan Native	NA	NA		-0.03346	<.0001
Asian/Pacific Islander	NA	NA		-0.20491	<.0001
Black	NA	NA		-0.06702	<.0001
Other/Unknown	NA	NA		0.01116	0.1526
Ethnicity					
Hispanic	NA	NA		-0.08082	<.0001
Non-Hispanic	NA	NA		Reference	-
Unknown	NA	NA		-0.05751	<.0001
ADI element					
Home value (median)	NA	NA		0.00208	0.2466
Family income (median)	NA	NA		-0.00197	0.0188
Income disparity**	NA	NA		-0.00118	0.0428
Monthly mortgage (median)	NA	NA		0.00029	0.9517
< 9 years of education (%)	NA	NA		-0.00124	<.0001

	Baseline SHR			SDS/SES-adjusted SHR	
Covariate	**Coefficient**	**P-value**		**Coefficient**	**P-value**
No high school diploma (%)	NA	NA		0.00186	<.0001
Home ownership rate (%)	NA	NA		-0.00056	<.0001
Families below the poverty level (%)	NA	NA		0.00061	0.0019
Gross rent (median)	NA	NA		0.01567	0.0081
Single-parent households with children <18 (%)	NA	NA		-0.00017	0.2071
Unemployment rate	NA	NA		0.00157	0.0001
Comorbidities at start of ESRD					
At least one of the comorbidities listed below	0.08624	<.0001		0.07638	<.0001
Atherosclerotic heart disease	0.04999	<.0001		0.04289	<.0001
Other cardiac disease	0.04395	<.0001		0.03238	<.0001
Diabetes***	-0.02026	<.0001		-0.04055	<.0001
Congestive heart failure	0.04269	<.0001		0.03675	<.0001
Inability to ambulate	0.02042	<.0001		0.01702	<.0001
Chronic obstructive pulmonary disease	0.05646	<.0001		0.04056	<.0001
Inability to transfer	0.02401	<.0001		0.02181	0.0002
Malignant neoplasm, cancer	0.04102	<.0001		0.03391	<.0001
Peripheral vascular disease	0.04104	<.0001		0.02916	<.0001
Cerebrovascular disease, CVA, TIA	0.01904	<.0001		0.01454	<.0001
Tobacco use (current smoker)	0.08539	<.0001		0.08095	<.0001
Alcohol dependence	0.01285	0.036		0.01570	0.0105
Drug dependence	0.17361	<.0001		0.17165	<.0001
No Medical Evidence (CMS-2728) Form	0.15316	<.0001		0.17504	<.0001
Cause of ESRD					
Diabetes	0.03848	<.0001		0.03011	<.0001
Missing	-0.03547	<.0001		-0.04048	<.0001
Sex: Female	0.07156	<.0001		0.06285	<.0001
Age					
0-14	0.48884	<.0001		0.49754	<.0001
15-24	0.13135	<.0001		0.17018	<.0001
25-44	-0.0678	<.0001		-0.02533	<.0001
45-59	-0.065	<.0001		-0.03439	<.0001
60-74	Reference	-		Reference	-
75+	0.10178	<.0001		0.07273	<.0001
BMI					
Log BMI	-0.15032	<.0001		-0.16225	<.0001
BMI missing	0.01656	0.0002		0.01456	0.0064
Calendar year					
2010	Reference	-		Reference	-
2011	-0.02546	<.0001		-0.02546	<.0001
2012	-0.12676	<.0001		-0.12349	<.0001
2013	-0.16265	<.0001		-0.16155	<.0001
In nursing home the previous year	0.20788	<.0001		0.17739	<.0001
Diabetes as cause of ESRD X time on ESRD interaction term					
91 days-6 months	Reference	-		Reference	-
6 months-1 year	0.03417	<.0001		0.02973	<.0001
1-2 years	0.01166	0.0737		0.00827	0.2049
2-3 years	0.00139	0.8356		0.00004	0.9954
3-5 years	-0.01549	0.0147		-0.01139	0.073
5+ years	-0.06398	<.0001		-0.05036	<.0001
Cause of ESRD: diabetes X sex: female interaction term	-0.02622	<.0001		-0.02295	<.0001
Age X diabetes as cause of ESRD interaction term					

Covariate	Baseline SHR			SDS/SES-adjusted SHR	
	Coefficient	P-value		Coefficient	P-value
0-14	-0.93749	<.0001		-0.87713	0.0003
15-24	0.16727	<.0001		0.17698	<.0001
25-44	0.15502	<.0001		0.15213	<.0001
45-59	0.05013	<.0001		0.04798	<.0001
60-74	Reference	-		Reference	-
75+	-0.03426	<.0001		-0.03067	<.0001
Age X female sex interaction term					
0-14	-0.13038	0.0002		-0.11088	0.0019
15-24	0.24562	<.0001		0.24326	<.0001
25-44	0.12877	<.0001		0.12323	<.0001
45-59	0.03139	<.0001		0.02849	<.0001
60-74	Reference	-		Reference	-
75+	-0.00664	0.0685		-0.00662	0.0696

*Patients without Medicare coverage or with unknown coverage type were excluded from the model.
**Log(100)*(the ratio of the number of households with less than $10,000 in income to the number of households with $50,000 or more in income).
***The diabetes indicator includes all diabetes comorbidities on CMS-2728 and diabetes as cause of ESRD.

Table 3b. Comparing coefficients between sensitivity models with and without SDS/SES adjustors, 2010-2013: Prevalent comorbidity coefficients

ICD-9 Description	ICD-9 Code	Baseline SHR			SDS/SES-adjusted SHR	
		Coefficient	P-value		Coefficient	P-value
Protein-cal malnutr NOS	2639	0.10345	<.0001		0.09068	<.0001
Aut neuropthy in oth dis	3371	0.02621	<.0001		0.02174	<.0001
Epilep NOS w/o intr epil	34590	0.19176	<.0001		0.16817	<.0001
Cerebral edema	3485	0.09181	<.0001		0.07959	<.0001
Subendo infarct, initial	41071	0.18348	<.0001		0.14855	<.0001
AMI NEC, unspecified	41080	0.03986	0.0367		0.07768	<.0001
AMI NOS, unspecified	41090	-0.03149	<.0001		0.01671	0.0021
Intermed coronary synd	4111	0.2052	<.0001		0.20521	<.0001
Ac ischemic hrt dis NEC	41189	0.11644	<.0001		0.11839	<.0001
Angina pectoris NEC/NOS	4139	0.12568	<.0001		0.1392	<.0001
Cardiomyopath in oth dis	4258	0.16331	<.0001		0.16447	<.0001
Atriovent block complete	4260	0.02671	0.0001		0.03722	<.0001
Parox ventric tachycard	4271	0.09607	<.0001		0.09379	<.0001
Parox tachycardia NOS	4272	0.06145	<.0001		0.07383	<.0001
Atrial fibrillation	42731	0.13302	<.0001		0.13334	<.0001
Atrial flutter	42732	0.08346	<.0001		0.07437	<.0001
Sinoatrial node dysfunct	42781	-0.00923	0.0206		0.01865	<.0001
Subdural hemorrhage	4321	0.03408	0.0004		0.04615	<.0001
Stricture of artery	4471	0.00238	0.6534		0.02688	<.0001
Paralytic ileus	5601	0.10245	<.0001		0.09073	<.0001
Convulsions NEC	78039	0.10277	<.0001		0.11375	<.0001
Gangrene	7854	0.05466	<.0001		0.04253	<.0001
Cachexia	7994	0.14375	<.0001		0.13784	<.0001
Candidal esophagitis	11284	0.1985	<.0001		0.18944	<.0001
Sarcoidosis	135	0.0624	<.0001		0.05333	<.0001
Malignant neopl rectum	1541	0.1335	<.0001		0.1436	<.0001
Mal neo liver, primary	1550	0.12225	<.0001		0.12933	<.0001
Mal neo upper lobe lung	1623	0.08088	<.0001		0.07581	<.0001

		Baseline SHR			SDS/SES-adjusted SHR	
ICD-9 Description	**ICD-9 Code**	**Coefficient**	**P-value**		**Coefficient**	**P-value**
Mal neo bronch/lung NOS	1629	0.13617	<.0001		0.15539	<.0001
Malign neopl prostate	185	-0.03133	<.0001		0.00491	0.4173
Malig neo bladder NOS	1889	0.10792	<.0001		0.12933	<.0001
Malig neopl kidney	1890	0.02548	0.0004		0.04364	<.0001
Malign neopl thyroid	193	-0.04837	0.0087		-0.02906	0.1153
Secondary malig neo lung	1970	0.17282	<.0001		0.15946	<.0001
Second malig neo liver	1977	0.38071	<.0001		0.3608	<.0001
Secondary malig neo bone	1985	0.29043	<.0001		0.29427	<.0001
Malignant neoplasm NOS	1991	0.13518	<.0001		0.14138	<.0001
Oth lymp unsp xtrndl org	20280	0.14363	<.0001		0.1379	<.0001
Mult mye w/o achv rmson	20300	0.19204	<.0001		0.19396	<.0001
Ch lym leuk wo achv rmsn	20410	0.25565	<.0001		0.23055	<.0001
Essntial thrombocythemia	23871	0.10421	<.0001		0.09762	<.0001
Low grde myelody syn les	23872	0.14376	<.0001		0.16016	<.0001
Myelodysplastic synd NOS	23875	0.17806	<.0001		0.17918	<.0001
DMII wo cmp nt st uncntr	25000	0.11986	<.0001		0.15129	<.0001
DMII wo cmp uncntrld	25002	0.02111	<.0001		0.04779	<.0001
DMII keto nt st uncntrld	25010	0.03729	<.0001		0.08276	<.0001
DMII ketoacd uncontrold	25012	0.13424	<.0001		0.11517	<.0001
DMI ketoacd uncontrold	25013	0.25355	<.0001		0.20779	<.0001
DMII hprosmlr uncontrold	25022	0.12376	<.0001		0.10357	<.0001
DMII renl nt st uncntrld	25040	0.0746	<.0001		0.07666	<.0001
DMI renl nt st uncntrld	25041	0.04644	<.0001		0.052	<.0001
DMII ophth nt st uncntrl	25050	0.00743	0.0064		0.00591	0.0305
DMI ophth uncntrld	25053	0.05823	<.0001		0.04352	<.0001
DMII neuro nt st uncntrl	25060	0.05824	<.0001		0.06459	<.0001
DMI neuro nt st uncntrld	25061	0.04909	<.0001		0.05464	<.0001
DMII neuro uncntrld	25062	0.07612	<.0001		0.07231	<.0001
DMI neuro uncntrld	25063	0.13715	<.0001		0.12346	<.0001
DMII circ nt st uncntrld	25070	-0.04017	<.0001		-0.02883	<.0001
DMI circ nt st uncntrld	25071	-0.05298	<.0001		-0.03436	<.0001
DMII circ uncntrld	25072	-0.02251	<.0001		-0.01743	0.0015
DMII oth nt st uncntrld	25080	0.08205	<.0001		0.07395	<.0001
DMI oth nt st uncntrld	25081	0.02286	0.0002		0.02003	0.0012
DMII oth uncntrld	25082	0.03781	<.0001		0.03026	<.0001
DMI oth uncntrld	25083	0.00729	0.3939		0.00901	0.2922
Glucocorticoid deficient	25541	0.17576	<.0001		0.16647	<.0001
Oth severe malnutrition	262	0.0382	<.0001		0.02159	0.0003
Dis urea cycle metabol	2706	0.06036	0.0002		0.06852	<.0001
Amyloidosis NEC	27739	0.15827	<.0001		0.14513	<.0001
Metabolism disorder NEC	27789	0.21983	<.0001		0.21405	<.0001
Morbid obesity	27801	0.07927	<.0001		0.06141	<.0001
Obesity hypovent synd	27803	-0.05432	<.0001		-0.06425	<.0001
Sickle cell disease NOS	28260	0.71791	<.0001		0.69038	<.0001
Antin chemo indcd pancyt	28411	0.10449	0.0005		0.08143	0.007
Other pancytopenia	28419	0.1945	<.0001		0.18252	<.0001
Neutropenia NOS	28800	0.16551	<.0001		0.1658	<.0001
Drug induced neutropenia	28803	0.14431	<.0001		0.14311	<.0001
Prim hypercoagulable st	28981	0.18562	<.0001		0.17246	<.0001
Senile dementia uncomp	2900	-0.02563	0.0001		0.00253	0.708
Senile delusion	29020	-0.11382	<.0001		-0.0962	<.0001
Vascular dementia,uncomp	29040	-0.00174	0.8249		0.00329	0.6754
Drug withdrawal	2920	0.26748	<.0001		0.2474	<.0001
Dementia w/o behav dist	29410	0.01212	0.0613		0.02147	0.0009

