Kidney Medicine

Nursing Home Status Adjustment for Standardized Mortality and Hospitalization in Dialysis Facility Reports

Shu Chen, Megan Slowey, Valarie B. Ashby, Lonnie Barnes, Aaron Pearson, Jian Kang, and Joseph M. Messana**

Rationale & Objective: Compared to the original nursing home status (any nursing home stay in the previous calendar year), new nursing home status variables were developed to improve the risk adjustment of Standardized Mortality/Hospitalization Ratio (SMR/SHR) models used in public reporting of dialysis quality of care, such as the Annual Dialysis Facility Report.

Study Design: Retrospective observational study.

Setting & Participants: 625,040 US maintenance dialysis patients with >90 kidney failure days in 2019.

Predictors: Nursing home status variables; patient characteristics; comorbid conditions.

Outcomes: Mortality/hospitalization.

Analytical Approach: We assigned patients and patient times (SMR/SHR model) to one of 3 mutually exclusive categories: long-term care (≥90 days), short-term care (1-89 days), or non-nursing home, based on nursing home stay during the previous 365 days from the first day of the time period at risk. Nursing home status was derived from the Nursing Home Minimum Data Set. Comparisons of hazard ratios from adjusted models, facility SMR/SHR performance, and model C-statistics between the original/new models were performed.

Results: SMR's hazard ratio of original nursing home status (2.09) was lower than both ratios of short-term care (2.38) and long-term care (2.43), whereas SHR's hazard ratio of original nursing home status (1.10) was between the ratios of long-term care (1.01) and short-term care (1.20). There was a difference in hazard ratios between short-term care and long-term care for both measures. Small percentages of facilities changed performance categories: 0.7% for SMR and 0.4% for SHR. The SMR C-statistic improved whereas the SHR C-statistic was relatively unchanged.

Limitations: Limited capture of subacute rehabilitation stays in the nursing home by using a 90-day cutoff for short-term care and long-term care; unable to draw causal inference about nursing home care.

Conclusions: Use of a nursing home metric that effectively separates short-term from long-term nursing home utilization results in more meaningful risk adjustment that generally comports with Medicare payment policy, potentially resulting in more interpretable results for dialysis stakeholders.

Visual Abstract included

Complete author and article information provided before references.

**J.K. and J.M.M. contributed equally to this work.*

Correspondence to J.M. Messana (jmessana@med.umich.edu)

Kidney Med. 5(2):100580. Published online December 8, 2022.

doi: 10.1016/j.xkme.2022.100580

Within the dialysis patient population, acute care hospitalization is quite common. After acute hospitalization, dialysis patients may be admitted to nursing homes to receive both personal care and rehabilitative services, with the goal of improving their functional status enough to allow discharge to a self-care environment. Alternatively, some nursing home residents utilize the nursing home as long-term residence without the likelihood of rehabilitation to self-care. These different scenarios often overlap, and an initial rehab admission may transition to a long-term stay if attempts at initial rehabilitation are unsuccessful or other illness intervenes.

Skilled nursing facility/long-term care facility residents tend to be older, have more comorbid conditions and are more functionally impaired. Nursing home dialysis patients are especially at risk of mortality, hospitalization, and rehospitalization within 30 days of hospital discharge.[1-3] More Medicare beneficiaries with kidney failure are admitted to skilled nursing facility in the last 90 days of life, a percentage that increased from 23% in 2000 to 32% in 2015.[4] Previous studies have reported on outcomes of incident elder dialysis patients with nursing home stays more than 90 days,[3,5,6] but research comparing short-term and long-term nursing home patients within the dialysis population is limited. Few studies have explored the demographic, modality, and health outcome differences between short-term, long-term, and non-nursing home patients within the dialysis population.

Under contract by the Centers for Medicare & Medicaid Services (CMS), the Dialysis Facility Reports are produced annually for over 7,500 facilities in the United States.[7] The nursing home status of dialysis patients plays an important role in the calculation of several measures in the Dialysis Facility Report. These reports provide those involved in dialysis care with facility-specific data on patient characteristics, patterns of treatment, and patterns in transplantation, hospitalization, and mortality, alongside comparisons to local and national averages.[7] Compared to non-nursing home dialysis patients, those with nursing home exposure consistently have higher mortality and hospitalization rates. Our motivation for pursuing this research was to help develop more accurate and clinically consistent nursing home risk adjustment for the statistical models from which dialysis facility quality measures used in both public reporting and value-based purchasing programs are derived.

PLAIN-LANGUAGE SUMMARY

The original nursing home status (any nursing home stay in the previous calendar year) adjusted in the Standardized Mortality Ratio and the Standardized Hospitalization Ratio models of the Dialysis Facility Report is a strong predictor of mortality/hospitalization outcomes but does not precisely reflect recent nursing home status or consider the length of nursing home stays. We developed a new nursing home metric that effectively separates short-term from long-term nursing home utilization, provides more specific information about nursing home stays in this population, and improves the risk adjustment of these important outcome models. Use of the new nursing home utilization metric results in a more meaningful risk adjustment that generally comports with Medicare payment policy, potentially resulting in more interpretable results for dialysis stakeholders.

