All-Cause Admissions and Readmission Measure Endorsement Project
Standing Committee Call: SDS Trial Period Webinar #3
May 13, 2016
12:00-2:30 PM ET

Please use the following information to access the conference call line and webinar:

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AGENDA

12:00 pm **Welcome and Introductions**
John Bulger, DO, MBA (Co-chair)
Cristie Travis, MSHA (Co-chair)
Erin O'Rourke, Senior Director
Taroon Amin, PhD, MA, MPH, Consultant
Zehra Shahab, MPH, Project Manager

12:05 pm **Background and Goal of Today's Call**
Erin O'Rourke, Senior Director

12:15 pm **Discussion of SDS Trial Period Measures**

Setting Specific Readmissions Measures

1) #2375: PointRight OnPoint-30 SNF Rehospitalizations
   Lead Discussants: Chen, Travis, Auger

2) #2380: Rehospitalization During the First 30 Days of Home Health
   Lead Discussants: Roberts, Brooks, Lind

3) #2496: Standardized Readmission Ratio (SRR) for dialysis facilities
   Lead Discussants: Fishbane, Joynt, Kaplan

4) #2502: All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)
   Lead Discussants: BHall, Robinson

5) #2505: Emergency Department Use without Hospital Readmission During the First 30 Days of Home Health
   Lead Discussants: Fields, Heidenreich

6) #2510: Skilled Nursing Facility 30-Day All-Cause Readmission Measure (SNFRM)
Lead Discussants: Briggs, Niewczyk

7) #2512: All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)
Lead Discussants: *Grigonis, Glance, Raphael*

<u>Population Level Admissions and Readmissions Measures</u>

1) #2503: Hospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries
Lead Discussants: LKHall, Smith, Bulger

2) #2504: 30-day Rehospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries
Lead Discussants: Centeno, Minton-Foltz, Foy

2:10 pm **NQF Member and Public Comment**

2:25 pm **Next Steps/Committee Timeline**
Zehra Shahab, Project Manager

2:30 pm **Adjourn**

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
2375	PointRight ® Pro 30™	The developers note limited literature on SNF readmissions. SDS risk factors such as ethnicity, English language proficiency or marital status may have a relationship with a SNF admission being sent back to a hospital. These may impact the communication with healthcare team about one's condition as well as decisions about the preferences of rehospitalization or not. While there appears to be differences in rehospitalization	Person characteristics from MDS (Minimum Data Set): • Race • Age (already included in RA model) • Gender (already included in RA model) • Marital status (possibly crossed with age and Gender) • Language • Gender • Dual eligibility/state buy-in Facility characteristics: • Percent of	Given the long list of variables the developers have indicated they would be looking at, the SC suggested narrowing down the list to the most impactful variables, especially regarding facility and regional characteristics (disparities). The Committee was in agreement that looking at county-level data can provide a picture of the relationship between the community and	• Marital status (married or single) • Race (black or non black) • Medicaid enrollment (via the patient having a non-missing Medicaid identifier)	• The risk model for the currently-endorsed measure used an ordinary logistic regression, predicting the probability of rehospitalization at the stay level. • The developer noted that because race and Medicaid enrollment correlate with lower quality facilities it is important to decompose the effect of SDS factors into between-facility and within facility components. The between-facility part of the effect correlates with facility quality and should not be controlled for in the measure; the within-facility part of the effect may	• Age and gender are included in the original model. Additional SDS variables were not included.

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		rates by ethnicity in the literature, these differences appear to be related to differences in the quality of SNFs and the clustering of different ethnicities with poor quality SNFs. Thus, risk adjusting for ethnicity may have the unintended effect of adjusting for poor quality providers. However, this finding has not been extensively tested.	patients by race • Percent of patients by age category • Percent of patients by Gender • Percent of patients by gender • Percent of patients by marital status • Percent of patients by language • Percent of patients by state buy-in indicator • Percent of the facility's census that is receiving post-acute care (i.e., admitted from a hospital	healthcare facilities or providers and how this affects patient's health status, especially for this setting.		represent differences outside the facility's control. • To model this, the developer used a two-stage logistic mode. First the developer fit a logistic regression including all clinical adjustors as well as race and Medicaid enrollment, with facility fixed effects. Second, the developer fit a second logistic regression (this time without fixed effects) including all clinical adjustors plus marital status, and included race and Medicaid with the coefficients set as those in the first regression. • The developers exploratory data	