ICD-9 Description	ICD-9 Code	Baseline SHR			SDS/SES-adjusted SHR	
		Coefficient	P-value		Coefficient	P-value
Dementia w behavior dist	29411	-0.02334	0.0177		-0.00281	0.7757
Demen NOS w/o behv dstrb	29420	0.04516	<.0001		0.04207	<.0001
Mental disor NEC oth dis	2948	0.04058	<.0001		0.0466	<.0001
Schizophrenia NOS-unspec	29590	0.15532	<.0001		0.15092	<.0001
Depress psychosis-unspec	29620	0.17524	<.0001		0.1634	<.0001
Recurr depr psychos-unsp	29630	0.08526	<.0001		0.0741	<.0001
Recur depr psych-severe	29633	0.07789	<.0001		0.08623	<.0001
Bipolar disorder NOS	29680	0.19198	<.0001		0.16867	<.0001
Bipolar disorder NEC	29689	0.08524	<.0001		0.08315	<.0001
Episodic mood disord NOS	29690	0.07786	<.0001		0.0807	<.0001
Alcoh dep NEC/NOS-unspec	30390	0.16788	<.0001		0.15674	<.0001
Alcoh dep NEC/NOS-remiss	30393	0.07322	<.0001		0.05354	<.0001
Opioid dependence-unspec	30400	0.25245	<.0001		0.23688	<.0001
Opioid dependence-contin	30401	0.18003	<.0001		0.1673	<.0001
Drug depend NOS-unspec	30490	0.27902	<.0001		0.27214	<.0001
Cereb degeneration NOS	3319	0.08582	<.0001		0.11595	<.0001
Grand mal status	3453	0.01548	0.1722		0.01564	0.1675
Psymotr epil w/o int epi	34540	-0.08114	<.0001		-0.06901	<.0001
Anoxic brain damage	3481	-0.03408	0.0008		-0.03967	0.0001
Idio periph neurpthy NOS	3569	0.09859	<.0001		0.10174	<.0001
Neuropathy in diabetes	3572	0.04133	<.0001		0.02274	<.0001
Critical illness myopthy	35981	-0.09196	<.0001		-0.08218	<.0001
Prolif diab retinopathy	36202	-0.08631	<.0001		-0.06471	<.0001
Mod nonprolf db retinoph	36205	-0.07697	<.0001		-0.0567	<.0001
Diabetic macular edema	36207	-0.0601	<.0001		-0.04416	<.0001
Hyp ht dis NOS w ht fail	40291	0.03839	<.0001		0.05711	<.0001
Pulm embol/infarct NEC	41519	0.13237	<.0001		0.13027	<.0001
Prim pulm hypertension	4160	-0.01251	0.0316		0.02908	<.0001
Chr pulmon heart dis NEC	4168	0.15189	<.0001		0.13335	<.0001
Prim cardiomyopathy NEC	4254	0.16394	<.0001		0.15779	<.0001
Crbl emblsm w infrct	43411	0.01754	0.0772		0.01317	0.1847
Crbl art ocl NOS w infrc	43491	0.07113	<.0001		0.07869	<.0001
Aortic atherosclerosis	4400	0.09852	<.0001		0.08793	<.0001
Athscl extrm ntv art NOS	44020	0.00141	0.6632		0.01909	<.0001
Ath ext ntv at w claudct	44021	0.04379	<.0001		0.06012	<.0001
Ath ext ntv at w rst pn	44022	0.09607	<.0001		0.09649	<.0001
Ath ext ntv art ulcrtion	44023	0.02268	<.0001		0.03187	<.0001
Dsct of thoracic aorta	44101	0.23712	<.0001		0.24884	<.0001
Lower extremity aneurysm	4423	0.10898	<.0001		0.10403	<.0001
Periph vascular dis NEC	44389	0.01881	0.0012		0.02819	<.0001
Periph vascular dis NOS	4439	0.09731	<.0001		0.10228	<.0001
Deep phlebitis-leg NEC	45119	0.00269	0.7906		0.03874	0.0001
Oth inf vena cava thromb	4532	0.2153	<.0001		0.20467	<.0001
Ac DVT/emb prox low ext	45341	0.12676	<.0001		0.10691	<.0001
Ch DVT/embl low ext NOS	45350	0.12558	<.0001		0.11544	<.0001
Ch DVT/embl prox low ext	45351	0.09937	<.0001		0.09291	<.0001
Ch emblsm subclav veins	45375	0.17741	<.0001		0.17209	<.0001
Ac DVT/embl up ext	45382	0.08862	<.0001		0.08867	<.0001
Ac emblsm axillary veins	45384	0.10835	<.0001		0.09897	<.0001
Ac embl internl jug vein	45386	0.16307	<.0001		0.15905	<.0001
Ac embl thorac vein NEC	45387	0.13445	<.0001		0.1339	<.0001
Esoph varice oth dis NOS	45621	0.19764	<.0001		0.17113	<.0001
Obs chr bronc w(ac) exac	49121	0.16393	<.0001		0.15724	<.0001
Obs chr bronc w ac bronc	49122	0.11419	<.0001		0.10931	<.0001

		Baseline SHR			SDS/SES-adjusted SHR	
ICD-9 Description	**ICD-9 Code**	**Coefficient**	**P-value**		**Coefficient**	**P-value**
Emphysema NEC	4928	0.05787	<.0001		0.07762	<.0001
Chronic obst asthma NOS	49320	0.10527	<.0001		0.10032	<.0001
Ch obst asth w (ac) exac	49322	0.10999	<.0001		0.10446	<.0001
Bronchiectas w/o ac exac	4940	0.06175	<.0001		0.07671	<.0001
Chr airway obstruct NEC	496	0.1908	<.0001		0.18441	<.0001
Food/vomit pneumonitis	5070	0.05726	<.0001		0.04838	<.0001
Postinflam pulm fibrosis	515	0.11769	<.0001		0.12366	<.0001
Lung involv in oth dis	5178	0.17403	<.0001		0.15417	<.0001
Ac resp flr fol trma/srg	51851	-0.04255	0.0003		-0.05125	<.0001
Ot pul insuf fol trm/srg	51852	-0.0827	0.0003		-0.0681	0.0032
Other pulmonary insuff	51882	0.13098	<.0001		0.1543	<.0001
Chronic respiratory fail	51883	0.0293	<.0001		0.0179	0.0021
Acute & chronc resp fail	51884	0.02507	<.0001		0.00683	0.1906
Gastrostomy comp - mech	53642	0.10042	<.0001		0.11609	<.0001
Regional enteritis NOS	5559	0.17154	<.0001		0.14951	<.0001
Ulceratve colitis unspcf	5569	0.06821	<.0001		0.07949	<.0001
Chr vasc insuff intest	5571	0.15765	<.0001		0.14385	<.0001
Fecal impaction	56032	0.09744	<.0001		0.09478	<.0001
Intestinal obstruct NOS	5609	0.10671	<.0001		0.11453	<.0001
Alcohol cirrhosis liver	5712	0.05621	<.0001		0.05224	<.0001
Cirrhosis of liver NOS	5715	0.20344	<.0001		0.20181	<.0001
Hepatic encephalopathy	5722	0.17945	<.0001		0.16256	<.0001
Portal hypertension	5723	0.20086	<.0001		0.18288	<.0001
Oth sequela, chr liv dis	5728	0.14523	<.0001		0.14782	<.0001
Chronic pancreatitis	5771	0.38153	<.0001		0.36579	<.0001
Pressure ulcer, low back	70703	0.0362	<.0001		0.02419	<.0001
Pressure ulcer, hip	70704	0.09173	<.0001		0.09029	<.0001
Pressure ulcer, buttock	70705	0.00396	0.4043		0.0221	<.0001
Ulcer of lower limb NOS	70710	0.01138	0.0098		0.02116	<.0001
Ulcer other part of foot	70715	0.04066	<.0001		0.04168	<.0001
Ulcer oth part low limb	70719	0.03358	<.0001		0.02956	<.0001
Chronic skin ulcer NEC	7078	0.07843	<.0001		0.08132	<.0001
Syst lupus erythematosus	7100	0.24781	<.0001		0.23436	<.0001
Systemic sclerosis	7101	0.12899	<.0001		0.13113	<.0001
Pyogen arthritis-unspec	71100	0.03922	0.0151		0.07424	<.0001
Pyogen arthritis-l/leg	71106	0.11218	<.0001		0.09919	<.0001
Rheumatoid arthritis	7140	0.10921	<.0001		0.10251	<.0001
Inflamm polyarthrop NOS	7149	0.02641	0.1369		0.05225	0.0033
Sacroiliitis NEC	7202	0.16649	<.0001		0.17183	<.0001
Ac osteomyelitis-unspec	73000	-0.04005	0.0005		-0.01211	0.2959
Ac osteomyelitis-ankle	73007	-0.03799	<.0001		-0.02268	0.0005
Ac osteomyelitis NEC	73008	-0.01851	0.102		-0.01646	0.1459
Osteomyelitis NOS-hand	73024	0.05835	0.0001		0.06307	<.0001
Osteomyelitis NOS-ankle	73027	-0.03107	<.0001		-0.04842	<.0001
Path fx vertebrae	73313	0.1329	<.0001		0.1435	<.0001
Aseptic necrosis femur	73342	0.20291	<.0001		0.1894	<.0001
Asept necrosis bone NEC	73349	0.17431	<.0001		0.17243	<.0001
Coma	78001	0.02143	0.1083		0.03361	0.012
Fracture of pubis-closed	8082	0.06248	<.0001		0.04974	<.0001
Pelvic fracture NOS-clos	8088	-0.01048	0.4819		0.02635	0.0755
Fx femur intrcaps NEC-cl	82009	0.03652	0.0079		0.01917	0.1618
Fx neck of femur NOS-cl	8208	-0.02685	<.0001		-0.0007617	0.9099
Fx femur NOS-closed	82100	-0.05632	<.0001		-0.03439	0.0012
Amput below knee, unilat	8970	-0.10393	<.0001		-0.07656	<.0001

ICD-9 Description	ICD-9 Code	Baseline SHR			SDS/SES-adjusted SHR	
		Coefficient	P-value		Coefficient	P-value
Amputat bk, unilat-compl	8971	-0.10582	<.0001		-0.07636	<.0001
Amput above knee, unilat	8972	-0.08573	<.0001		-0.06596	<.0001
Amputat leg, unilat NOS	8974	-0.077	<.0001		-0.05693	0.0017
React-indwell urin cath	99664	0.15093	<.0001		0.12326	<.0001
Compl heart transplant	99683	0.02305	0.3552		0.0336	0.1755
Asymp hiv infectn status	V08	0.37403	<.0001		0.35665	<.0001
Heart transplant status	V421	0.26702	<.0001		0.23506	<.0001
Liver transplant status	V427	0.16234	<.0001		0.13283	<.0001
Trnspl status-pancreas	V4283	0.14978	<.0001		0.10397	<.0001
Gastrostomy status	V441	0.02184	0.0173		0.01005	0.2728
Ileostomy status	V442	0.12312	<.0001		0.1086	<.0001
Colostomy status	V443	0.13378	<.0001		0.12704	<.0001
Urinostomy status NEC	V446	0.33981	<.0001		0.31177	<.0001
Respirator depend status	V4611	-0.02597	0.001		-0.02041	0.0095
Status amput othr toe(s)	V4972	0.031	<.0001		0.02001	<.0001
Status amput below knee	V4975	0.02473	<.0001		0.01286	0.0032
Status amput above knee	V4976	0.01774	0.0036		0.01293	0.034
Atten to gastrostomy	V551	-0.03053	0.0012		-0.01125	0.2309
Long-term use of insulin	V5867	0.12534	<.0001		0.10276	<.0001
BMI 40.0-44.9, adult	V8541	0.03116	<.0001		0.01971	0.0009
Less than 6 months of Medicare eligible claims in the previous calendar year	—	0.73799	<.0001		0.5303	<.0001

Evaluating Adjustments for SDS/SES

Figure 1. Comparison of SHRs adjusted and not adjusted for race by facility percentage of black patients (deciles), 2013

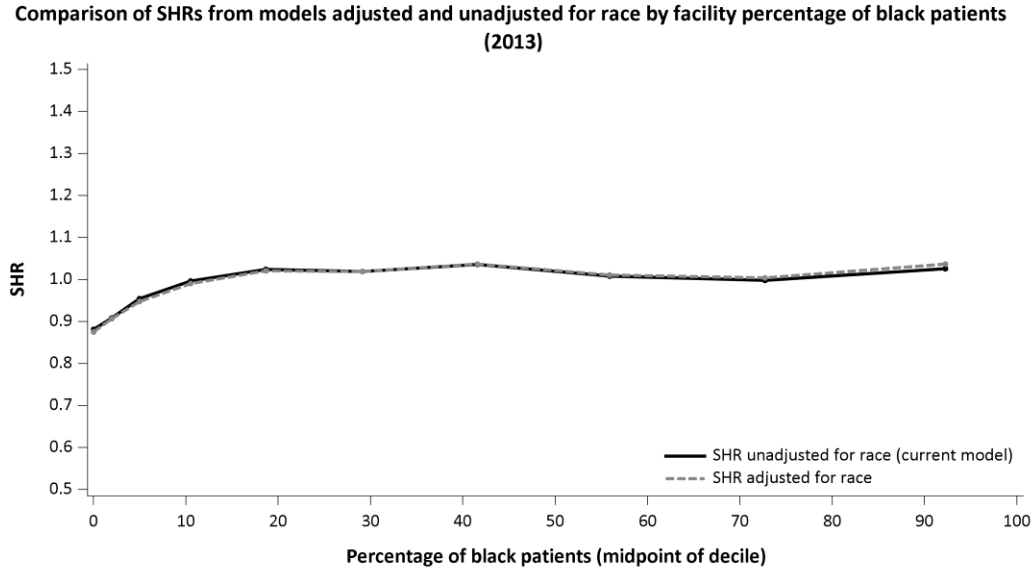


Figure 2. Comparison of SHRs adjusted and not adjusted for Hispanic ethnicity by facility percentage of Hispanic patients

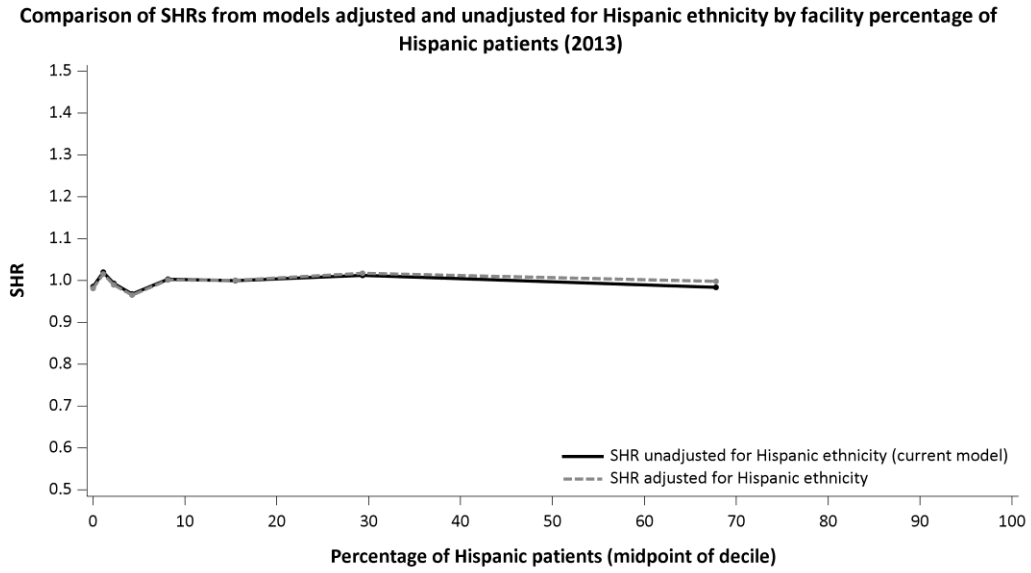
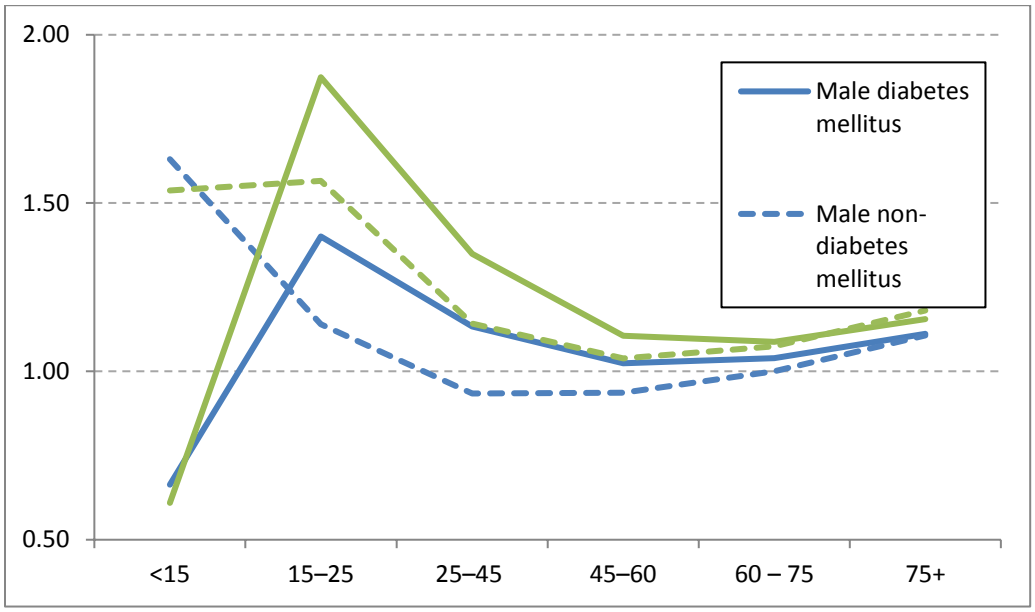


Figure 3. Relative effects of coefficients related to sex in the 2013 SHR model



Patient-level SDS: Compared with males, females were more likely to experience a hospital admission (OR=1.06; p<0.01).However the interaction of female sex and age demonstrated the highest odds were observed in the age 15 – 24, 25-44, and 45-59 age groups, with a decreasing gradient, and the 45-59 age group showing the most diminished impact. There was no significant difference in the oldest female-age-specific group. These results suggest the possibility of an unidentified biologic effect or, alternatively, confounding by an unmeasured association for younger females. Hispanics were less likely to be admitted to the hospital (OR=0.92; p<0.01) than non- Hispanics. Compared with white patients, Asian/PI (OR=0.81, p<0.01), Native American (OR=0.97, p<0.01) and black (OR=0.94, p<0.01) patients

were less likely to be admitted to the hospital. The results for ethnicity and race are consistent with prior studies within the dialysis setting.