The original Dialysis Facility Report definition for nursing home status of having any nursing home stay in the previous calendar year may not precisely capture the true exposure in dialysis patients because it does not account for either stays in the current year or length of stay. We hypothesized a better approach would be to define nursing home status in 2 ways: the presence of a short-term care (1-89 days) or long-term care (≥90 days) stay in the previous year from time at risk. Ninety days approximately mirrors Medicare payment philosophy regarding rehab-focused and long-term nursing home use, and based on previously published literature, differentiates between these 2 distinct nursing home populations.[8-11]

In this report, we describe the patient characteristics and health outcomes of short-term and long-term nursing home dialysis patients compared to the non-nursing home dialysis population. We evaluate the effectiveness of adjusting for nursing home status by differentiating between short-term and long-term nursing home stays as compared to adjusting for any stay in the previous year. Methods improvement is demonstrated through Standardized Mortality Ratio (SMR) and Standardized Hospitalization Ratio (SHR) modeling for dialysis patients in 2019. Besides its use in the Dialysis Facility Report, the SHR measure is used for payment adjustments in the End-Stage Renal Disease Quality Incentive Program, and SMR/SHR measures are used in public reporting for Dialysis Facility Compare/Star Ratings.

METHODS

Study Population

We conducted a population-based study using CMS Medicare claims and data from Consolidated Renal Operations in a Web-Enabled Network (CROWNWeb) for US dialysis patients in 2019. CROWNWeb is a national data system containing dialysis facility-reported clinical and administrative data, including data from the CMS-2728 Medical Evidence, CMS-2746 Death Notification, and CMS-2744 Annual Facility Survey forms.[12] The CMS-2728 form provides evidence of kidney failure for Medicare entitlement, registers a patient into the national renal registry, and contains patient data.[13]

This study included 625,040 patients who were on maintenance dialysis any time in 2019 and had more than 90 days with kidney failure. The minimum 90-day period assures that most patients are eligible for Medicare insurance either as their primary or secondary insurer. Patients that had at least one Medicare eligible month during the year were included in the hospitalization analyses (N = 450,948). To ensure more complete hospitalization data, a month was deemed eligible if it was within 2 months following a month having at least $900 of Medicare-paid dialysis claims or at least one Medicare inpatient claim.

Data

We identified dialysis patients primarily using data from CROWNWeb, the CMS-2728 form, and Medicare dialysis claims. The determination of nursing home status and length of stay during a year in SMR/SHR models is based on the CMS Minimum Data Set, which is a national registry of nursing home patients.[14] Patient characteristics including age, sex, race, ethnicity, body mass index at incidence, primary kidney failure cause, incident comorbid conditions, years on dialysis, Medicare coverage, mortality, and modality are from the CMS-2728 form and other administrative data at the start of the study period. We obtained patient-level prevalent comorbid conditions and hospital admissions from Medicare claims.

To determine patient time period at risk, we identified the dialysis provider at each point in time using a combination of Medicare dialysis claims, the CMS-2728, and CROWNWeb. Starting with day 91 of kidney failure, we determined facility treatment histories for each patient, and assigned a facility only once the patient had been treated there for 60 days. When a patient was transferred from a facility, the patient remained assigned there for 60 days to attribute the sequelae of treatment to that facility.[7]

In the SMR/SHR models, we compared 2 ways of defining nursing home status at the patient time at risk level. Using the Minimum Data Set, the original Dialysis Facility Report nursing home status variable was defined as having at least 1 day in a nursing home during the previous calendar year. The length of stay was calculated as the time a patient was in a nursing home during the previous 365 days from the first day of each time period at risk in 2019. The days did not have to be consecutive. In the new nursing home status method, 2 indicator variables were created based on nursing home stays: short-term care for stays between 1-89 days and long-term care for stays

Table 1. Counts/Percentages of Dialysis Patient Demographics by Nursing Home Status in Previous 365 Days

	Short-Term Nursing Home Care	Long-Term Nursing Home Care	No Nursing Home Care
Patients, N (%)[a]	70,264 (11.2%)	35,322 (5.7%)	519,454 (83.1%)
Demographic			
Age as of January 1, 2019			
<55	7,961 (11.3%)	4,171 (11.8%)	156,982 (30.2%)
55 to <65	14,644 (20.8%)	8,483 (24.0%)	132,117 (25.4%)
65 to <75	23,478 (33.4%)	11,772 (33.3%)	130,440 (25.1%)
75+	24,175 (34.4%)	10,890 (30.8%)	98,119 (18.9%)
Sex			
Female	33,361 (47.5%)	17,709 (50.1%)	212,732 (41.0%)
Male	36,903 (52.5%)	17,613 (49.9%)	306,722 (59.1%)
Race			
Asian/Pacific Islander	2,850 (4.1%)	1,244 (3.5%)	35,120 (6.8%)
Black	21,134 (30.1%)	12,948 (36.7%)	171,547 (33.0%)
Native American	602 (0.9%)	332 (0.9%)	6,153 (1.2%)
White	45,470 (64.7%)	20,691 (58.6%)	303,846 (58.5%)
Other Race	208 (0.3%)	107 (0.3%)	2,788 (0.5%)
Ethnicity			
Non-Hispanic	61,279 (87.2%)	31,130 (88.1%)	414,278 (79.8%)
Hispanic	8,663 (12.3%)	4,034 (11.4%)	101,853 (19.6%)
Vintage as of January 1, 2019			
< 1 yr since start of dialysis	16,086 (28.5%)	6,167 (19.6%)	83,059 (18.5%)
1 to <2 y since start of dialysis	8,262 (14.6%)	4,839 (15.4%)	71,190 (15.8%)
2 to <5 y since start of dialysis	15,742 (27.8%)	9,901 (31.5%)	142,503 (31.7%)
5+ y since start of dialysis	16,449 (29.1%)	10,540 (33.5%)	153,156 (34.0%)
Modality[b]			
In-center hemodialysis	51,957 (94.1%)	29,810 (95.9%)	380,361 (85.9%)
Home hemodialysis	673 (1.2%)	982 (3.2%)	8,600 (1.9%)
Peritoneal dialysis	2,463 (4.5%)	281 (0.9%)	53,172 (12.0%)
Uncertain dialysis	119 (0.2%)	20 (0.1%)	692 (0.2%)
Medicare payer[b]			
Group Health Organization	14,350 (26.0%)	4,960 (16.0%)	82,920 (18.7%)
Medicare Primary	32,822 (59.5%)	21,253 (68.4%)	247,849 (56.0%)
Medicare as Secondary Payer	4,851 (8.8%)	2,141 (6.9%)	49,039 (11.1%)
Other/unknown	3,189 (5.8%)	2,739 (8.8%)	63,017 (14.2%)
Dual eligibility flag[b]			
No	35,898 (65.0%)	12,717 (40.9%)	294,616 (66.5%)
Yes	19,314 (35.0%)	18,376 (59.1%)	148,209 (33.5%)