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			in the prior 30 days) • Percent of the facility's census that is covered by Medicare FFS • Percent of facility's residents with Medicaid benefits interacted with three levels of liberality of Medicaid eligibility, and three levels of liberality of per diem Medicaid SNF reimbursement • The number of beds in the facility • The ownership			analysis used MDS data from 2,790 SNFs that consistently submitted data to PointRight and had more than 30 admission from the hospital in 2014. This resulted in a total of 745,832 admissions from acute care hospitals. The 30-day rehospitalization rate for this group was 18.3% • The developers used a two-level fixed effects framework to apportion the impact of SDS factors between the facility level and the individual patient level. • First the developers tested the variation of the standardized risk ratios (SRRs) across facilities by a) the proportion of Medicaid	

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			of the facility (nonprofit, for profit individual, for profit chain, public) Regional characteristics (County or CBSA of SNF): • Median household income • Percent of households >= 133% of Federal poverty level • Percent of adults eligible for Medicaid (according to state standards) • Percent of			patients, and b) the proportion of black patients. The developers found that at the facility level a higher proportion of black patients and/or a higher proportion of Medicaid patients are associated with higher risk-adjusted rehospitalization rates. • Next the developers examined the effect of adding SDS factors on the variance explained by the ordinary logistic risk adjustment model. o All three variables had significant effects but there was no improveme	

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			persons >= 65 with private insurance • Percent of persons >= 65 with Medicaid • Percent of persons >= 65 with Medicare FFS • Percent of persons >= 65 with Medicare Advantage • Percent of persons in the labor force >= 25 who are unemployed • Percent of persons >= 18 who are homeless • Percent of persons aged >= 30 with a			nt in the model's c-statistic. o The c-statistic of the current model is 0.676. The c-statistic after adding the SDS factors was also 0.676 • The developers concluded that all of the variance in rehospitalization explainable by the current variables could be accounted for without the use of the SDS variables. • To study the extent to which health care disparities between different	

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			graduate degree; percent of persons aged >= 25 with a college degree • Percent of persons >= 30 who live in rented dwellings • Percent of people in the geographical region and the same demographic category who are poor			• socio-economic groups are the result of differential care within the nursing home or are due to differences resulting from unequal quality of care across nursing homes the developers compared the Pro-30 model with a conditional fixed-effects logistic regression model, then used the SDS factor coefficients as the first state of a two-stage logistic regression approach. • The developers analyzed the structural caused of SDS effects on the risk model. • Finally, the developers measured the effect on classification of facility performance of applying the revised model with	

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						SDS factors. In only one of 2760 cases did a facility's decide rank change by more than one between the old and new risk adjustment models. • The developers ultimately chose not to include the SDS factors in the risk adjustment model.	
2380	Rehospitalization during the First 30 days of Home Health	Findings from the literature support a linkage between proposed SDS factors and ED use and hospital readmission. Individuals with lower social economic status (SES) are more likely to use EDs for primary health care services. In the	Medicare Claims Data: • Prior Care Setting • Age and gender interactions • Health Status (from Medicare claims) • Medicare Enrollment Status	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These variables represent the underlying conceptual construct well. In addition to looking	• Medicaid Status – included in the CMS Enrollment Database (EDB) • Rural Location – determined from beneficiary address, as captured in	• A single multinomial logit model was used to predict the Rehospitalization During the First 30 Days of Home Health measure. • Of the 1,669,802 qualifying home health stays beginning from July 1, 2010 to June 30, 2013, a random 80 percent sample without replacement was chosen to calibrate the	Age and gender are included in the original model. Additional SDS variables were not included.

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		home health setting, the 30-day period for re-hospitalization occurs while the patient is living in their own home, increasing the likelihood that non-medical factors, including geographic location and economic resources, will have an impact on acute care use. More specific findings regarding the documented relationship between socio-demographic factors, readmission and ED use are described below.	• Additional interactions between Hierarchical Condition Categories (HCCs) and Medicare Enrollment Status (income and employment) Identified additional SDS factors to be tested from Medicare Enrollment Database (EDB) and Survey data: • Race/Ethnicity (EDB) • Medicaid Status (EDB) • Rural location	at neighborhood characteristics, the Committee highlights the importance of looking at rural location, as stated in the developer's future analysis plan.	EDB • SES Index Score – determined from beneficiary address linked to American Community Survey (ACS) data. The index is a composite of seven ACS variables: o Percentage of people in the labor force who are unemployed o Percentage of persons below US poverty line	multinomial logit model and to estimate marginal effects for model development purposes. The remaining 20 percent of the stays were used to cross-validate the model. • To determine which risk factors should be included in the risk adjustment model, a Wald test of joint restrictions was applied to each variable in each of 1,150 bootstrap samples created using simple random sampling, with replacement, of 80 percent of all home health stays. The Wald test determined the likelihood that the change in either or both outcomes associated	