Patient-level SES: Compared with Medicare-only patients, patients with both Medicare and Medicaid (OR=1.08; p<0.01) and patients with Medicare as secondary/Medicare HMO (OR=2.66, p<0.01) were more likely to be hospitalized. The result for dually eligible patients having higher odds of hospitalization is consistent with the hypothesis that this insurance category, on average, represents an at-risk group. Further examination is needed for the higher odds of hospitalization for patients with Medicare as secondary payer or HMO. It is possible that these patients represent a larger portion of incident ESRD patients, which have a known higher risk of complications in the first year of ESRD.

Patients who were employed prior to ESRD incidence were more likely to be admitted to the hospital (OR=1.05; p<0.01) than unemployed patients. Note that for employment categories, the "Other/Unknown" category also had higher odds of hospital admission. We note this represents diverse patient groups with regard to SES, such as students, homemakers and those who are retired. The higher odds of hospitalization may be associated with unmeasured risk characteristics of this diverse group but that will require further empirical examination based on data availability.

Area-level SES: Overall, measures of area-level deprivation had very low impact on the odds of hospitalization. Among statistically significant impacts were measures of low median family income (OR=0.998, p=0.0188), the percentage of families below the poverty level (OR=1.001, p=0.002), the percentage of individuals without a high school diploma (OR=1.002, p<0.01), and the area-level unemployment rate (OR=1.002, p<0.01). In general the magnitude of the effects of the individual indicators was very small. In addition to the very small coefficients, a few were not in the expected direction suggesting potential collinearity with other SES or SDS factors in the model.

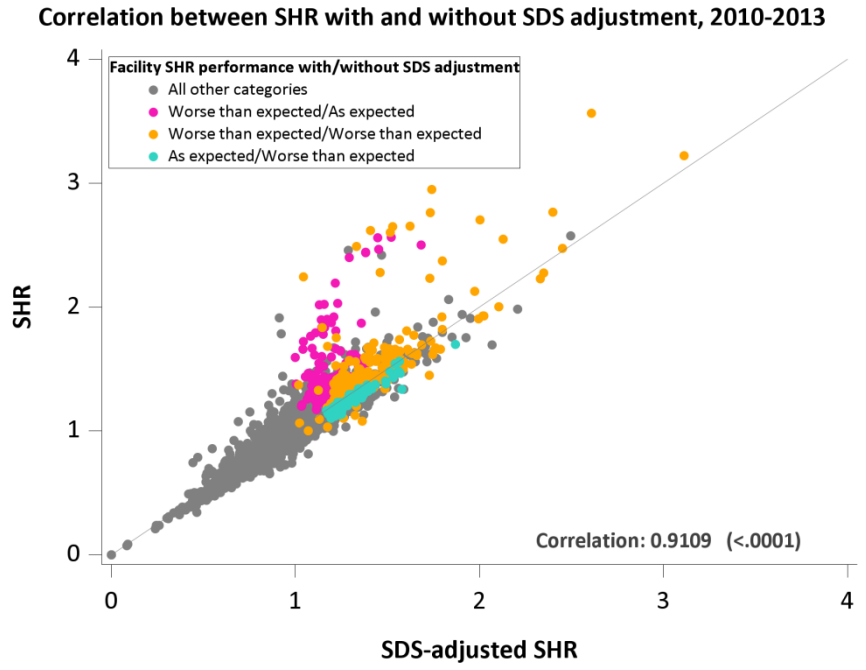


Table 4. Flagging rates, by model with and without all SDS/SES adjustors: 2010-2013

Baseline SHR	Model With SDS/SES			Total
	Better than Expected	As Expected	Worse than Expected	
Better than Expected	166	21	3	**190 (3.1%)**
As Expected	45	5546	81	**5672 (91.0%)**
Worse than Expected	5	123	244	**372 (6.0%)**
Total	**216 (3.5%)**	**5690 (91.3%)**	**328 (5.3%)**	—

After adjustment for SDS/SES, 278 facilities (4.5%) changed performance categories. 105 (1.7%) facilities were down-graded, and 173 (2.8%) were upgraded.

These analyses indicate that select patient-level variables for SDS/SES affect expected hospitalization rates, while area-level indicators had either minimal or no effect on expected hospital admissions. Furthermore, SHRs with and without adjustment for SDS/SES are highly correlated (0.9109) but adjustment for SDS/SES shifts facility performance only slightly. This suggests SDS/SES does not contribute much to the flagging profiles for facility performance.

In the final SHR model we continue to include sex (SDS factor) for risk adjustment. Our analysis of medical evidence and claims data is generally supportive of the current approach to sex adjustment in the SHR. It is consistent with the consensus opinion that adjustment for sex is appropriate, in that there is some evidence of physiological cause for higher hospitalization rates among females.

Table 3a above presents the manner in which the SHR adjusts for sex, given current judgment that physiology accounts for some, if not a substantial part, of observed differences in hospitalization by sex. The main adjustment reflects the observation that, adjusting for age and a set of comorbidities, females are more likely to be hospitalized. The interaction terms for age and sex in the model indicate that the effect of sex depends substantially on patient age. Females in the 15-45 age range face a greater risk of experiencing an admission, as compared to men of the same age with similar risk profiles. This does not appear to be a consequence of facility performance, however, because the disparity is not generally applicable to females, but only to a limited age group. It is therefore important to risk adjust for sex to ensure that women in facilities with larger numbers of women aged 15 to 45 are not inappropriately disadvantaged in terms of access to care.

Figure 3 shows the interaction of age and sex in the SHR model, for patients diagnosed with and without diabetes. The figure makes clear that for both male and female patients, independent of diagnoses of diabetes, hospitalization is strongly associated with young age. Further, the male-female difference is concentrated in the younger age categories. Beyond age 45, where the hospitalization rates are generally quite low, there is very little difference between males and females. The figure also demonstrates that high hospitalization rates for females reflects utilization by younger females, suggesting a physiologic effect rather than a systematic difference in care by sex.

Race, ethnicity and patient level SES factors are not included in the final risk adjusted model. While adjustment for these factors would account for different outcomes by race and ethnicity and SES factors and guard against barriers in access to care, adjustment would also introduce the potential unintended consequence of allowing access to lower quality of care. Additionally, race and Hispanic ethnicity were

observed to indicate lower risk of hospitalization, including race, Hispanic ethnicity did not contribute more to the SHR compared to a model with most of the current set of adjustors; similarly for socioeconomic status (Figures 1-2 above). We are currently examining other measures of SES and SDS to assess impact on expected hospitalization and whether it would be appropriate to adjust for these factors.

Given the very small impact of area-level SES factors we decided not to include these as risk adjustments in the final model. While other studies have shown the association between these patient and area-level SDS/SES factors and hospitalization, further work is needed to demonstrate that differences based on these factors are not related to facility care, in order to prevent disparities in care. Patients in lower SES strata are typically in poorer health as they face greater resource limitation as a result of their limited access to primary care. Adjusting for SES would effectively further comprise the quality of care received as it would lower standards of care based on an assumption these patients will just generally always be sicker.

2b4.5. Method Used to Develop the Statistical Model or Stratification Approach

Two-way interactions were examined and selected for the final model based on both the magnitude and statistical significance of the estimates.

2b4.6. Statistical Risk Model Discrimination Statistics (e.g., c-statistic, R^2)

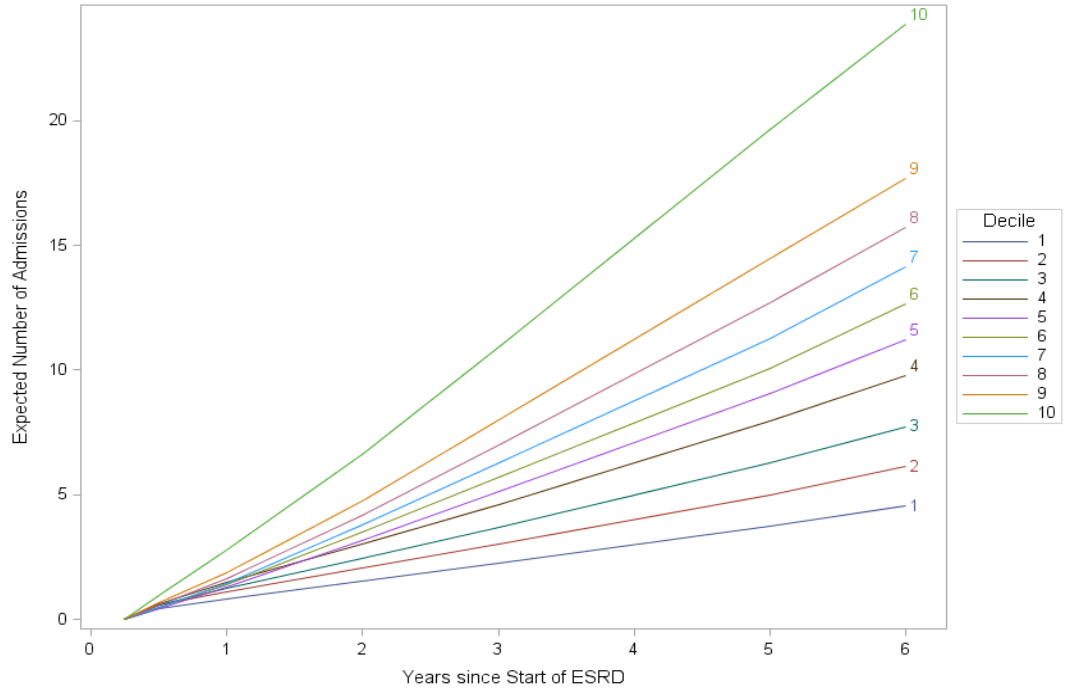
The C-statistic for a recurrent event model measures the concordance between the observed rate of recurrent events and the model-based rate. The estimate of the c-statistic for the SHR is 0.65.

2b4.7. Statistical Risk Model Calibration Statistics (e.g., Hosmer-Lemeshow statistic)

N/A

2b4.8. Statistical Risk Model Calibration—Risk decile plots or calibration curves

Decile plots showing piecewise linear estimates of the cumulative rates by years since start of ESRD are plotted in Figure 4. **Figure 4.** Decile Plot for SHR Admissions (2013 data).



Martingale residual plots were also examined (Figures 5-7).

Figure 5. Martingale Residuals by Age of Patient with LOESS Curve (2013 data).

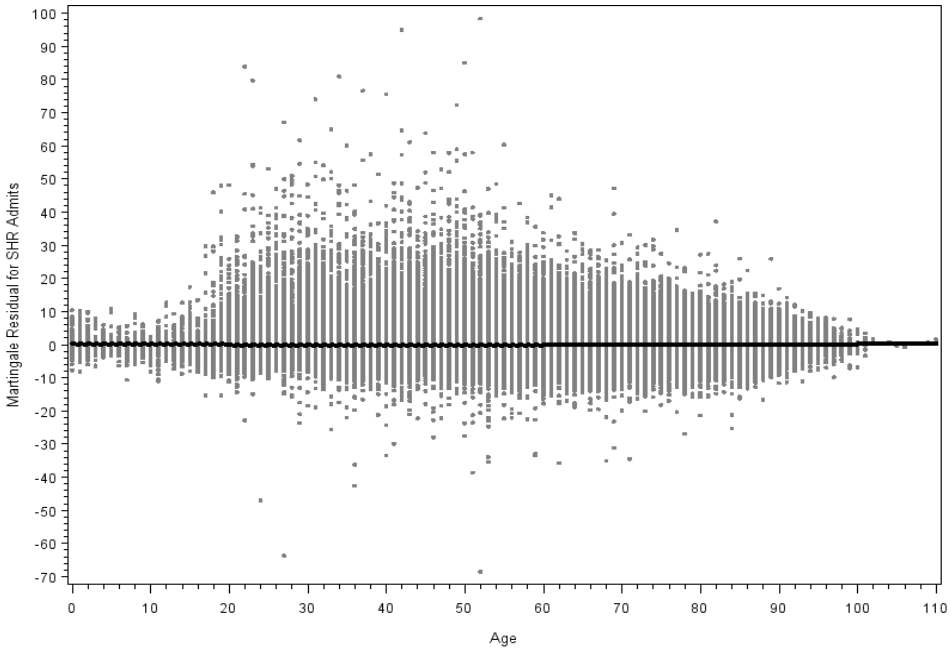


Figure 6. Martingale Residuals by BMI of Patient with LOESS Curve (2013 data).