[a]Includes patients on maintenance dialysis with more than 90 days of kidney failure in 2019.
[b]For patients on maintenance dialysis on January 1, 2019, "Group Health Organization" refers to Medicare Advantage; "Medicare Primary" includes Medicare Primary Part A and Part B; "Medicare as Secondary Payer" includes Medicare as Secondary Payer with/without EGHP (commercial insurance). For the point prevalent cohort presented in this table, nursing home residents being treated with hemodialysis are categorized as treated with home hemodialysis if the CROWNWeb treatment location indicated "skilled nursing facility /Long-Term Care Facility" as of January 1, 2019.

between 90-365 days. In Table 1, patients were assigned to 1 of 3 mutually exclusive categories of nursing home status: having at least 1 period at risk with a nursing home stay ≥90 days (long-term care), having at least 1 period with nursing home stay between 1-89 days (short-term care), or having no nursing home stay. If a patient had multiple stays of 1-89 day duration, but their cumulative number of days in a nursing home was ≥ 90, the patient would be classified as long-term care.

Statistical Analyses

To compare the unadjusted effects of the original and new nursing home variables over time at risk, we used Kaplan-Meier survival curves for mortality and expected count profiles fitted by Poisson regression with time at risk as the predictor for hospital admissions. Patient years (PYs) were defined as time at risk beginning at the start of the facility treatment period until the earliest occurrence of transplant, date of death, end of facility treatment period, or December 31 of that year. Rates were calculated as the number of occurrences per 100 PYs.

The SMR/SHR for each facility is defined as the ratio of the observed number of deaths/hospital admissions at that facility to the number of deaths/hospital admissions expected under a national norm, where the expectation is adjusted to reflect characteristics of that facility's patients.

Risk adjustment was performed using a 2-stage Cox regression model from 2016-2019 data.[15-17] More details on both the SMR and SHR models have been described elsewhere.[7] Adjustments included age, race (SMR only), ethnicity (SMR only), sex, diabetes as kidney failure cause, dialysis duration, nursing home status, comorbid conditions and body mass index at incidence, calendar year, interaction terms between race, sex, and duration and kidney failure cause (SMR only), interaction terms between age, sex, and duration and kidney failure cause (SHR only), and 210 comorbid conditions identified through Medicare claims (SHR only).

Replacing the original nursing home variable with the 2 nursing home status variables, we compared the 2 model fitting results in terms of the crude ratios, adjusted hazard ratios, facility SMR/SHR performance and concordance-statistics (C-statistics) for evaluating model goodness of fit.[18-20] SMRs were not calculated if there were fewer than 3 expected deaths, and SHRs were not calculated if there were less than 5 PYs at risk. Statistically significant ($P < 0.05$) facility ratios were classified as "better than expected" if they were less than 1.00 or "worse than expected" if greater than 1.00. Otherwise, the classification was "as expected."

Analyses were performed using R version 3.6.1(The R Foundation for Statistical Computing Platform) and SAS Version 9.4 (SAS Institute Inc). All analyses were performed under CMS contract, which does not require review from an institutional review board.

RESULTS

Patient Demographics

In Table 1, we report the distributions of demographic characteristics, dialysis duration, dialysis modality, and Medicare coverage status by nursing home status. Among the 625,040 eligible patients in 2019, there were 70,264 (11.2%) short-term care patients and 35,322 (5.7%) long-term care patients. Both short- and long-term nursing home groups were older and had relatively higher proportions of female, in-center hemodialysis, and Medicare Primary insurance than the non-nursing home group. Short-term care patients were more likely to be White (64.7% vs. 58.6%) and have less than one year of dialysis (28.5% vs 19.6%) when compared to long-term care patients. With regard to Medicare coverage, short-term care patients were more likely to use a Group Health Organization (26.0% vs 16.0% in long-term care), and long-term care patients were more likely to have Medicare-Medicaid dual eligibility (59.1% vs 35.0% in short-term care). In Tables S1 and S2, the raw death rate (deaths per 100 PYs) in short-term care (37.1) was significantly lower than long-term care (41.8), whereas the raw admission rate (admissions per 100 PYs) in short-term care (306.2) was higher than long-term care (252.3). Additional unadjusted analytic results are included in Tables S1-S3 and Fig S1.