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		• A recent study of 30-day hospital readmission of elderly patients with initial discharge destination of HH care found race to be a significant predictor of readmission. • One study of 1375 patients examining differential use of EDs by various racial and ethnic groups found confounding impact by other SDS variables and concluded that programs to reduce inappropriate ED use must be	(EDB) • Neighborhood characteristics (survey)		o Median household income o Median value of owner-occupied homes o Percentage of persons aged ≥ 25 years with less than a 12th-grade education o Percentage of persons aged ≥ 25 years with at least 4 years of college o Percentage of households containing one or more	with each covariate was statistically different from zero. The current risk adjustment model includes only covariates that were significant at a level of 0.05 for either outcome in at least 80 percent of bootstrap samples. • To evaluate the impact of each risk factor, the marginal effects were calculated. The marginal effect represents the relative impact of each risk factor on the outcome. • Goodness of fit statistics were then calculated for the calibrated model and the 20 percent sample was used for cross-validation. • Once the significant risk factors were identified	

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		sensitive to an array of complex socioeconomic issues and may necessitate a substantial paradigm shift in how acute care is provided inlow SES communities. Research has also shown that ED wait time is also linked to factors related to race/ethnicity, with black patients having longer wait times than nonblack patients. • Even after adjustment for potential confounding factors, lower			person per room	in the development stage, the model was then calibrated using 100 percent of home health stays. • To determine the impact of SDS factors on the risk adjustment model the developer performed a number of analyses: o Prevalence of each SDS factor across home health agencies (HHA); o Distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor to	

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		income is a positive predictor of readmission risk of patients for heart failure. • A study of community-dwelling elders with Medicare coverage discharged to home found that living alone and lower levels of education were significant predictors of readmission. • Significant disparities have been found in visits to the ED for conditions sensitive to ambulatory care by race/ethnicity, insurance status,				determine if there is variation in HHA performance across populations with low/high proportions of each SDS factor; o Univariate associations between the SDS characteristics and the outcome; o C-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to	

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		age group, and socioeconomic status.				improvement in the model's ability to differentiate between outcomes; o and HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment. • The median percentage of stays for beneficiaries with dual Medicaid eligibility is 17.7% (IQR: 8.4% to 40%). The median percentage of stays for beneficiaries who live rural locations is 2.4% (IQR: 0% to 30%). The median	

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						percentage of stays for beneficiaries with high and low SES Index Scores is 25.3% (IQR: 10.7% to 46.2%) and 6.9% (IQR: 0% to 24.1%), respectively. • The developer found that in a univariate association HHAs that provide care to dual-Medicaid beneficiaries or beneficiaries classified with low SES Index score have higher unadjusted performance rates (i.e., higher readmission rates). • The c-statistic scores are similar across all variations of the risk adjustment models. The effect sizes for the SDS characteristics are modest and their	

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						inclusion in the risk adjustment model has a negligible impact on the parameter estimates of the clinical characteristics. o The c-statistic for the original model is 0.7119. The c-statistic for the original model plus all SDS variables in 0.7120. • The developers found that of the 11,580 HHAs, 21 (0.18%) HHAs shift categorizations by adjusting for Medicaid Status, 5 (0.04%) HHAs shift categorizations by adjusting for rural status, and 39 (0.34%) HHAs shift categorizations by adjusting for the SDS	

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						Index. Of the 11,580 HHAs, 45 (0.39%) HHAs shift categorizations by adjusting for all SDS variables.	
2496	Standardized Readmission Ratio (SRR) for dialysis facilities	There has been increasing interest in exploring the relation of hospital readmissions for dialysis patients with patient characteristics such as income, education, insurance status, race and employment status. However, many existing studies of this set of relationships were conducted in other health care situations, such as in nursing homes	National ESRD patient database and Medicare Claims Standard Analysis Files: • Unemployment status six months prior to onset of ESRD • Dual eligibility status at index discharge (low-income) • Medicare as secondary insurance coverage at index	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These variables represent the underlying conceptual construct well. With the measures focus on dialysis setting, the Committee recommended testing several additional variables:	• Patient level (Data obtained from Medicare claims and administrative data) oEmployment status 6 months prior to ESRD onset o Race o Ethnicity o Medicare coverage at index hospital discharge • ZIP code	• The measure's risk adjustment is based on a two-stage logistic model. Adjustment is made for patient age, sex, diabetes, duration of ESRD, BMI at ESRD incidence, prior-year comorbidities, length of hospital stay and presence of a high-risk diagnosis at discharge. In the first stage of this model, both dialysis facilities and hospitals are represented as random effects, and regression adjustments are made for the set of patient-level characteristics listed	Age and gender are included in the original model. Additional SDS variables were not included.