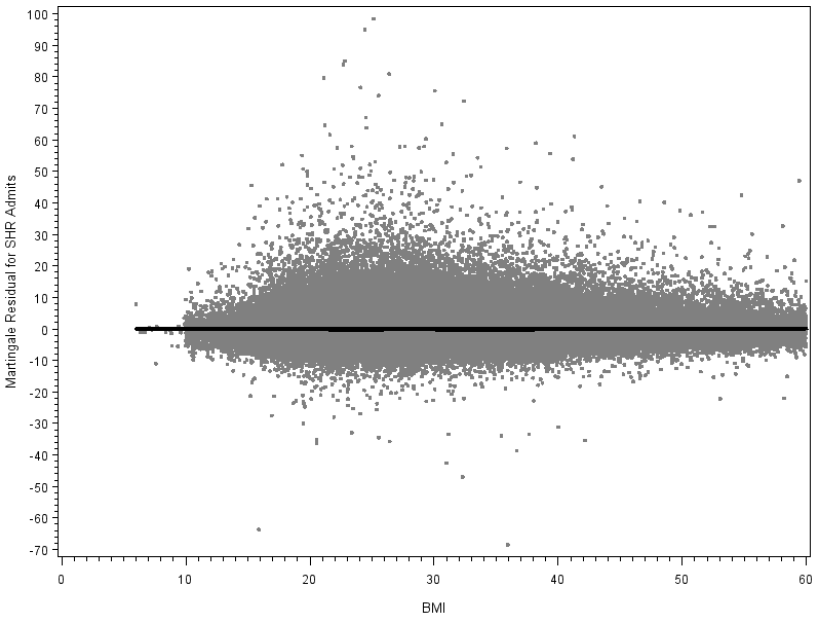
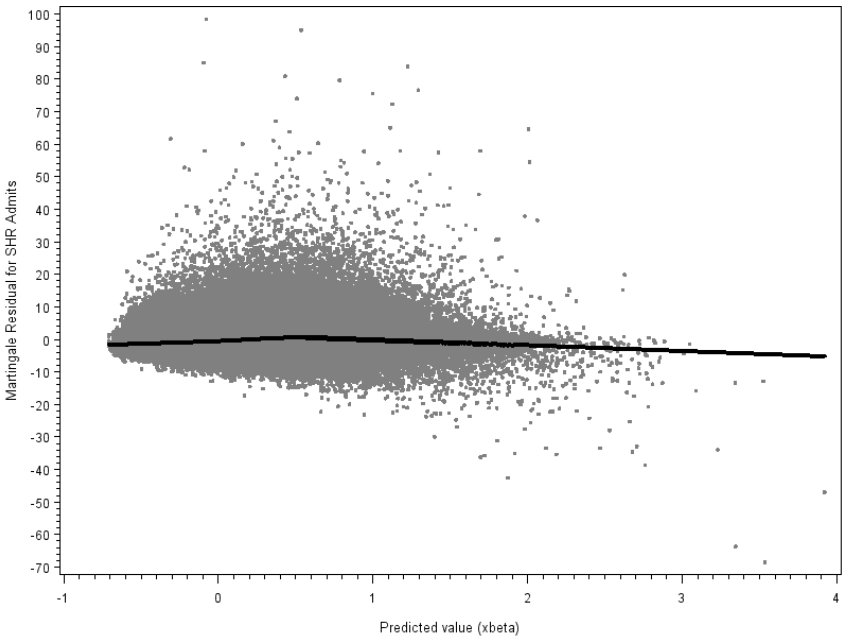


Figure 7. Martingale Residuals by Predicted Value of Patient with LOESS Curve (2013 data).



2b4.9. Results of Risk stratification Analysis

N/A

2b4.10. Interpretation

The decile plot shows that the risk factors in the model are discriminating well between patients. There is good separation among all 10 groups, and the ordering is as predicted by the model (patients predicted to be at lower risk have lower hospitalization rates). The absolute differences between the groups is also large, with patients predicted to have the highest hospitalization rates (line 10) having 3 times higher hospitalization rates than those predicted to have the lowest rates (line 1).

The Martingale residual plots also did not indicate problems with the model fit. There was no pattern in the residuals that suggested lack of fit in any of the variables considered. In the LOESS plots attached, the LOESS curve for the mean of the residuals is flat indicating that there is no problem with the fit for each of the variables considered. The adjustment variables are highly predictive of the hospital admissions, and model extensions to examine interactions suggest a good overall fit.

2b4.11. Optional Additional Testing for Risk Adjustment

N/A

2b5—Identification of statistically significant and clinically meaningful differences

2b5.1. Method for determining

To adjust for over-dispersion of the data, we compute the p-value for our estimates using the empirical null distribution, a robust approach that takes account of the natural random variation among facilities that is not
accounted for in the model (Efron, 2004; Kalbfleisch and Wolfe, 2013). Our algorithm consists of the following concrete steps. First, we fit an over-dispersed Poisson model (e.g., SAS PROC GENMOD with link=log, dist=poisson and scale=dscale) for the number of hospital admissions

$$\log(E[\mathbf{n}_{ik}]) = \log(\mathbf{E}_{ik}) + \boldsymbol{\theta}_k,$$

where $\mathbf{n}_{ik}$ is the observed number of events for patient *i* in facility *k*, $\mathbf{E}_{ik}$ is the expected number of events for patient *i* in facility *k* and $\boldsymbol{\theta}_k$ is the facility-specific intercept. Here, i ranges over the number of patients $\underline{N_k}$ who are treated in the *k*th facility. The natural log of the SHR for the *k*th facility is then given by the corresponding estimate of $\boldsymbol{\theta}_k$. The standard error of $\boldsymbol{\theta}_k$ is obtained from the robust estimate of variance arising from the overdispersed Poisson model.

Second, we obtain a z-score for each facility by dividing the natural log of its SHR by the standard error from the general linear model described above. These z-scores are then grouped into quartiles based on the number of patient years at risk for Medicare patients in each facility. Finally, using robust estimates of location and scale based on the normal curve fitted to the center of the z-scores for the SHR, we derive the mean and variance of a normal empirical null distribution for each quartile. This empirical null distribution is then used to calculate the p-value for a facility's SHR.

2b5.2. Statistical Results

Table 5. Number and percentage of facilities by classification of SHR, 2013. Categories stratified by facility size.

Number of patients	Better than expected	As expected	Worse than expected
< 51	0.26% (15)	31.86% (1,866)	1.47% (86)
51 - 87	0.39% (23)	31.71% (1,857)	1.79% (105)
> 87	0.43% (25)	30.46% (1,784)	1.64% (96)

2b5.3. Interpretation

Without empirical null methods, a large number of facilities will be flagged, including many larger facilities with a relatively small difference between the rates of hospitalization. In contrast, the methods based on the empirical null make appropriate adjustments for over dispersion. Using this method, facilities are flagged if they have outcomes that are extreme when compared to the variation in outcomes for other facilities of a similar size. Overall, most facilities are flagged as expected (94.03%),

while approximately 1% are better than expected, and approximately 5% are flagged as worse than expected.

2b6—Comparability of performance scores

2b6.1. Method of testing conducted to demonstrate comparability
N/A

2b6.2. Statistical Results
N/A

2b6.3. Interpretation
N/A

Feasibility:

3a.1. How are the data elements needed to compute measure scores generated
Generated by and used by healthcare personnel during the provision of care, e.g., blood pressure, lab value, medical condition

3b.1. Are the data elements needed for the measure as specified available electronically
ALL data elements are in defined fields in a combination of electronic sources

3b.3. If this is an eMeasure, provide a summary of the feasibility assessment
N/A

3c.1. Describe what you have learned or modified as a result of testing
N/A

3c.2. Describe any fees, licensing, or other requirements
N/A

Usability and Use:

4.1—Current and Planned Use

4a.1. Program, sponsor, purpose, geographic area, accountable entities, patients
Public Reporting: Dialysis Facility Compare (DFC)

Purpose: Dialysis Facility Compare helps patients find detailed information about Medicare-certified dialysis facilities. They can compare the services and the quality of care that facilities provide.

Geographic area: United States

Number of accountable entities: All Medicare-certified dialysis facilities that are eligible for the measure, and have at least 5 patient years at risk. For the most recent DFC report, that was 5,992 facilities.

Patients included: All patients who meet the requirements to be included in the measure.

4a.2. If not publicly reported or used for accountability, reasons
N/A

4a.3. If not, provide a credible plan for implementation
N/A

4b.1. Progress on improvement
Hospitalization rates have decreased over time as evidenced by the coefficients for calendar year from the SHR model. The hospitalization rate for 2011 decreased by 3% compared to 2010 (p-value <0.0001). Subsequent years had a larger decrease in the hospitalization rate compared to 2010 at 12.7% lower for 2012 and about 16.2% lower for 2013 (p-value<0.0001 for both).

SHR Calendar Year Model Coefficients, 2010-2013:
2011: Coefficient = -0.03, P-value = <0.0001
2012: Coefficient = -0.127, P-value = <0.0001
2013: Coefficient = -0.162, P-value = <0.0001

4b.2. If no improvement was demonstrated, what are the reasons
N/A

Related and Competing Measures:

5—Relation to Other NQF-Endorsed Measures
Yes

5.1a. The measure titles and NQF numbers are listed here
0369 : Standardized Mortality Ratio for Dialysis Facilities
2496 : Standardized Readmission Ratio (SRR) for dialysis facilities

5.1 b. If the measures are not NQF-endorsed, indicate the measure title

5a—Harmonization

5a.1. Are the measure specifications completely harmonized
No

5a.2. If not completely harmonized, identify the differences rationale, and impact
These measures are not completely harmonized. Each measure assesses different outcomes as reflected in certain differences across the measure specifications. SHR, SMR and SRR are harmonized to the population they measure (Medicare-covered ESRD patients), methods (SMR and SHR) and certain risk adjustment factors specific to the ESRD population. SHR and SMR adjust for all the same comorbidity risk factors, a similar set of patient characteristics, and use fixed effects in their modeling approach. The differences between SHR, SMR and SRR reflect adjustment for factors specific to the outcome of each respective measure. Both SHR and SMR adjust for a set of prevalent comorbidities (observed in a prior year), however the complete set of comorbidities differs for SRR. SRR excludes planned readmissions; and adjusts for discharging hospital, acknowledging that for readmission, hospitals also bear accountability for properly coordinating care with the dialysis facility. These risk adjustments in SRR account for those characteristics specifically associated with readmission, and do not apply to SHR or

SMR. SHR adjusts for sex to account for sex-age specific effects associated with higher hospitalization. Only SMR adjusts for state death rates, race, and ethnicity to account for these respective differences related to mortality outcomes and that are deemed outside of a facility's control.

5b—Competing measures

5b.1 Describe why this measure is superior to competing measures
N/A

Additional Information:

Co.1.—Measure Steward Point of Contact
Co.1.1. Organization
Centers for Medicare & Medicaid Services
Co.1.2. First Name
Sophia
Co.1.3. Last Name
Chan
Co.1.4. Email Address
Sophia.Chan@cms.hhs.gov
Co.1.5. Phone Number
410-786-5050

Co.2.—Developer Point of Contact (indicate if same as Measure Steward Point of Contact
Co.2.1. Organization
University of Michigan Kidney Epidemiology and Cost Center
Co.2.2. First Name
Casey
Co.2.3. Last Name
Parrotte
Co.2.4. Email Address
parrotte@med.umich.edu
Co.2.5. Phone Number
734-763-1617

Ad.1. Workgroup/Expert Panel Involved in Measure Development
The following is a list of TEP members who participated in the End-Stage Renal Disease Evaluation of Potential Prevalent Comorbidity Adjustments in the Standardized Hospitalization Ratio (SHR) and the Standardized Mortality Ratio (SMR) TEP. In this advisory role, the primary duty of the TEP was to review any existing measures in terms of comorbidities included as adjusters, and determine if there was sufficient evidence to support the inclusion of specific proposed comorbidities as measure adjusters, and relatedly, suggest measure specifications.

Caroline Steward, APRN, CCRN, CNN
Advanced Practice Nurse (Hemodialysis)
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Turfts Medical Center
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Cincinnati, OH

Roberta Wager, MSN, RN
Renal Care Coordinator
Fresenius Medical Care
Member of Forum of ESRD Networks Beneficiary Council
Forum of ESRD Networks
Boerne, TX

Danielle Ward
Member of Forum of ESRD Networks Beneficiary Council
Forum of ESRD Networks

Board Member
Network 6
Wake Forest, NC

Ad.2. Year the Measure Was First Released

Ad.3. Month and Year of Most Recent Revision
04, 2016

Ad.4. What is your frequency for review/update of this measure?
Annually

Ad.5. When is your next scheduled review/update for this measure?
04, 2017

Ad.6. Copyright Statement

Ad.7. Disclaimers

Ad.8. Additional Information/Comments

S.15. Detailed risk model specifications

The modeling process has two stages. At stage I, a stratified model is fitted to the national data with piecewise-constant baseline rates and stratification by facility. Specifically, the model is of the following form

$$Pr(\text{ hospital admission on day } t \text{ given covariates } X) = r_{0k}(t) \exp(\beta' X_{ik})$$

where X_{ik} is the vector of covariates for the i^{th} patient in the k^{th} facility and β is the vector of regression coefficients. Time t is measured from the start of ESRD. The baseline rate function $r_{0k}(t)$ is specific to the k^{th} facility, and is assumed to be a step function with break points at 6 months, 1 year, 2 years, 3 years and 5 years since the onset of dialysis. This model allows the baseline hospitalization rates to vary between strata (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. The stratification on facilities is important in this phase to avoid bias due to possible confounding between covariates and facility effects.

At stage II, the relative risk estimates from the first stage are used to create offsets and an unstratified model is fitted to obtain estimates of an overall baseline rate function. That is, we estimate a common baseline rate of admissions, $r_0(t)$, across all facilities by considering the model

$$Pr(\text{ hospital admission on day } t \text{ given covariates } X) = r_0(t) R_{ik,}$$

where $R_{ik} = \exp(\beta' X_{ik})$ is the estimated relative risk for patient i in facility k obtained from the stage I. In our computation, we assume the baseline to be a step function with 6 unknown parameters, $\alpha_1, \ldots, \alpha_6$, to estimate. These estimates are used to compute the expected number of admissions given a patient's characteristics.

Specifically, let t_{iks} represent the number of days that patient i from facility k is under observation in the s^{th} time interval with estimated rate α_s. The corresponding expected number of hospital admissions in the s^{th} interval for this patient is calculated as

$$E_{iks} = \alpha_s t_{iks} R_{ik} .$$

It should be noted that t_{iks} and hence E_{iks} can be 0 if patient i from facility k is never at risk during the s^{th} time interval. Summing the E_{iks} over all 6 intervals and all N_k patients in facility k gives

$$\text{Exp} = \sum_{i=1}^{N_k} \sum_{s=1}^{6} E_{iks} = \sum_{i=1}^{N_k} \sum_{s=1}^{6} \alpha_s t_{iks} R_{ik} ,$$

which is the expected number of hospital admissions during follow-up at that facility.