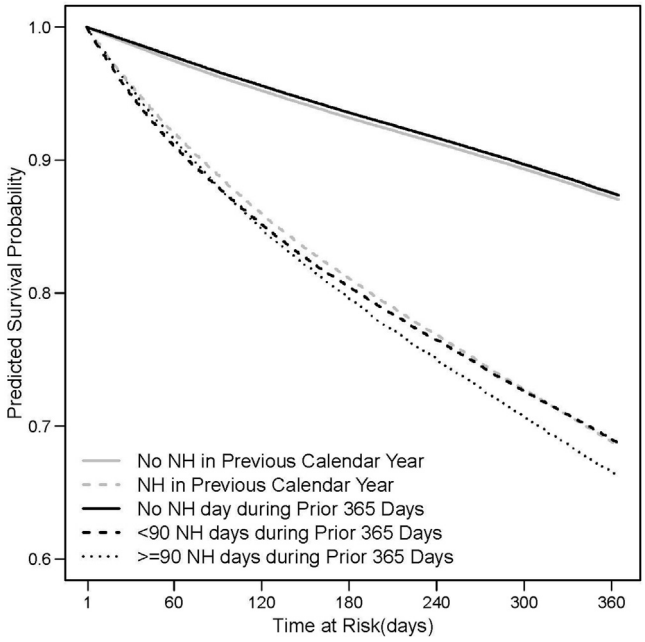


Figure 1. The unadjusted Kaplan-Meier survival curves of time at risk (days) to survival probability by original and new nursing home status variables in 2019. Predicted survival probability versus time at risk (days) for dialysis patients in 2019 by original and new nursing home status, no other variable adjusted.

Patient Survival and Hospitalization Rates

Survival curves for mortality and expected hospital admissions were used to compare the unadjusted effects of the original and new nursing home variables over time at risk in Figs 1 and 2. The baseline curves of the original (solid blue) nursing home variables and those of the new (solid red) nursing home variables were close in both comparisons. The survival probability of the original nursing home (0.81) was higher than those of short-term care (0.80) and long-term care (0.79) on day 180, whereas the survival probability of short-term care (0.68) became close to that of the original nursing home (0.68), and the probability of long-term care (0.66) became smaller on day 365 (Fig 1). The expected admission curve of short-term care overlapped with the curve of the model using the original nursing home variable until day 240 and became higher than the original afterward, whereas the admission curve of the model using long-term care remained significantly lower than both short-term care and original curves over time (Fig 2).

Facility Performance

We analyzed SMRs/SHRs from 7,732 facilities with 97.7% having at least 1 nursing home patient during the year. Differences between the single original nursing home identifier and the 2 new nursing home identifiers are reported in Tables 2-5. Because new nursing home identifiers provide additional information, there were 2,788 (0.6%) and 2,802 (1.0%) more PYs identified as nursing

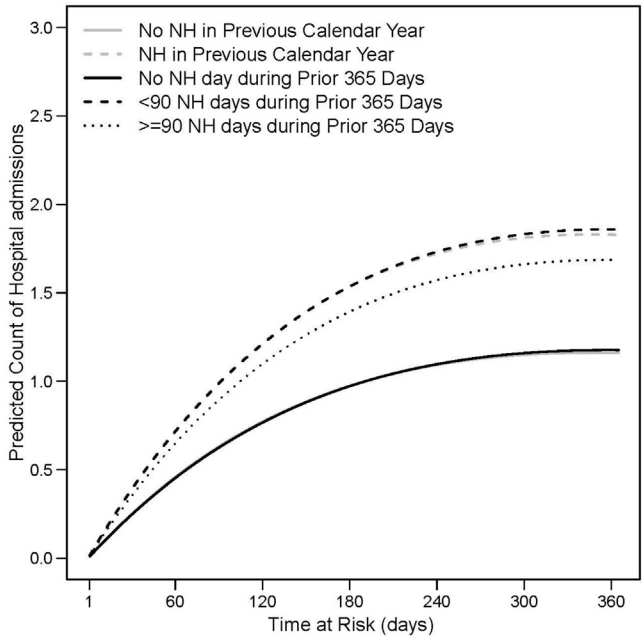


Figure 2. The unadjusted Poisson regression curves of time at risk (days) to count of hospital admissions by original and new nursing home status variables in 2019. Predicted count of hospital admissions versus time at risk (days) for dialysis patients in 2019 by original and new nursing home status, no other variable adjusted.

home in the new mortality and hospitalization models, respectively, compared to the models using the original nursing home variable.

The results from the adjusted models were generally consistent with results from the unadjusted analyses presented in Figs 1 and 2. Both the original and new nursing home variables were strongly associated with increased mortality in the dialysis population. However, the magnitude of the short-term care and long-term care hazard ratios were both larger than the hazard ratio associated with the original nursing home variable. The adjusted hazard ratio (95% confidence interval) of the original nursing home variable was 2.09 (2.07-2.11), whereas the ratio was 2.38 (2.36-2.40) for short-term care and 2.43 (2.40-2.46) for long-term care.