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		and hospitals. In addition, much of the work on socio-demographic (SDS) factors and readmissions has been done at the geographic level, as opposed to the individual patient level. o Philbin et al. (2001) found substantially higher risks of readmission for persons residing in low income ZIP codes. o Foster et al. (2014) applied the Community Need Index (CNI) developed by Truven Health	discharge (higher income) • Race • Age	• Regional characteristics (county-level variables) • Partial versus full dual or disability status (in addition to status at index discharge)	level Area Deprivation Index (ADI) derived from Census data (Source: Singh, GK. Area deprivation and widening inequalities in US mortality, 1969–1998. Am J Public Health. 2003;93(7):1137–1143)	above. From this stage, the developers obtain the estimated standard deviation of the random effects of hospitals. • The second stage of the model is a mixed-effects model, in which facilities are fixed effects and hospitals are modeled as random effects, with the standard deviation specified as equal to its estimate from the first stage. The expected number of readmissions for each facility is estimated as the summation of the probabilities of readmission for the discharges of all patients in this facility, assuming the national average or norm for facility effect. This model accounts for	

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		Analytics to analyze variation in all-cause hospital readmission, with and without adjustment for socioeconomic (SES) characteristics and race. The results show that standardizing for SES characteristics and race reduces the variation in readmission across hospitals, potentially resulting in a fairer comparison of readmission rates.				a given facility's case mix using the same set of patient-level characteristics as those in the first stage. • The developer notes that all risk factors included in the model have face validity, and all but four- age 60-75 years, being underweight, being respirator-dependent or experiencing a hip fracture/dislocation at some point in the year leading up to hospitalization—are also significantly predictive of readmission in the original SRR model. • The c-statistic for the original model is 0.6265. • Using hierarchical binary logistic regression the developers fit three	

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		o Singh has developed the Area Deprivation Index (ADI) with colleagues at the University of Wisconsin. Like the CNI, the ADI reflects a full set of SES and demographic characteristics, measured at the ZIP code level. He found area differences in mortality associated with low SDS. All the aforementioned studies have provided evidence that, at least at a conceptual level, patient SDS				additional models for readmissions to • 2014 hospitalization data (Medicare claims), including covariates from the original SRR model and adding several SES indicators as well as patients' race/ethnicity. • Several patient-level factors are significantly predictive of readmissions (being unemployed, being dually eligible for Medicare and Medicaid, race and Hispanic ethnicity). • After adding these covariates, the SRRs remain highly correlated with the original SRR model (correlation coefficient >.99 for all models) and outlier	

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		characteristics may affect the likelihood of hospital readmission among dialysis patients. The developer also conducted preliminary analyses of the relationship between SDS and the SRR for dialysis facilities. The developers found some indication that patients who come from the ZIP codes with higher incomes have somewhat lower readmission rates, though the effect is fairly modest. The developers found that within the same facilities,				facilities are flagged at a nearly identical rate (kappa statistic >.96 for all models). • The developers note that results show that facility profiling changes very little with the addition of these selected patient- or area-level SDS/SES factors. This empirical finding demonstrating very minimal differences, coupled with the risk of reducing patients' access to high quality care supports their recommendation to not adjust for SDS factors.	

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		black patients have an odds ratio of 0.9993 for readmission compared to the non-black patients. Similarly, within the facilities, Hispanic patients have an odds ratio of 0.98 for readmission compared to those who are identified as non-Hispanic. Both results suggest that race and ethnicity not have strong impact on readmission within the same facility. On the other hand, there is an obvious upward trend in the SRR among facilities with increasing					

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		proportions of black patients. This indicates that, even having accounted for the within-facility differences in readmissions between black and non-black patients, facilities with higher proportions of black patients have higher readmission rates than those with lower proportion of black patients.					
2502	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitatio	The potential relationship between SDS risk factors and the outcome of readmissions postdischarge from Inpatient Rehabilitation	Medicare claims data: • Age • Gender • Race • Dual Eligibility Indicator	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These variables represent the underlying	• Race • Dual status • Poverty • Education • Housing • Employment • Community characteristi c including:	• This measure uses a hierarchical logistic regression model developed to harmonize with NQF #1789. • The equation is hierarchical in that both individual patient characteristics are	Age, gender, and original reason for entitlement are included in the original model. Additional SDS variables were