Let Obs be the observed total number of hospital admissions at this facility. The SHR for hospital admissions is the ratio of the observed total admissions to this expected value, or

$$\text{SHR} = \text{Obs/Exp}$$

S.15. Detailed risk model specifications

Model Coefficients, Data Years 2010–2013.

Covariate	Coefficient	P-value
Comorbidities at start of ESRD		
At least one of the comorbidities listed below	0.08624	<.0001
Atherosclerotic heart disease	0.04999	<.0001
Other cardiac disease	0.04395	<.0001
Diabetes*	-0.02026	<.0001
Congestive heart failure	0.04269	<.0001
Inability to ambulate	0.02042	<.0001
Chronic obstructive pulmonary disease	0.05646	<.0001
Inability to transfer	0.02401	<.0001
Malignant neoplasm, cancer	0.04102	<.0001
Peripheral vascular disease	0.04104	<.0001
Cerebrovascular disease, CVA, TIA	0.01904	<.0001
Tobacco use (current smoker)	0.08539	<.0001
Alcohol dependence	0.01285	0.036
Drug dependence	0.17361	<.0001
No Medical Evidence (CMS-2728) Form	0.15316	<.0001
Cause of ESRD		
Diabetes	0.03848	<.0001
Missing	-0.03547	<.0001
Sex: Female	0.07156	<.0001
Age		
0-14	0.48884	<.0001
15-24	0.13135	<.0001
25-44	-0.0678	<.0001
45-59	-0.065	<.0001
60-74	Reference	
75+	0.10178	<.0001
BMI		
Log BMI	-0.15032	<.0001
BMI missing	0.01656	0.0002
Calendar year		
2010	Reference	
2011	-0.02546	<.0001
2012	-0.12676	<.0001
2013	-0.16265	<.0001
In nursing home the previous year	0.20788	<.0001

Diabetes as cause of ESRD X time on ESRD interaction term		
91 days-6 months	Reference	
6 months-1 year	0.03417	<.0001
1-2 years	0.01166	0.0737
2-3 years	0.00139	0.8356
3-5 years	-0.01549	0.0147
5+ years	-0.06398	<.0001
Cause of ESRD: diabetes X sex: female interaction term	-0.02622	<.0001
Age X diabetes as cause of ESRD interaction term		
0-14	-0.93749	<.0001
15-24	0.16727	<.0001
25-44	0.15502	<.0001
45-59	0.05013	<.0001
60-74	Reference	
75+	-0.03426	<.0001
Age X female sex interaction term		
0-14	-0.13038	0.0002
15-24	0.24562	<.0001
25-44	0.12877	<.0001
45-59	0.03139	<.0001
60-74	Reference	
75+	-0.00664	0.0685

*The diabetes indicator includes all diabetes comorbidities on CMS-2728 and diabetes as cause of ESRD

Prevalent Comorbidity Coefficients, Data Years 2010–2013

ICD-9 Description	ICD-9 Code	Coefficient	P-value
Sarcoidosis	135	0.0624	<.0001
Malign neopl prostate	185	-0.03133	<.0001
Malign neopl thyroid	193	-0.04837	0.0087
Oth severe malnutrition	262	0.0382	<.0001
Chr airway obstruct NEC	496	0.1908	<.0001
Postinflam pulm fibrosis	515	0.11769	<.0001
Malignant neopl rectum	1541	0.1335	<.0001
Mal neo liver, primary	1550	0.12225	<.0001
Mal neo upper lobe lung	1623	0.08088	<.0001
Mal neo bronch/lung NOS	1629	0.13617	<.0001

Malig neo bladder NOS	1889	0.10792	<.0001
Malig neopl kidney	1890	0.02548	0.0004
Secondary malig neo lung	1970	0.17282	<.0001
Second malig neo liver	1977	0.38071	<.0001
Secondary malig neo bone	1985	0.29043	<.0001
Malignant neoplasm NOS	1991	0.13518	<.0001
Protein-cal malnutr NOS	2639	0.10345	<.0001
Dis urea cycle metabol	2706	0.06036	0.0002
Senile dementia uncomp	2900	-0.02563	0.0001
Drug withdrawal	2920	0.26748	<.0001
Mental disor NEC oth dis	2948	0.04058	<.0001
Cereb degeneration NOS	3319	0.08582	<.0001
Aut neuropthy in oth dis	3371	0.02621	<.0001
Grand mal status	3453	0.01548	0.1722
Anoxic brain damage	3481	-0.03408	0.0008
Cerebral edema	3485	0.09181	<.0001
Idio periph neurpthy NOS	3569	0.09859	<.0001
Neuropathy in diabetes	3572	0.04133	<.0001
Intermed coronary synd	4111	0.2052	<.0001
Angina pectoris NEC/NOS	4139	0.12568	<.0001
Prim pulm hypertension	4160	-0.01251	0.0316
Chr pulmon heart dis NEC	4168	0.15189	<.0001
Prim cardiomyopathy NEC	4254	0.16394	<.0001
Cardiomyopath in oth dis	4258	0.16331	<.0001
Atriovent block complete	4260	0.02671	0.0001
Parox ventric tachycard	4271	0.09607	<.0001
Parox tachycardia NOS	4272	0.06145	<.0001
Subdural hemorrhage	4321	0.03408	0.0004
Aortic atherosclerosis	4400	0.09852	<.0001
Lower extremity aneurysm	4423	0.10898	<.0001
Periph vascular dis NOS	4439	0.09731	<.0001
Stricture of artery	4471	0.00238	0.6534
Oth inf vena cava thromb	4532	0.2153	<.0001
Emphysema NEC	4928	0.05787	<.0001
Bronchiectas w/o ac exac	4940	0.06175	<.0001
Food/vomit pneumonitis	5070	0.05726	<.0001
Lung involv in oth dis	5178	0.17403	<.0001
Regional enteritis NOS	5559	0.17154	<.0001
Ulceratve colitis unspcf	5569	0.06821	<.0001
Chr vasc insuff intest	5571	0.15765	<.0001
Paralytic ileus	5601	0.10245	<.0001
Intestinal obstruct NOS	5609	0.10671	<.0001
Alcohol cirrhosis liver	5712	0.05621	<.0001
Cirrhosis of liver NOS	5715	0.20344	<.0001

Hepatic encephalopathy	5722	0.17945	<.0001
Portal hypertension	5723	0.20086	<.0001
Oth sequela, chr liv dis	5728	0.14523	<.0001
Chronic pancreatitis	5771	0.38153	<.0001
Chronic skin ulcer NEC	7078	0.07843	<.0001
Syst lupus erythematosus	7100	0.24781	<.0001
Systemic sclerosis	7101	0.12899	<.0001
Rheumatoid arthritis	7140	0.10921	<.0001
Inflamm polyarthrop NOS	7149	0.02641	0.1369
Sacroiliitis NEC	7202	0.16649	<.0001
Gangrene	7854	0.05466	<.0001
Cachexia	7994	0.14375	<.0001
Fracture of pubis-closed	8082	0.06248	<.0001
Pelvic fracture NOS-clos	8088	-0.01048	0.4819
Fx neck of femur NOS-cl	8208	-0.02685	<.0001
Amput below knee, unilat	8970	-0.10393	<.0001
Amputat bk, unilat-compl	8971	-0.10582	<.0001
Amput above knee, unilat	8972	-0.08573	<.0001
Amputat leg, unilat NOS	8974	-0.077	<.0001
Candidal esophagitis	11284	0.1985	<.0001
Oth lymp unsp xtrndl org	20280	0.14363	<.0001
Mult mye w/o achv rmson	20300	0.19204	<.0001
Ch lym leuk wo achv rmsn	20410	0.25565	<.0001
Essntial thrombocythemia	23871	0.10421	<.0001
Low grde myelody syn les	23872	0.14376	<.0001
Myelodysplastic synd NOS	23875	0.17806	<.0001
DMII wo cmp nt st uncntr	25000	0.11986	<.0001
DMII wo cmp uncntrld	25002	0.02111	<.0001
DMII keto nt st uncntrld	25010	0.03729	<.0001
DMII ketoacd uncontrold	25012	0.13424	<.0001
DMI ketoacd uncontrold	25013	0.25355	<.0001
DMII hprosmlr uncontrold	25022	0.12376	<.0001
DMII renl nt st uncntrld	25040	0.0746	<.0001
DMI renl nt st uncntrld	25041	0.04644	<.0001
DMII ophth nt st uncntrl	25050	0.00743	0.0064
DMI ophth uncntrld	25053	0.05823	<.0001
DMII neuro nt st uncntrl	25060	0.05824	<.0001
DMI neuro nt st uncntrld	25061	0.04909	<.0001
DMII neuro uncntrld	25062	0.07612	<.0001
DMI neuro uncntrld	25063	0.13715	<.0001
DMII circ nt st uncntrld	25070	-0.04017	<.0001
DMI circ nt st uncntrld	25071	-0.05298	<.0001
DMII circ uncntrld	25072	-0.02251	<.0001
DMII oth nt st uncntrld	25080	0.08205	<.0001

DMI oth nt st uncntrld	25081	0.02286	0.0002
DMII oth uncntrld	25082	0.03781	<.0001
DMI oth uncntrld	25083	0.00729	0.3939
Glucocorticoid deficient	25541	0.17576	<.0001
Amyloidosis NEC	27739	0.15827	<.0001
Metabolism disorder NEC	27789	0.21983	<.0001
Morbid obesity	27801	0.07927	<.0001
Obesity hypovent synd	27803	-0.05432	<.0001
Sickle cell disease NOS	28260	0.71791	<.0001
Antin chemo indcd pancyt	28411	0.10449	0.0005
Other pancytopenia	28419	0.1945	<.0001
Neutropenia NOS	28800	0.16551	<.0001
Drug induced neutropenia	28803	0.14431	<.0001
Prim hypercoagulable st	28981	0.18562	<.0001
Senile delusion	29020	-0.11382	<.0001
Vascular dementia,uncomp	29040	-0.00174	0.8249
Dementia w/o behav dist	29410	0.01212	0.0613
Dementia w behavior dist	29411	-0.02334	0.0177
Demen NOS w/o behv dstrb	29420	0.04516	<.0001
Schizophrenia NOS-unspec	29590	0.15532	<.0001
Depress psychosis-unspec	29620	0.17524	<.0001
Recurr depr psychos-unsp	29630	0.08526	<.0001
Recur depr psych-severe	29633	0.07789	<.0001
Bipolar disorder NOS	29680	0.19198	<.0001
Bipolar disorder NEC	29689	0.08524	<.0001
Episodic mood disord NOS	29690	0.07786	<.0001
Alcoh dep NEC/NOS-unspec	30390	0.16788	<.0001
Alcoh dep NEC/NOS-remiss	30393	0.07322	<.0001
Opioid dependence-unspec	30400	0.25245	<.0001
Opioid dependence-contin	30401	0.18003	<.0001
Drug depend NOS-unspec	30490	0.27902	<.0001
Psymotr epil w/o int epi	34540	-0.08114	<.0001
Epilep NOS w/o intr epil	34590	0.19176	<.0001
Critical illness myopthy	35981	-0.09196	<.0001
Prolif diab retinopathy	36202	-0.08631	<.0001
Mod nonprolf db retinoph	36205	-0.07697	<.0001
Diabetic macular edema	36207	-0.0601	<.0001
Hyp ht dis NOS w ht fail	40291	0.03839	<.0001
Subendo infarct, initial	41071	0.18348	<.0001
AMI NEC, unspecified	41080	0.03986	0.0367
AMI NOS, unspecified	41090	-0.03149	<.0001
Ac ischemic hrt dis NEC	41189	0.11644	<.0001
Pulm embol/infarct NEC	41519	0.13237	<.0001
Atrial fibrillation	42731	0.13302	<.0001

Atrial flutter	42732	0.08346	<.0001
Sinoatrial node dysfunct	42781	-0.00923	0.0206
Crbl emblsm w infrct	43411	0.01754	0.0772
Crbl art ocl NOS w infrc	43491	0.07113	<.0001
Athscl extrm ntv art NOS	44020	0.00141	0.6632
Ath ext ntv at w claudct	44021	0.04379	<.0001
Ath ext ntv at w rst pn	44022	0.09607	<.0001
Ath ext ntv art ulcrtion	44023	0.02268	<.0001
Dsct of thoracic aorta	44101	0.23712	<.0001
Periph vascular dis NEC	44389	0.01881	0.0012
Deep phlebitis-leg NEC	45119	0.00269	0.7906
Ac DVT/emb prox low ext	45341	0.12676	<.0001
Ch DVT/embl low ext NOS	45350	0.12558	<.0001
Ch DVT/embl prox low ext	45351	0.09937	<.0001
Ch emblsm subclav veins	45375	0.17741	<.0001
Ac DVT/embl up ext	45382	0.08862	<.0001
Ac emblsm axillary veins	45384	0.10835	<.0001
Ac embl internl jug vein	45386	0.16307	<.0001
Ac embl thorac vein NEC	45387	0.13445	<.0001
Esoph varice oth dis NOS	45621	0.19764	<.0001
Obs chr bronc w(ac) exac	49121	0.16393	<.0001
Obs chr bronc w ac bronc	49122	0.11419	<.0001
Chronic obst asthma NOS	49320	0.10527	<.0001
Ch obst asth w (ac) exac	49322	0.10999	<.0001
Ac resp flr fol trma/srg	51851	-0.04255	0.0003
Ot pul insuf fol trm/srg	51852	-0.0827	0.0003
Other pulmonary insuff	51882	0.13098	<.0001
Chronic respiratory fail	51883	0.0293	<.0001
Acute & chronc resp fail	51884	0.02507	<.0001
Gastrostomy comp - mech	53642	0.10042	<.0001
Fecal impaction	56032	0.09744	<.0001
Pressure ulcer, low back	70703	0.0362	<.0001
Pressure ulcer, hip	70704	0.09173	<.0001
Pressure ulcer, buttock	70705	0.00396	0.4043
Ulcer of lower limb NOS	70710	0.01138	0.0098
Ulcer other part of foot	70715	0.04066	<.0001
Ulcer oth part low limb	70719	0.03358	<.0001
Pyogen arthritis-unspec	71100	0.03922	0.0151
Pyogen arthritis-l/leg	71106	0.11218	<.0001
Ac osteomyelitis-unspec	73000	-0.04005	0.0005
Ac osteomyelitis-ankle	73007	-0.03799	<.0001
Ac osteomyelitis NEC	73008	-0.01851	0.102
Osteomyelitis NOS-hand	73024	0.05835	0.0001
Osteomyelitis NOS-ankle	73027	-0.03107	<.0001