The adjusted hospitalization model yielded somewhat different results. The hazard ratios for all 3 nursing home indicators in the acute care hospitalization model were statistically significant, but with much smaller effect sizes compared to the mortality model. In addition, the long-term care variable hazard ratio was only marginally different from 1.0, whereas the short-term care variable was larger than either the long-term care or original nursing home variables. The adjusted hospitalization hazard ratio (95% confidence interval) was 1.10 (1.10-1.11) for the original nursing home variable, 1.20 (1.19-1.20) for short-term care, and 1.01 (1.00-1.01) for long-term care. A sensitivity analysis limited to only in-center hemodialysis patients demonstrated nearly identical results as the main analysis.

After changing the adjustment from the original nursing home variable to the 2 new nursing home variables, 49 (0.7%) facilities changed performance categories for SMR: 31 were upgraded (14 from as expected to better; 17 from worse to as expected) and 18 were degraded (10 from better to as expected; 8 from as expected to worse). The C-statistic increased from 0.67 to 0.71. For SHR, 30 (0.4%) facilities changed performance categories: 15 were upgraded (5 from as expected to better; 11 from worse to as expected) and 14 were degraded (5 from better to as expected; 9 from as expected to worse). The C-statistic slightly increased from 0.616 to 0.617 (Tables 3 and 5).

DISCUSSION

For several years, the Dialysis Facility Reports have utilized a single nursing home variable definition in models for outcomes for mortality, hospitalization, and several other metrics of dialysis facility performance.[7] However, the original Dialysis Facility Report nursing home status definition of having any nursing home stay in the previous calendar year did not precisely capture the true exposure in dialysis patients because it did not account for either stays in the current year or length of stay. As part of a systematic review of the intersection of maintenance dialysis care and nursing home utilization in this patient population, we explored alternative definitions for nursing home utilization that might more effectively adjust for the impact of the subset of maintenance dialysis patients in nursing

Table 2. Mortality Model Summary: Deaths, Patient Years at Risk, Unadjusted Death Rate, Crude Death Ratios, and Hazard Ratios from the Adjusted Model for the Original and New Models, 2019

	In Nursing Home, Original Model[a]		In Nursing Home, New Model[a]		
Measure	**No**	**Yes**	**No**	**Yes, 1-89 d**	**Yes, 90+ d**
Deaths	61,655	26,473	59,023	18,338	10,767
Patient years	439,235	67,139	436,447	44,871	25,056
Hazard ratio (95% confidence interval)[b]	ref	2.09 (2.07-2.11)	ref	2.38 (2.36-2.40)	2.43 (2.40-2.46)

[a]The C-statistic increased from 0.67 in the original model to 0.71 in the new model.
[b]Based on the model from 2016-2019. Adjusted the Cox model for calendar year, age, race, ethnicity, sex, diabetes, years since start of dialysis, nursing home status, patient comorbid conditions at incidence, and patient body mass index at incidence.

Table 3. Comparison of SMR Facility Performance in 2019 Using Two Different Approaches to Define nursing home Status*

	New Model SMR			
Original Model SMR	**Worse Than Expected**	**As Expected**	**Better Than Expected**	**Total**
Worse than expected	229 (3.4%)	17 (0.3%)	0 (0.0%)	246 (3.6%)
As expected	8 (0.1%)	6,328 (93.1%)	9 (0.1%)	6,345 (93.3%)
Better than expected	0 (0.0%)	10 (0.2%)	197 (2.9%)	207 (3.1%)
Total	237 (3.5%)	6,355 (93.5%)	206 (3.0%)	6,798 (100.0%)

Note: SMRs were not calculated if there were fewer than 3 expected deaths (N = 934).
Abbreviation: SMR, Standardized Mortality Ratio.

homes on patient and facility outcomes used in public reporting and oversight of dialysis facility care.

Two goals of nursing home admission include (1) personal care and rehabilitative services, typically after acute hospitalization, with the goal of improving functional status enough to allow discharge to a self-care environment, and (2) patients unable to self-care often utilize the nursing home as long-term residence without the likelihood of rehabilitation. These very different scenarios often overlap, and an initial rehab admission may transition to a long-term stay if attempts at initial rehabilitation are unsuccessful or other illness intervenes.

Current literature is generally consistent with the results of our study. In research examining community transitions from nursing homes, Gassoumis et al[10] showed that over 90% of community discharges from nursing homes occur during the first 90 days of stay. After 90 days, patients are more likely to remain in the nursing home, be transferred to another care setting, or die. In a Keeler et al[8] study, "short-stayers" in the nursing home generally came from hospitals, consisted of patients convalescing from acute illnesses, and either got well or died in a fairly short period of time, whereas "long-stayers" were usually elderly, often had cognitive disabilities, and many were no longer able to live outside of institutions. Most "long-stayers" stayed for years, possibly the rest of their lives.

Bowling et al[21] demonstrated higher mortality in skilled nursing facility resident maintenance dialysis patients compared to that expected for incident maintenance dialysis patients as a whole. In this population, higher mortality was associated with greater non-kidney failure comorbid condition burden, and long-term stay (≥100 days) in nursing facilities was associated with higher comorbid condition scores. These results suggest a heterogeneous nursing home dialysis population with a varying comorbid condition burden that is, on average, higher in long-term stay residents. Hall et al[2] documented the association between short-term nursing home residency and acute hospitalization in maintenance dialysis patients. In their study, nearly 50% of these nursing home residents were admitted to the acute care hospital within 30 days of placement in the nursing home. Although consistent with our results demonstrating increased hospitalization in short-term nursing home residents, our modeling did not identify persistent effects on hospitalization in long-term residents, which may result from both the very high mortality and rehospitalization rates in short-term nursing home residents.

While acknowledging the overlap and potential limitations of any definition of rehabilitation versus long-term stay, we chose to evaluate 2 nursing home utilization definitions based on total days spent in nursing facilities (combined subacute and long-term) in the prior 365 days. Ninety days as a cutoff for the 2 indicators generally reflects Medicare payment policies for duration of subacute rehabilitation stays in nursing homes. Clearly, some patients with less than 90 days nursing home experience in a year are not rehabilitation candidates; their short experience in nursing home care may be the result of events that limit the nursing home stay (ie, hospitalization, rehospitalization or death). Given that limitation, our preliminary evaluation of the 90-day cutoff criterion suggested that we could identify 2 different, albeit overlapping subpopulations of maintenance dialysis patients. In addition, we hoped to improve our risk-adjustment approach by applying this new definition of nursing home use in our

Table 4. Hospitalization Model Summary: Hospital Admissions, Patient Years at Risk, Unadjusted Hospitalization Rate, Crude Hospitalization Admission Ratios and Hazard Ratios from the Adjusted Model for the Original and New Models, 2019

	In Nursing Home, Original Model[a]		In Nursing Home, New Model[a]		
Measure	**No**	**Yes**	**No**	**Yes, 1-89 d**	**Yes, 90+ d**
Hospital admissions	474,944	142,039	466,926	98,545	51,512
Patient years	273,857	49,636	271,054	32,309	20,130
Hazard Ratio (95% confidence interval)[b]	ref	1.10 (1.10-1.11)	ref	1.20 (1.19-1.20)	1.01 (1.00-1.01)

[a]The C-statistic slightly increased from 0.616 in the original model to 0.617 in the new model.
[b]Hazard ratio from mode 2016-2019. Adjusted the Cox model for patient age, sex, diabetes at incidence, duration of dialysis, nursing home status, patient comorbid conditions at incidence, body mass index at incidence, calendar year of treatment, and prevalent comorbid conditions.

Table 5. Comparison of SHR Facility Performance in 2019 Using 2 Different Approaches to Define Nursing Home Status

	New Model SHR			
Original Model SHR	**Worse Than Expected**	**As Expected**	**Better than Expected**	**Total**
Worse than expected	293 (4.0%)	11 (0.2%)	0 (0.0%)	304 (4.2%)
As expected	9 (0.1%)	6,896 (94.7%)	5 (0.1%)	6,910 (94.9%)
Better than expected	0 (0.0%)	5 (0.1%)	65 (0.9%)	70 (1.0%)
Total	302 (4.2%)	6,912 (94.9%)	70 (1.0%)	7,284 (100.0%)

Note: SHRs were not calculated if there were less than 5 patient years at risk (N=448).
Abbreviation: SHR, Standardized Hospitalization Ratio.

risk-adjusted national models of maintenance dialysis patients.

The results presented in this paper confirm the importance of adjusting for nursing home status, even in models adjusting for patient demographics and an extensive list of comorbid conditions. In addition, we show that short-term nursing home care status behaves somewhat differently than long-term status in models predicting either mortality or hospitalization when compared to our pre-existing nursing home metric. Although all 3 nursing home metrics evaluated in our research are strong predictors of mortality, when compared to the older solitary nursing home metric, both the short-term care and long-term care metrics result in incremental identification of nursing home use and are stronger predictors of mortality. The short-term care and long-term care metrics also improve identification of nursing home use when applied to the active Medicare-insured subset of patients used for hospitalization modeling. However, in this subset of patients, the short-term care measure is the strongest predictor of hospitalization, while the long-term care metric is the weakest of the 3 nursing home metrics tested. The new nursing home metrics improved the SMR C-statistic from 0.67 to 0.71 whereas the C-statistic of the SHR model was relatively unchanged, increasing only from 0.616 to 0.617. Despite the benefits associated with the new nursing home classification in the models, inclusion of the short-term care/long-term care nursing home adjuster results in relatively little impact on the facility performance rating compared to the previous single nursing home adjuster, with reclassification of 0.7% for SMR and 0.4% for SHR of dialysis facilities from "as expected" to either "better than expected" or "worse than expected" in 2019.

The nature of our study design does not allow us to draw causal inference about nursing home care. Rather, it is much more likely that comorbid condition burden and illnesses requiring either short-term rehabilitative or long-term nursing home residency, at least in part, drive both hospitalization and mortality. We cannot exclude the possibility that nursing home care could contribute causally to the outcomes measured here, but further investigation is required to evaluate that possibility.

In conclusion, adjustment for nursing home status is an important component of the overall risk-adjustment strategy when evaluating US dialysis facility outcomes. Use of a nursing home utilization metric that effectively separates short-term from long-term nursing home utilization results in more meaningful risk adjustment that generally comports with Medicare payment policy, potentially resulting in more readily interpretable results for dialysis stakeholders.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: The histogram of total nursing home days during the previous 365 days from the first day of each time period at risk for time periods with total nursing home days > 0.

Table S1: Mortality of Dialysis Patients by Nursing Home Status in Previous 365 Days.

Table S2: Hospitalization of Medicare Dialysis Patients by Nursing Home Status in Previous 365 Days.

Table S3: Prevalent Comorbid Conditions of Medicare Dialysis Patients by Nursing Home Status in Previous 365 days.