Path fx vertebrae	73313	0.1329	<.0001
Aseptic necrosis femur	73342	0.20291	<.0001
Asept necrosis bone NEC	73349	0.17431	<.0001
Coma	78001	0.02143	0.1083
Convulsions NEC	78039	0.10277	<.0001
Fx femur intrcaps NEC-cl	82009	0.03652	0.0079
Fx femur NOS-closed	82100	-0.05632	<.0001
React-indwell urin cath	99664	0.15093	<.0001
Compl heart transplant	99683	0.02305	0.3552
Asymp hiv infectn status	V08	0.37403	<.0001
Heart transplant status	V421	0.26702	<.0001
Liver transplant status	V427	0.16234	<.0001
Trnspl status-pancreas	V4283	0.14978	<.0001
Gastrostomy status	V441	0.02184	0.0173
Ileostomy status	V442	0.12312	<.0001
Colostomy status	V443	0.13378	<.0001
Urinostomy status NEC	V446	0.33981	<.0001
Respirator depend status	V4611	-0.02597	0.001
Status amput othr toe(s)	V4972	0.031	<.0001
Status amput below knee	V4975	0.02473	<.0001
Status amput above knee	V4976	0.01774	0.0036
Atten to gastrostomy	V551	-0.03053	0.0012
Long-term use of insulin	V5867	0.12534	<.0001
BMI 40.0-44.9, adult	V8541	0.03116	<.0001
Less than 6 months of Medicare eligible claims in the previous calendar year		0.73799	<.0001

ICD-9 to 10 Mapping: Adjustments

ICD9DX	ICD9::ICD9DX_desc	ICD10CM	ICD10::ICD10CM_desc
11284	Candidal esophagitis	B3781	B3781 Candidal esophagitis
135	Sarcoidosis	D869	D869 Sarcoidosis, unspecified
1541	Malignant neoplasm of rectum	C20	C20 Malignant neoplasm of rectum
1550	Malignant neoplasm of liver, primary	C220	C220 Liver cell carcinoma
1550	Malignant neoplasm of liver, primary	C222	C222 Hepatoblastoma
1550	Malignant neoplasm of liver, primary	C227	C227 Other specified carcinomas of liver
1550	Malignant neoplasm of liver, primary	C228	C228 Malignant neoplasm of liver, primary, unspecified as to type
1623	Malignant neoplasm of upper lobe, bronchus or lun	C3410	C3410 Malignant neoplasm of upper lobe, unspecified bronchus or lung
1629	Malignant neoplasm of bronchus and lung, unspecif	C3490	C3490 Malignant neoplasm of unspecified part of unspecified bronchus or lung
185	Malignant neoplasm of prostate	C61	C61 Malignant neoplasm of prostate
1889	Malignant neoplasm of bladder, part unspecified	C679	C679 Malignant neoplasm of bladder, unspecified
1890	Malignant neoplasm of kidney, except pelvis	C649	C649 Malignant neoplasm of unspecified kidney, except renal pelvis
193	Malignant neoplasm of thyroid gland	C73	C73 Malignant neoplasm of thyroid gland
1970	Secondary malignant neoplasm of lung	C7800	C7800 Secondary malignant neoplasm of unspecified lung
1977	Malignant neoplasm of liver, secondary	C787	C787 Secondary malignant neoplasm of liver and intrahepatic bile duct
1985	Secondary malignant neoplasm of bone and bone m	C7951	C7951 Secondary malignant neoplasm of bone
1985	Secondary malignant neoplasm of bone and bone m	C7952	C7952 Secondary malignant neoplasm of bone marrow
1991	Other malignant neoplasm without specification of	C801	C801 Malignant (primary) neoplasm, unspecified
20280	Other malignant lymphomas, unspecified site, extra	C8580	C8580 Other specified types of non-Hodgkin lymphoma, unspecified site
20280	Other malignant lymphomas, unspecified site, extra	C8589	C8589 Other specified types of non-Hodgkin lymphoma, extranodal and solid organ sites
20300	Multiple myeloma, without mention of having achie	C9000	C9000 Multiple myeloma not having achieved remission
20410	Chronic lymphoid leukemia, without mention of hav	C9110	C9110 Chronic lymphocytic leukemia of B-cell type not having achieved remission
23871	Essential thrombocythemia	D473	D473 Essential (hemorrhagic) thrombocythemia
23872	Low grade myelodysplastic syndrome lesions	D460	D460 Refractory anemia without ring sideroblasts, so stated
23872	Low grade myelodysplastic syndrome lesions	D461	D461 Refractory anemia with ring sideroblasts
23872	Low grade myelodysplastic syndrome lesions	D4620	D4620 Refractory anemia with excess of blasts, unspecified
23872	Low grade myelodysplastic syndrome lesions	D4621	D4621 Refractory anemia with excess of blasts 1
23872	Low grade myelodysplastic syndrome lesions	D46A	D46A Refractory cytopenia with multilineage dysplasia
23872	Low grade myelodysplastic syndrome lesions	D46B	D46B Refractory cytopenia with multilineage dysplasia and ring sideroblasts
23875	Myelodysplastic syndrome, unspecified	D469	D469 Myelodysplastic syndrome, unspecified
25000	Diabetes mellitus without mention of complication,	E119	E119 Type 2 diabetes mellitus without complications
25002	Diabetes mellitus without mention of complication,	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25010	Diabetes with ketoacidosis, type II or unspecified ty	E1169	E1169 Type 2 diabetes mellitus with other specified complication
25010	Diabetes with ketoacidosis, type II or unspecified ty	E1310	E1310 Other specified diabetes mellitus with ketoacidosis without coma
25012	Diabetes with ketoacidosis, type II or unspecified ty	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25012	Diabetes with ketoacidosis, type II or unspecified ty	E1169	E1169 Type 2 diabetes mellitus with other specified complication
25012	Diabetes with ketoacidosis, type II or unspecified ty	E1310	E1310 Other specified diabetes mellitus with ketoacidosis without coma
25013	Diabetes with ketoacidosis, type I [juvenile type], ur	E1010	E1010 Type 1 diabetes mellitus with ketoacidosis without coma
25013	Diabetes with ketoacidosis, type I [juvenile type], ur	E1065	E1065 Type 1 diabetes mellitus with hyperglycemia
25022	Diabetes with hyperosmolarity, type II or unspecifie	E1100	E1100 Type 2 diabetes mellitus with hyperosmolarity without nonketotic hyperglycemic-hyperosmolar com
25022	Diabetes with hyperosmolarity, type II or unspecifie	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25040	Diabetes with renal manifestations, type II or unspe	E1129	E1129 Type 2 diabetes mellitus with other diabetic kidney complication
25041	Diabetes with renal manifestations, type I [juvenile t	E1029	E1029 Type 1 diabetes mellitus with other diabetic kidney complication
25050	Diabetes with ophthalmic manifestations, type II or	E11311	E11311 Type 2 diabetes mellitus with unspecified diabetic retinopathy with macular edema
25050	Diabetes with ophthalmic manifestations, type II or	E11319	E11319 Type 2 diabetes mellitus with unspecified diabetic retinopathy without macular edema
25050	Diabetes with ophthalmic manifestations, type II or	E1136	E1136 Type 2 diabetes mellitus with diabetic cataract
25050	Diabetes with ophthalmic manifestations, type II or	E1139	E1139 Type 2 diabetes mellitus with other diabetic ophthalmic complication
25053	Diabetes with ophthalmic manifestations, type I [juv	E10311	E10311 Type 1 diabetes mellitus with unspecified diabetic retinopathy with macular edema
25053	Diabetes with ophthalmic manifestations, type I [juv	E10319	E10319 Type 1 diabetes mellitus with unspecified diabetic retinopathy without macular edema
25053	Diabetes with ophthalmic manifestations, type I [juv	E1036	E1036 Type 1 diabetes mellitus with diabetic cataract
25053	Diabetes with ophthalmic manifestations, type I [juv	E1039	E1039 Type 1 diabetes mellitus with other diabetic ophthalmic complication
25053	Diabetes with ophthalmic manifestations, type I [juv	E1065	E1065 Type 1 diabetes mellitus with hyperglycemia
25060	Diabetes with neurological manifestations, type II or	E1140	E1140 Type 2 diabetes mellitus with diabetic neuropathy, unspecified
25061	Diabetes with neurological manifestations, type I [ju	E1040	E1040 Type 1 diabetes mellitus with diabetic neuropathy, unspecified
25062	Diabetes with neurological manifestations, type II or	E1140	E1140 Type 2 diabetes mellitus with diabetic neuropathy, unspecified
25062	Diabetes with neurological manifestations, type II or	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25063	Diabetes with neurological manifestations, type I [ju	E1040	E1040 Type 1 diabetes mellitus with diabetic neuropathy, unspecified
25063	Diabetes with neurological manifestations, type I [ju	E1065	E1065 Type 1 diabetes mellitus with hyperglycemia
25070	Diabetes with peripheral circulatory disorders, type	E1151	E1151 Type 2 diabetes mellitus with diabetic peripheral angiopathy without gangrene
25071	Diabetes with peripheral circulatory disorders, type	E1051	E1051 Type 1 diabetes mellitus with diabetic peripheral angiopathy without gangrene
25072	Diabetes with peripheral circulatory disorders, type	E1151	E1151 Type 2 diabetes mellitus with diabetic peripheral angiopathy without gangrene
25072	Diabetes with peripheral circulatory disorders, type	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25080	Diabetes with other specified manifestations, type I	E11618	E11618 Type 2 diabetes mellitus with other diabetic arthropathy
25080	Diabetes with other specified manifestations, type I	E11620	E11620 Type 2 diabetes mellitus with diabetic dermatitis
25080	Diabetes with other specified manifestations, type I	E11621	E11621 Type 2 diabetes mellitus with foot ulcer
25080	Diabetes with other specified manifestations, type I	E11622	E11622 Type 2 diabetes mellitus with other skin ulcer
25080	Diabetes with other specified manifestations, type I	E11628	E11628 Type 2 diabetes mellitus with other skin complications
25080	Diabetes with other specified manifestations, type I	E11630	E11630 Type 2 diabetes mellitus with periodontal disease
25080	Diabetes with other specified manifestations, type I	E11638	E11638 Type 2 diabetes mellitus with other oral complications
25080	Diabetes with other specified manifestations, type I	E11649	E11649 Type 2 diabetes mellitus with hypoglycemia without coma
25080	Diabetes with other specified manifestations, type I	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25080	Diabetes with other specified manifestations, type I	E1169	E1169 Type 2 diabetes mellitus with other specified complication
25081	Diabetes with other specified manifestations, type I	E10618	E10618 Type 1 diabetes mellitus with other diabetic arthropathy
25081	Diabetes with other specified manifestations, type I	E10620	E10620 Type 1 diabetes mellitus with diabetic dermatitis
25081	Diabetes with other specified manifestations, type I	E10621	E10621 Type 1 diabetes mellitus with foot ulcer
25081	Diabetes with other specified manifestations, type I	E10622	E10622 Type 1 diabetes mellitus with other skin ulcer
25081	Diabetes with other specified manifestations, type I	E10628	E10628 Type 1 diabetes mellitus with other skin complications
25081	Diabetes with other specified manifestations, type I	E10630	E10630 Type 1 diabetes mellitus with periodontal disease
25081	Diabetes with other specified manifestations, type I	E10638	E10638 Type 1 diabetes mellitus with other oral complications
25081	Diabetes with other specified manifestations, type I	E10649	E10649 Type 1 diabetes mellitus with hypoglycemia without coma
25081	Diabetes with other specified manifestations, type I	E1065	E1065 Type 1 diabetes mellitus with hyperglycemia
25081	Diabetes with other specified manifestations, type I	E1069	E1069 Type 1 diabetes mellitus with other specified complication
25082	Diabetes with other specified manifestations, type I	E1165	E1165 Type 2 diabetes mellitus with hyperglycemia
25082	Diabetes with other specified manifestations, type I	E1169	E1169 Type 2 diabetes mellitus with other specified complication
25083	Diabetes with other specified manifestations, type I	E1065	E1065 Type 1 diabetes mellitus with hyperglycemia
25083	Diabetes with other specified manifestations, type I	E1069	E1069 Type 1 diabetes mellitus with other specified complication
25541	Glucocorticoid deficiency	E271	E271 Primary adrenocortical insufficiency