ARTICLE INFORMATION

Authors' Full Names and Academic Degrees: Shu Chen, MS, Megan Slowey, MPH, Valarie B. Ashby, MA, Lonnie Barnes, MS, Aaron Pearson, MS, Jian Kang, PhD*, and Joseph M. Messana, MD*

Authors' Affiliations: Kidney Epidemiology and Cost Center, University of Michigan, Ann Arbor, Michigan (SC, MS, VBA, LB, AP, JK, JMM); Department of Biostatistics, University of Michigan, Ann Arbor, Michigan (SC, MS, VBA, LB, AP, JK); and Department of Internal Medicine-Nephrology Division, University of Michigan, Ann Arbor, Michigan (JMM).

Address for Correspondence: Joseph M. Messana, MD, School of Public Health, University of Michigan, Kidney Epidemiology and Cost Center, 1415 Washington Heights, Suite 3645 SPH I, Ann Arbor, MI 48109-2029. Email: jmessana@med.umich.edu

Authors' Contributions: Research idea and study design: JMM, JK, VBA, SC; data acquisition: SC, AP; data analysis/interpretation: primarily MS, LB, all authors participated; statistical analysis: SC, JK. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

Support: This study was supported through a contract from the Centers for Medicare and Medicaid Services: Utilization of Data Indicators in the ESRD, Transplant, and OPOs' Survey Processes, Contract Number 75FCMC21R0030.

Financial Disclosure: The authors declare that they have no relevant financial interests.

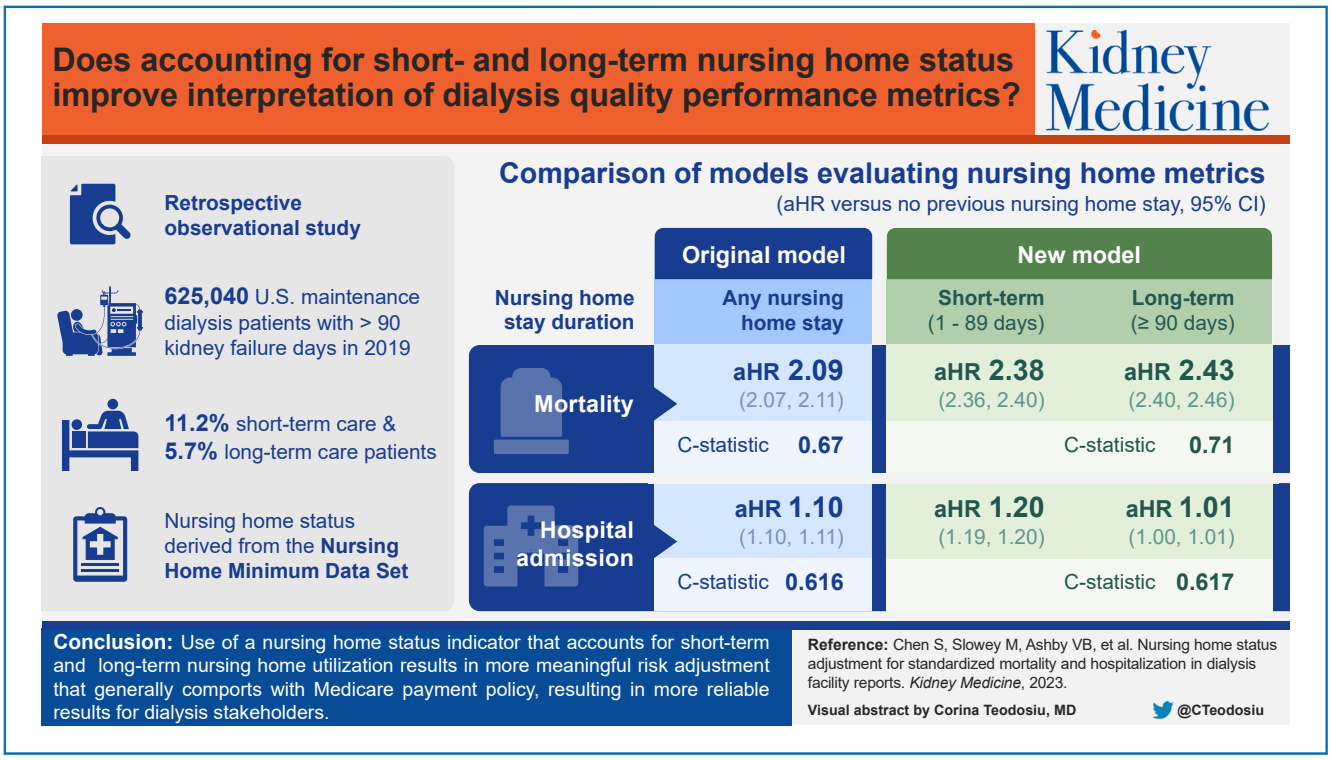
Disclaimer: The statements in this publication are solely the responsibility of the authors and do not necessarily represent the

views of the CMS, although CMS supported the decision to submit this manuscript for publication. CMS did not participate in the study design, analysis, or reporting for this study. Data were obtained from CMS under the contract and associated Data Use Agreement.

Peer Review: Received May 19, 2022. Evaluated by 2 external peer reviewers, with direct editorial input from the Statistical Editor and the Editor-in-Chief. Accepted in revised form October 2, 2022.

REFERENCES

1. Carey HB, Chorney W, Pherson K, Finkelstein FO, Kliger AS. Continuous peritoneal dialysis and the extended care facility. *Am J Kidney Dis*. 2001;37(3):580-587.
2. Hall RK, Toles M, Massing M, et al. Utilization of acute care among patients with ESRD discharged home from skilled nursing facilities. *Clin J Am Soc Nephrol*. 2015;10(3):428-434.
3. Bowling CB, Plantinga L, Hall RK, Mirk A, Zhang R, Kutner N. Association of nondisease-specific problems with mortality, long-term care, and functional impairment among older adults who require skilled nursing care after dialysis initiation. *Clin J Am Soc Nephrol*. 2016;11(12):2218-2224.
4. USRD System. *USRDS 2018 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2018.
5. Kurella Tamura M, O'Hare AM, McCulloch CE, Johansen KL. Signs and symptoms associated with earlier dialysis initiation in nursing home residents. *Am J Kidney Dis*. 2010;56(6):1117-1126.
6. Kurella Tamura M, Covinsky KE, Chertow GM, Yaffe K, Landefeld CS, McCulloch CE. Functional status of elderly adults before and after initiation of dialysis. *N Engl J Med*. 2009;361(16):1539-1547.
7. DialysisData. Dialysis Facility Report Methodology. Accessed July 2021. https://dialysisdata.org/content/dialysis-facility-report-methodology
8. Keeler EB, Kane RL, Solomon DH. Short- and long-term residents of nursing homes. *Med Care*. 1981;19(3):363-370.
9. Eskildsen M, Price T. Nursing home care in the USA. *Geriatr Gerontol Int*. 2009;9(1):1-6.
10. Gassoumis ZD, Fike KT, Rahman AN, Enguidanos SM, Wilber KH. Who transitions to the community from nursing homes? Comparing patterns and predictors for short-stay and long-stay residents. *Home Health Care Serv Q*. 2013;32(2):75-91.
11. Hirdes JP, Heckman GA, Morinville A, et al. One way out? A multistate transition model of outcomes after nursing home admission. *J Am Med Dir Assoc*. 2019;20(11):1425-1431.e1.
12. Centers for Medicare & Medicaid Services. CROWNWeb website. Accessed July 2021. https://mycrownweb.org/
13. Centers for Medicare & Medicaid Services. CMS-2728 Form. End stage renal disease medical evidence report Medicare entitlement and/or patient registration. https://www.cms.gov/Medicare/CMS-Forms/CMS-Forms/downloads/CMS2728.pdf
14. Centers for Medicare & Medicaid Services. Minimum Data Set 3.0 Public Reports. Accessed July 2021. https://www.cms.gov/Research-Statistics-Data-and-Systems/Computer-Data-and-Systems/Minimum-Data-Set-3-0-Public-Reports
15. Kalbfleisch J, Wolfe R, Bell S, et al. Risk adjustment and the assessment of disparities in dialysis mortality outcomes. *J Am Soc Nephrol*. 2015;26(11):2641-2645.
16. Cox DR. Regression models and life-tables. *J R Stat Soc B*. 1972;34(2):187-202.
17. Kalbfleisch JD, Prentice RL. *The Statistical Analysis of Failure Time Data*. John Wiley & Sons; 2002.
18. Steyerberg EW, Harrell FE, Borsboom GJ, Eijkemans MJ, Vergouwe Y, Habbema JD. Internal validation of predictive models: efficiency of some procedures for logistic regression analysis. *J Clin Epidemiol*. 2001;54(8):774-781.
19. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. 2nd ed. John Wiley & Sons; 2000.
20. Cook NR. Use and misuse of the receiver operating characteristic curve in risk prediction. *Circulation*. 2007;115(7):928-935.
21. Bowling CB, Zhang R, Franch H, et al. Underreporting of nursing home utilization on the CMS-2728 in older incident dialysis patients and implications for assessing mortality risk. *BMC Nephrol*. 2015;16:32.


Does accounting for short- and long-term nursing home status improve interpretation of dialysis quality performance metrics?
Kidney Medicine
Retrospective observational study
625,040 U.S. maintenance dialysis patients with > 90 kidney failure days in 2019
11.2% short-term care & 5.7% long-term care patients
Nursing home status derived from the Nursing Home Minimum Data Set
Comparison of models evaluating nursing home metrics
(aHR versus no previous nursing home stay, 95% CI)
Original model
New model
Nursing home stay duration
Any nursing home stay
Short-term (1 - 89 days)
Long-term (≥ 90 days)
Mortality
aHR 2.09 (2.07, 2.11)
aHR 2.38 (2.36, 2.40)
aHR 2.43 (2.40, 2.46)
C-statistic 0.67
C-statistic 0.71
Hospital admission
aHR 1.10 (1.10, 1.11)
aHR 1.20 (1.19, 1.20)
aHR 1.01 (1.00, 1.01)
C-statistic 0.616
C-statistic 0.617
Conclusion: Use of a nursing home status indicator that accounts for short-term and long-term nursing home utilization results in more meaningful risk adjustment that generally comports with Medicare payment policy, resulting in more reliable results for dialysis stakeholders.
Reference: Chen S, Slowey M, Ashby VB, et al. Nursing home status adjustment for standardized mortality and hospitalization in dialysis facility reports. Kidney Medicine, 2023.
Visual abstract by Corina Teodosiu, MD
@CTeodosiu