25541	Glucocorticoid deficiency	E272	E272 Addisonian crisis
25541	Glucocorticoid deficiency	E2740	E2740 Unspecified adrenocortical insufficiency
262	Other severe protein-calorie malnutrition	E43	E43 Unspecified severe protein-calorie malnutrition
2639	Unspecified protein-calorie malnutrition	E46	E46 Unspecified protein-calorie malnutrition
2706	Disorders of urea cycle metabolism	E7220	E7220 Disorder of urea cycle metabolism, unspecified
2706	Disorders of urea cycle metabolism	E7222	E7222 Arginosuccinic aciduria
2706	Disorders of urea cycle metabolism	E7223	E7223 Citrullinemia
2706	Disorders of urea cycle metabolism	E7229	E7229 Other disorders of urea cycle metabolism
27739	Other amyloidosis	E851	E851 Neuropathic heredofamilial amyloidosis
27739	Other amyloidosis	E853	E853 Secondary systemic amyloidosis
27739	Other amyloidosis	E858	E858 Other amyloidosis
27789	Other specified disorders of metabolism	C965	C965 Multifocal and unisystemic Langerhans-cell histiocytosis
27789	Other specified disorders of metabolism	C966	C966 Unifocal Langerhans-cell histiocytosis
27789	Other specified disorders of metabolism	E7139	E7139 Other disorders of fatty-acid metabolism
27789	Other specified disorders of metabolism	E803	E803 Defects of catalase and peroxidase
27789	Other specified disorders of metabolism	E8889	E8889 Other specified metabolic disorders
27789	Other specified disorders of metabolism	E889	E889 Metabolic disorder, unspecified
27801	Morbid obesity	E6601	E6601 Morbid (severe) obesity due to excess calories
27803	Obesity hypoventilation syndrome	E662	E662 Morbid (severe) obesity with alveolar hypoventilation
28260	Sickle-cell disease, unspecified	D571	D571 Sickle-cell disease without crisis
28411	Antineoplastic chemotherapy induced pancytopenia	D61810	D61810 Antineoplastic chemotherapy induced pancytopenia
28419	Other pancytopenia	D61818	D61818 Other pancytopenia
28800	Neutropenia, unspecified	D709	D709 Neutropenia, unspecified
28803	Drug induced neutropenia	D701	D701 Agranulocytosis secondary to cancer chemotherapy
28803	Drug induced neutropenia	D702	D702 Other drug-induced agranulocytosis
28981	Primary hypercoagulable state	D6851	D6851 Activated protein C resistance
28981	Primary hypercoagulable state	D6852	D6852 Prothrombin gene mutation
28981	Primary hypercoagulable state	D6859	D6859 Other primary thrombophilia
28981	Primary hypercoagulable state	D6861	D6861 Antiphospholipid syndrome
28981	Primary hypercoagulable state	D6862	D6862 Lupus anticoagulant syndrome
2900	Senile dementia, uncomplicated	F0390	F0390 Unspecified dementia without behavioral disturbance
29020	Senile dementia with delusional features	F0390	F0390 Unspecified dementia without behavioral disturbance
29020	Senile dementia with delusional features	F05	F05 Delirium due to known physiological condition
29040	Vascular dementia, uncomplicated	F0150	F0150 Vascular dementia without behavioral disturbance
2920	Drug withdrawal	F19939	F19939 Other psychoactive substance use, unspecified with withdrawal, unspecified
29410	Dementia in conditions classified elsewhere without	F0280	F0280 Dementia in other diseases classified elsewhere without behavioral disturbance
29411	Dementia in conditions classified elsewhere with be	F0281	F0281 Dementia in other diseases classified elsewhere with behavioral disturbance
29420	Dementia, unspecified, without behavioral disturba	F0390	F0390 Unspecified dementia without behavioral disturbance
2948	Other persistent mental disorders due to conditions	F060	F060 Psychotic disorder with hallucinations due to known physiological condition
2948	Other persistent mental disorders due to conditions	F068	F068 Other specified mental disorders due to known physiological condition
29590	Unspecified schizophrenia, unspecified	F209	F209 Schizophrenia, unspecified
29620	Major depressive affective disorder, single episode,	F329	F329 Major depressive disorder, single episode, unspecified
29630	Major depressive affective disorder, recurrent episc	F339	F339 Major depressive disorder, recurrent, unspecified
29633	Major depressive affective disorder, recurrent episc	F332	F332 Major depressive disorder, recurrent severe without psychotic features
29680	Bipolar disorder, unspecified	F319	F319 Bipolar disorder, unspecified
29689	Other bipolar disorders	F3181	F3181 Bipolar II disorder
29690	Unspecified episodic mood disorder	F39	F39 Unspecified mood [affective] disorder
30390	Other and unspecified alcohol dependence, unspeci	F1020	F1020 Alcohol dependence, uncomplicated
30393	Other and unspecified alcohol dependence, in remis	F1021	F1021 Alcohol dependence, in remission
30400	Opioid type dependence, unspecified	F1120	F1120 Opioid dependence, uncomplicated
30401	Opioid type dependence, continuous	F1120	F1120 Opioid dependence, uncomplicated
30490	Unspecified drug dependence, unspecified	F1920	F1920 Other psychoactive substance dependence, uncomplicated
3319	Cerebral degeneration, unspecified	G319	G319 Degenerative disease of nervous system, unspecified
3371	Peripheral autonomic neuropathy in disorders classi	G990	G990 Autonomic neuropathy in diseases classified elsewhere
3453	Grand mal status	G40301	G40301 Generalized idiopathic epilepsy and epileptic syndromes, not intractable, with status epilepticus
34540	Localization-related (focal) (partial) epilepsy and epi	G40201	G40201 Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex pa
34540	Localization-related (focal) (partial) epilepsy and epi	G40209	G40209 Localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with complex pa
34590	Epilepsy, unspecified, without mention of intractabl	G40901	G40901 Epilepsy, unspecified, not intractable, with status epilepticus
34590	Epilepsy, unspecified, without mention of intractabl	G40909	G40909 Epilepsy, unspecified, not intractable, without status epilepticus
3481	Anoxic brain damage	G931	G931 Anoxic brain damage, not elsewhere classified
3485	Cerebral edema	G936	G936 Cerebral edema
3569	Unspecified hereditary and idiopathic peripheral ne	G609	G609 Hereditary and idiopathic neuropathy, unspecified
3572	Polyneuropathy in diabetes	E0842	E0842 Diabetes mellitus due to underlying condition with diabetic polyneuropathy
3572	Polyneuropathy in diabetes	E0942	E0942 Drug or chemical induced diabetes mellitus with neurological complications with diabetic polyneurop
3572	Polyneuropathy in diabetes	E1042	E1042 Type 1 diabetes mellitus with diabetic polyneuropathy
3572	Polyneuropathy in diabetes	E1142	E1142 Type 2 diabetes mellitus with diabetic polyneuropathy
3572	Polyneuropathy in diabetes	E1342	E1342 Other specified diabetes mellitus with diabetic polyneuropathy
35981	Critical illness myopathy	G7281	G7281 Critical illness myopathy
36202	Proliferative diabetic retinopathy	E11359	E11359 Type 2 diabetes mellitus with proliferative diabetic retinopathy without macular edema
36205	Moderate nonproliferative diabetic retinopathy	E11339	E11339 Type 2 diabetes mellitus with moderate nonproliferative diabetic retinopathy without macular eden
36207	Diabetic macular edema	E11311	E11311 Type 2 diabetes mellitus with unspecified diabetic retinopathy with macular edema
40291	Unspecified hypertensive heart disease with heart f	I110	I110 Hypertensive heart disease with heart failure
41071	Subendocardial infarction, initial episode of care	I214	I214 Non-ST elevation (NSTEMI) myocardial infarction
41080	Acute myocardial infarction of other specified sites,	I2129	I2129 ST elevation (STEMI) myocardial infarction involving other sites
41090	Acute myocardial infarction of unspecified site, epis	I213	I213 ST elevation (STEMI) myocardial infarction of unspecified site
4111	Intermediate coronary syndrome	I200	I200 Unstable angina
41189	Other acute and subacute forms of ischemic heart d	I248	I248 Other forms of acute ischemic heart disease
4139	Other and unspecified angina pectoris	I208	I208 Other forms of angina pectoris
4139	Other and unspecified angina pectoris	I209	I209 Angina pectoris, unspecified
41519	Other pulmonary embolism and infarction	I2699	I2699 Other pulmonary embolism without acute cor pulmonale
4160	Primary pulmonary hypertension	I270	I270 Primary pulmonary hypertension
4168	Other chronic pulmonary heart diseases	I272	I272 Other secondary pulmonary hypertension
4168	Other chronic pulmonary heart diseases	I2789	I2789 Other specified pulmonary heart diseases
4254	Other primary cardiomyopathies	I425	I425 Other restrictive cardiomyopathy
4254	Other primary cardiomyopathies	I428	I428 Other cardiomyopathies
4258	Cardiomyopathy in other diseases classified elsewhe	I43	I43 Cardiomyopathy in diseases classified elsewhere
4260	Atrioventricular block, complete	I442	I442 Atrioventricular block, complete
4271	Paroxysmal ventricular tachycardia	I472	I472 Ventricular tachycardia
4272	Paroxysmal tachycardia, unspecified	I479	I479 Paroxysmal tachycardia, unspecified
42731	Atrial fibrillation	I4891	I4891 Unspecified atrial fibrillation

42732	Atrial flutter	I4892	I4892 Unspecified atrial flutter
42781	Sinoatrial node dysfunction	I495	I495 Sick sinus syndrome
42781	Sinoatrial node dysfunction	R001	R001 Bradycardia, unspecified
4321	Subdural hemorrhage	I6200	I6200 Nontraumatic subdural hemorrhage, unspecified
43411	Cerebral embolism with cerebral infarction	I6340	I6340 Cerebral infarction due to embolism of unspecified cerebral artery
43491	Cerebral artery occlusion, unspecified with cerebral	I6350	I6350 Cerebral infarction due to unspecified occlusion or stenosis of unspecified cerebral artery
4400	Atherosclerosis of aorta	I700	I700 Atherosclerosis of aorta
44020	Atherosclerosis of native arteries of the extremities,	I70209	I70209 Unspecified atherosclerosis of native arteries of extremities, unspecified extremity
44021	Atherosclerosis of native arteries of the extremities	I70219	I70219 Atherosclerosis of native arteries of extremities with intermittent claudication, unspecified extremity
44022	Atherosclerosis of native arteries of the extremities	I70229	I70229 Atherosclerosis of native arteries of extremities with rest pain, unspecified extremity
44023	Atherosclerosis of native arteries of the extremities	I7025	I7025 Atherosclerosis of native arteries of other extremities with ulceration
44101	Dissection of aorta, thoracic	I7101	I7101 Dissection of thoracic aorta
4423	Aneurysm of artery of lower extremity	I724	I724 Aneurysm of artery of lower extremity
44389	Other specified peripheral vascular diseases	I7389	I7389 Other specified peripheral vascular diseases
4439	Peripheral vascular disease, unspecified	I739	I739 Peripheral vascular disease, unspecified
4471	Stricture of artery	I771	I771 Stricture of artery
45119	Phlebitis and thrombophlebitis of deep veins of low	I80209	I80209 Phlebitis and thrombophlebitis of unspecified deep vessels of unspecified lower extremity
4532	Other venous embolism and thrombosis of inferior v	I82220	I82220 Acute embolism and thrombosis of inferior vena cava
4532	Other venous embolism and thrombosis of inferior v	I82221	I82221 Chronic embolism and thrombosis of inferior vena cava
45341	Acute venous embolism and thrombosis of deep ves	I82419	I82419 Acute embolism and thrombosis of unspecified femoral vein
45341	Acute venous embolism and thrombosis of deep ves	I82429	I82429 Acute embolism and thrombosis of unspecified iliac vein
45341	Acute venous embolism and thrombosis of deep ves	I82439	I82439 Acute embolism and thrombosis of unspecified popliteal vein
45341	Acute venous embolism and thrombosis of deep ves	I824Y9	I824Y9 Acute embolism and thrombosis of unspecified deep veins of unspecified proximal lower extremity
45350	Chronic venous embolism and thrombosis of unspec	I82509	I82509 Chronic embolism and thrombosis of unspecified deep veins of unspecified lower extremity
45350	Chronic venous embolism and thrombosis of unspec	I82599	I82599 Chronic embolism and thrombosis of other specified deep vein of unspecified lower extremity
45351	Chronic venous embolism and thrombosis of deep v	I82519	I82519 Chronic embolism and thrombosis of unspecified femoral vein
45351	Chronic venous embolism and thrombosis of deep v	I82529	I82529 Chronic embolism and thrombosis of unspecified iliac vein
45351	Chronic venous embolism and thrombosis of deep v	I82539	I82539 Chronic embolism and thrombosis of unspecified popliteal vein
45351	Chronic venous embolism and thrombosis of deep v	I825Y9	I825Y9 Chronic embolism and thrombosis of unspecified deep veins of unspecified proximal lower extremity
45375	Chronic venous embolism and thrombosis of subcla	I82B29	I82B29 Chronic embolism and thrombosis of unspecified subclavian vein
45382	Acute venous embolism and thrombosis of deep vei	I82629	I82629 Acute embolism and thrombosis of deep veins of unspecified upper extremity
45384	Acute venous embolism and thrombosis of axillary v	I82A19	I82A19 Acute embolism and thrombosis of unspecified axillary vein
45386	Acute venous embolism and thrombosis of internal	I82C19	I82C19 Acute embolism and thrombosis of unspecified internal jugular vein
45387	Acute venous embolism and thrombosis of other th	I82290	I82290 Acute embolism and thrombosis of other thoracic veins
45621	Esophageal varices in diseases classified elsewhere,	I8510	I8510 Secondary esophageal varices without bleeding
49121	Obstructive chronic bronchitis with (acute) exacerba	J441	J441 Chronic obstructive pulmonary disease with (acute) exacerbation
49122	Obstructive chronic bronchitis with acute bronchitis	J440	J440 Chronic obstructive pulmonary disease with acute lower respiratory infection
4928	Other emphysema	J439	J439 Emphysema, unspecified
49320	Chronic obstructive asthma, unspecified	J449	J449 Chronic obstructive pulmonary disease, unspecified
49322	Chronic obstructive asthma with (acute) exacerbatio	J441	J441 Chronic obstructive pulmonary disease with (acute) exacerbation
4940	Bronchiectasis without acute exacerbation	J479	J479 Bronchiectasis, uncomplicated
496	Chronic airway obstruction, not elsewhere classified	J449	J449 Chronic obstructive pulmonary disease, unspecified
5070	Pneumonitis due to inhalation of food or vomitus	J690	J690 Pneumonitis due to inhalation of food and vomit
515	Postinflammatory pulmonary fibrosis	J8410	J8410 Pulmonary fibrosis, unspecified
515	Postinflammatory pulmonary fibrosis	J8489	J8489 Other specified interstitial pulmonary diseases
5178	Lung involvement in other diseases classified elsewh	J99	J99 Respiratory disorders in diseases classified elsewhere
51851	Acute respiratory failure following trauma and surg	J95821	J95821 Acute postprocedural respiratory failure
51851	Acute respiratory failure following trauma and surg	J9600	J9600 Acute respiratory failure, unspecified whether with hypoxia or hypercapnia
51852	Other pulmonary insufficiency, not elsewhere classi	J951	J951 Acute pulmonary insufficiency following thoracic surgery
51852	Other pulmonary insufficiency, not elsewhere classi	J952	J952 Acute pulmonary insufficiency following nonthoracic surgery
51852	Other pulmonary insufficiency, not elsewhere classi	J953	J953 Chronic pulmonary insufficiency following surgery
51882	Other pulmonary insufficiency, not elsewhere classi	J80	J80 Acute respiratory distress syndrome
51883	Chronic respiratory failure	J9610	J9610 Chronic respiratory failure, unspecified whether with hypoxia or hypercapnia
51884	Acute and chronic respiratory failure	J9620	J9620 Acute and chronic respiratory failure, unspecified whether with hypoxia or hypercapnia
53642	Mechanical complication of gastrostomy	K9423	K9423 Gastrostomy malfunction
5559	Regional enteritis of unspecified site	K5090	K5090 Crohn's disease, unspecified, without complications
5569	Ulcerative colitis, unspecified	K5190	K5190 Ulcerative colitis, unspecified, without complications
5571	Chronic vascular insufficiency of intestine	K551	K551 Chronic vascular disorders of intestine
5601	Paralytic ileus	K560	K560 Paralytic ileus
5601	Paralytic ileus	K567	K567 Ileus, unspecified
56032	Fecal impaction	K5641	K5641 Fecal impaction
5609	Unspecified intestinal obstruction	K5660	K5660 Unspecified intestinal obstruction
5712	Alcoholic cirrhosis of liver	K7030	K7030 Alcoholic cirrhosis of liver without ascites
5715	Cirrhosis of liver without mention of alcohol	K740	K740 Hepatic fibrosis
5715	Cirrhosis of liver without mention of alcohol	K7460	K7460 Unspecified cirrhosis of liver
5715	Cirrhosis of liver without mention of alcohol	K7469	K7469 Other cirrhosis of liver
5722	Hepatic encephalopathy	K7290	K7290 Hepatic failure, unspecified without coma
5722	Hepatic encephalopathy	K7291	K7291 Hepatic failure, unspecified with coma
5723	Portal hypertension	K766	K766 Portal hypertension
5728	Other sequelae of chronic liver disease	K7210	K7210 Chronic hepatic failure without coma
5728	Other sequelae of chronic liver disease	K7290	K7290 Hepatic failure, unspecified without coma
5771	Chronic pancreatitis	K861	K861 Other chronic pancreatitis
70703	Pressure ulcer, lower back	L89139	L89139 Pressure ulcer of right lower back, unspecified stage
70703	Pressure ulcer, lower back	L89149	L89149 Pressure ulcer of left lower back, unspecified stage
70703	Pressure ulcer, lower back	L89159	L89159 Pressure ulcer of sacral region, unspecified stage
70704	Pressure ulcer, hip	L89209	L89209 Pressure ulcer of unspecified hip, unspecified stage
70705	Pressure ulcer, buttock	L89309	L89309 Pressure ulcer of unspecified buttock, unspecified stage
70710	Ulcer of lower limb, unspecified	L97909	L97909 Non-pressure chronic ulcer of unspecified part of unspecified lower leg with unspecified severity
70715	Ulcer of other part of foot	L97509	L97509 Non-pressure chronic ulcer of other part of unspecified foot with unspecified severity
70719	Ulcer of other part of lower limb	L97809	L97809 Non-pressure chronic ulcer of other part of unspecified lower leg with unspecified severity
7078	Chronic ulcer of other specified sites	L98419	L98419 Non-pressure chronic ulcer of buttock with unspecified severity
7078	Chronic ulcer of other specified sites	L98429	L98429 Non-pressure chronic ulcer of back with unspecified severity
7100	Systemic lupus erythematosus	M3210	M3210 Systemic lupus erythematosus, organ or system involvement unspecified
7101	Systemic sclerosis	M340	M340 Progressive systemic sclerosis
7101	Systemic sclerosis	M341	M341 CR(E)ST syndrome
7101	Systemic sclerosis	M349	M349 Systemic sclerosis, unspecified
71100	Pyogenic arthritis, site unspecified	M0000	M0000 Staphylococcal arthritis, unspecified joint
71100	Pyogenic arthritis, site unspecified	M0010	M0010 Pneumococcal arthritis, unspecified joint
71100	Pyogenic arthritis, site unspecified	M0020	M0020 Other streptococcal arthritis, unspecified joint
71100	Pyogenic arthritis, site unspecified	M0080	M0080 Arthritis due to other bacteria, unspecified joint

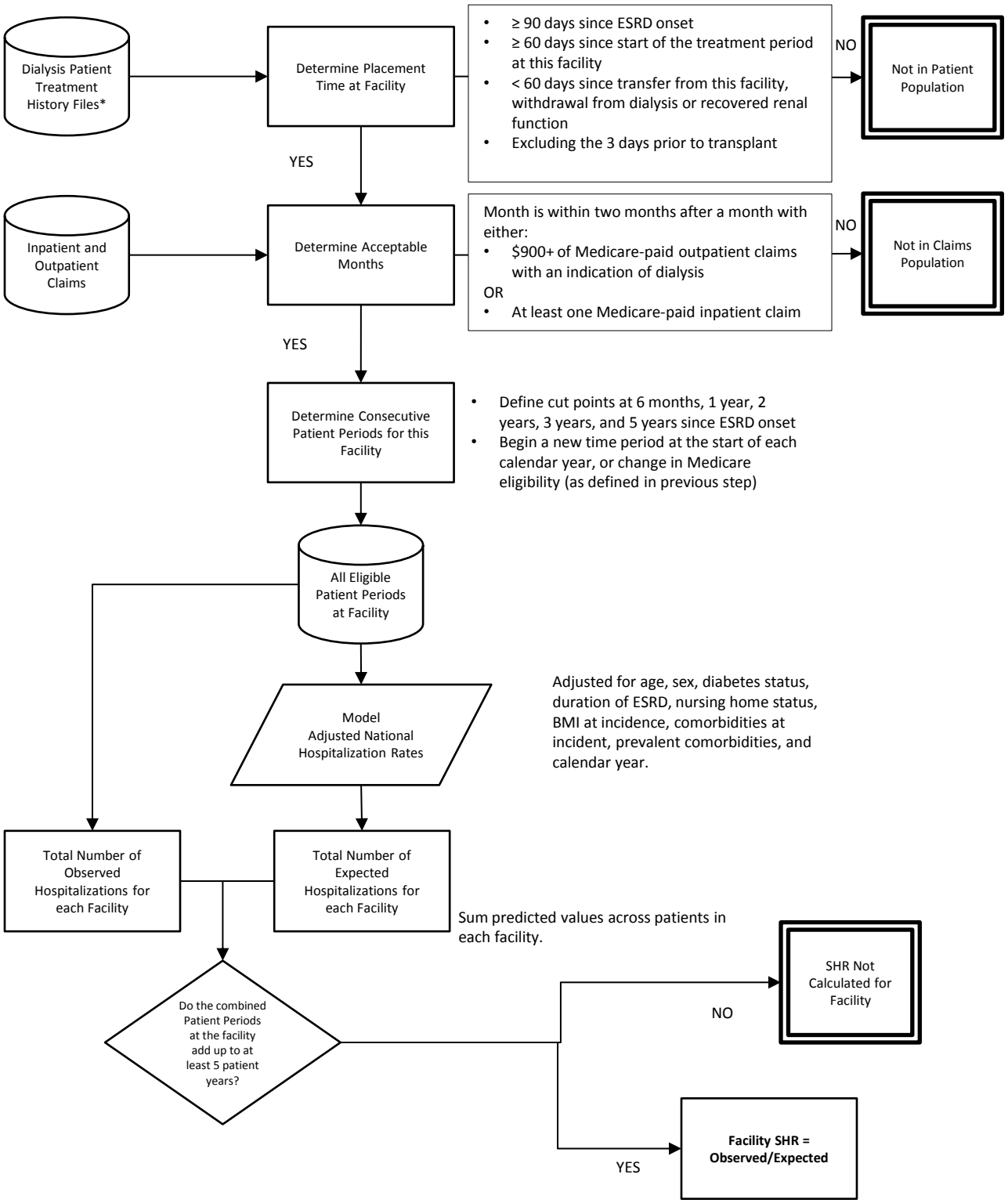
71100	Pyogenic arthritis, site unspecified	M009	M009 Pyogenic arthritis, unspecified
71106	Pyogenic arthritis, lower leg	M00069	M00069 Staphylococcal arthritis, unspecified knee
71106	Pyogenic arthritis, lower leg	M00169	M00169 Pneumococcal arthritis, unspecified knee
71106	Pyogenic arthritis, lower leg	M00269	M00269 Other streptococcal arthritis, unspecified knee
71106	Pyogenic arthritis, lower leg	M00869	M00869 Arthritis due to other bacteria, unspecified knee
7140	Rheumatoid arthritis	M069	M069 Rheumatoid arthritis, unspecified
7149	Unspecified inflammatory polyarthropathy	M064	M064 Inflammatory polyarthropathy
7202	Sacroiliitis, not elsewhere classified	M461	M461 Sacroiliitis, not elsewhere classified
73000	Acute osteomyelitis, site unspecified	M8610	M8610 Other acute osteomyelitis, unspecified site
73000	Acute osteomyelitis, site unspecified	M8620	M8620 Subacute osteomyelitis, unspecified site
73007	Acute osteomyelitis, ankle and foot	M86179	M86179 Other acute osteomyelitis, unspecified ankle and foot
73007	Acute osteomyelitis, ankle and foot	M86279	M86279 Subacute osteomyelitis, unspecified ankle and foot
73008	Acute osteomyelitis, other specified sites	M8618	M8618 Other acute osteomyelitis, other site
73008	Acute osteomyelitis, other specified sites	M8628	M8628 Subacute osteomyelitis, other site
73024	Unspecified osteomyelitis, hand	M869	M869 Osteomyelitis, unspecified
73027	Unspecified osteomyelitis, ankle and foot	M869	M869 Osteomyelitis, unspecified
73313	Pathologic fracture of vertebrae	M4850XA	M4850XA Collapsed vertebra, not elsewhere classified, site unspecified, initial encounter for fracture
73313	Pathologic fracture of vertebrae	M8008XA	M8008XA Age-related osteoporosis with current pathological fracture, vertebra(e), initial encounter for fract
73313	Pathologic fracture of vertebrae	M8448XA	M8448XA Pathological fracture, other site, initial encounter for fracture
73313	Pathologic fracture of vertebrae	M8468XA	M8468XA Pathological fracture in other disease, other site, initial encounter for fracture
73342	Aseptic necrosis of head and neck of femur	M87059	M87059 Idiopathic aseptic necrosis of unspecified femur
73349	Aseptic necrosis of bone, other	M8708	M8708 Idiopathic aseptic necrosis of bone, other site
78001	Coma	R4020	R4020 Unspecified coma
78039	Other convulsions	R569	R569 Unspecified convulsions
7854	Gangrene	I96	I96 Gangrene, not elsewhere classified
7994	Cachexia	R64	R64 Cachexia
8082	Closed fracture of pubis	S32501A	S32501A Unspecified fracture of right pubis, initial encounter for closed fracture
8082	Closed fracture of pubis	S32502A	S32502A Unspecified fracture of left pubis, initial encounter for closed fracture
8082	Closed fracture of pubis	S32509A	S32509A Unspecified fracture of unspecified pubis, initial encounter for closed fracture
8088	Closed unspecified fracture of pelvis	S329XXA	S329XXA Fracture of unspecified parts of lumbosacral spine and pelvis, initial encounter for closed fracture
82009	Other closed transcervical fracture of neck of femur	S72099A	S72099A Other fracture of head and neck of unspecified femur, initial encounter for closed fracture
8208	Closed fracture of unspecified part of neck of femur	S72009A	S72009A Fracture of unspecified part of neck of unspecified femur, initial encounter for closed fracture
82100	Closed fracture of unspecified part of femur	S7290XA	S7290XA Unspecified fracture of unspecified femur, initial encounter for closed fracture
8970	Traumatic amputation of leg(s) (complete) (partial),	S88119A	S88119A Complete traumatic amputation at level between knee and ankle, unspecified lower leg, initial enco
8970	Traumatic amputation of leg(s) (complete) (partial),	S88129A	S88129A Partial traumatic amputation at level between knee and ankle, unspecified lower leg, initial encoun
8971	Traumatic amputation of leg(s) (complete) (partial),	S88119A	S88119A Complete traumatic amputation at level between knee and ankle, unspecified lower leg, initial enco
8971	Traumatic amputation of leg(s) (complete) (partial),	S88129A	S88129A Partial traumatic amputation at level between knee and ankle, unspecified lower leg, initial encoun
8972	Traumatic amputation of leg(s) (complete) (partial),	S78019A	S78019A Complete traumatic amputation at unspecified hip joint, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S78029A	S78029A Partial traumatic amputation at unspecified hip joint, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S78119A	S78119A Complete traumatic amputation at level between unspecified hip and knee, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S78129A	S78129A Partial traumatic amputation at level between unspecified hip and knee, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S78919A	S78919A Complete traumatic amputation of unspecified hip and thigh, level unspecified, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S78929A	S78929A Partial traumatic amputation of unspecified hip and thigh, level unspecified, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S88019A	S88019A Complete traumatic amputation at knee level, unspecified lower leg, initial encounter
8972	Traumatic amputation of leg(s) (complete) (partial),	S88029A	S88029A Partial traumatic amputation at knee level, unspecified lower leg, initial encounter
8974	Traumatic amputation of leg(s) (complete) (partial),	S78919A	S78919A Complete traumatic amputation of unspecified hip and thigh, level unspecified, initial encounter
8974	Traumatic amputation of leg(s) (complete) (partial),	S78929A	S78929A Partial traumatic amputation of unspecified hip and thigh, level unspecified, initial encounter
8974	Traumatic amputation of leg(s) (complete) (partial),	S88919A	S88919A Complete traumatic amputation of unspecified lower leg, level unspecified, initial encounter
8974	Traumatic amputation of leg(s) (complete) (partial),	S88929A	S88929A Partial traumatic amputation of unspecified lower leg, level unspecified, initial encounter
99664	Infection and inflammatory reaction due to indwelli	T8351XA	T8351XA Infection and inflammatory reaction due to indwelling urinary catheter, initial encounter
99683	Complications of transplanted heart	T8620	T8620 Unspecified complication of heart transplant
99683	Complications of transplanted heart	T8621	T8621 Heart transplant rejection
99683	Complications of transplanted heart	T8622	T8622 Heart transplant failure
V08	Asymptomatic human immunodeficiency virus [HIV]	Z21	Z21 Asymptomatic human immunodeficiency virus [HIV] infection status
V421	Heart replaced by transplant	Z941	Z941 Heart transplant status
V427	Liver replaced by transplant	Z944	Z944 Liver transplant status
V4283	Pancreas replaced by transplant	Z9483	Z9483 Pancreas transplant status
V441	Gastrostomy status	Z931	Z931 Gastrostomy status
V442	Ileostomy status	Z932	Z932 Ileostomy status
V443	Colostomy status	Z933	Z933 Colostomy status
V446	Other artificial opening of urinary tract status	Z936	Z936 Other artificial openings of urinary tract status
V4611	Dependence on respirator, status	Z9911	Z9911 Dependence on respirator [ventilator] status
V4972	Other toe(s) amputation status	Z89429	Z89429 Acquired absence of other toe(s), unspecified side
V4975	Below knee amputation status	Z89519	Z89519 Acquired absence of unspecified leg below knee
V4976	Above knee amputation status	Z89619	Z89619 Acquired absence of unspecified leg above knee
V551	Attention to gastrostomy	Z431	Z431 Encounter for attention to gastrostomy
V5867	Long-term (current) use of insulin	Z794	Z794 Long term (current) use of insulin
V8541	Body Mass Index 40.0-44.9, adult	Z6841	Z6841 Body mass index (BMI) 40.0-44.9, adult

APPENDIX

Standardized Hospitalization Ratio for Dialysis Facilities

Appendix B: Calculation Algorithm/Measure Logic Diagram URL or Attachment S.19.

Standardized Hospitalization Ratio: The ratio of observed to expected hospital admissions
Numerator Statement: Number of hospital admissions observed
Denominator Statement: Number of hospital admissions expected based on the national rate for patients with similar characteristics



*Multiple data sources include CMS Consolidated Renal Operations in a Web-enabled Network (CROWNWeb), the CMS Annual Facility Survey (Form CMS-2744), Medicare dialysis and hospital payment records, the CMS Medical Evidence Form (Form CMS-2728), transplant data from the Organ Procurement and Transplant Network (OPTN), the Death Notification Form (Form CMS-2746), the Dialysis Facility Compare (DFC) and the Social Security Death Master File.