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	n Facilities (IRFs)	Facilities (IRFs) is plausible; however, the literature on such relationships specific to this setting is limited. The literature suggests that race and socio-economic status are possible patient-level risk factors that should be tested.	Long-Term Care Hospital (LTCH) Continuity Assessment Record & Evaluation (CARE) Data Set: • Marital status at time of admission • Preferred language County-level variables, (possible sources) U.S. Census data, the Health Professional Shortage Area designation database: • Median household income • Employment rate	conceptual construct well.	median household income, percent of residents with qualification for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment	accounted for as well as the clustering of patients into IRFs. • The statistical model estimates both the average predictive effect of the patient characteristics across all IRFs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. • The sum of the probabilities of readmission of all • patients in the facility measure, including both the effects of patient characteristics and the IRF, is the“predicted number” of readmissions after adjusting for case mix. The same equation is	not included.

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			• Degree of urbanization • Median education level • Availability of primary care providers		, non-English speakers, and levels of educational attainment. • provider supply and access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care,	used without the IRF effect to compute the "expected number" of readmissions for the same patients at the average IRF. The ratio of the predicted-to-expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This SRR is then multiplied by the mean readmission rate for all IRF stays to get the risk-standardized readmission rate (RSRR) for each facility. • To test SDS factors for this measure, the developers performed a number of analyses including: assessing variation in prevalence	

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					specialist, and physical therapist providers per capita.	of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. • The developer created a hierarchical logistic regression model that added patient-and county level SDS	

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						variables to the risk adjustment mode. • In order to evaluate models with all SDS variables added, the developer performed stepwise versions of logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. • The developer then evaluated the c-statistic for each model. • The stepwise regression models for the model with all patient- and county-level variables included had a c-statistic of 0.70. The original model had a c-statistic of 0.70, so no improvement was observed with the	

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						addition of SDS-related predictors. • The developer also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise selection was approximately 0.01 percentage points • The performance of 0.3 percent of facilities improved by between one half and 1 percentage point, and 1.3 percent of facilities' scores worsened by between one half and 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise	

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						model). Results from both analyses suggest that performance for the majority of facilities declined as a result of the additional SDS adjustment. • The developer examined the correlations of the original and SDS adjusted RSRRs. The developer notes that the high degree of correlation between the RSRRs (>0.97 for all three SDS-adjusted models that are the focus of this work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different. • The developer chose not to include SDS variables in the final risk	

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						adjustment model.	
2503 2504	Hospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries. 30-day Rehospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries	The readmissions/1000 measure describes the readmission experience of a population of fee-for-service (FFS) Medicare beneficiaries; members of the population are defined by the geography of where they live. The measure is intended to track change in readmissions over time for a geographic region, and the SDS composition of a region's population are unlikely to change	Medicare Part A Claims and Denominator File • Gender • Race/ethnicity (not viewed as reliable enough) • Age Group •	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer, and suggested that developers look at all 3 variables. These variables represent the underlying conceptual construct well. The Standing Committee recommended testing additional variables: • Neighborhood characteristics (area	• Population age distribution • Population gender distribution • Race	• This measure does not have a statistical risk model. • The developers recommend that the measure be stratified or adjusted by age category: Younger than 65, 65-69, 70-74, 75-79, 80-84, and 85 years and older. • Analysis of Medicare claims for change in hospitalization and rehospitalization rates between 2011 and 2014 shows the gender adjusted rates to be no different than crude rates, and rates calculated using adjustment for age and gender categories to be no difference than adjustment for the age	• Population age distribution

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		quickly, therefore we are using this measure without adjusting for the SDS of individual members. The readmissions/1000 measure probably reflects the influence of neighborhood contextual factors however, many of which are likely to be strongly correlated with socio-demographic (SD) determinants, or with personal SD factors that are often grouped into neighborhoods. What is unclear, and should be tested further, is whether or not		deprivation index – build on similar testing developer stated as having conducted in the past) • Housing status • Dual eligibility status • Facility characteristics		category only. • On average, communities showed a reduction in admission rates between 2011 and 2012 that was 3/1000 greater using the unadjusted rate as compared to the age adjusted rate. Several communities experienced unadjusted improvement rates more than 6/1000 better using the unadjusted rate. For readmission, communities showed a reduction in rates on average between 2011 and 2012 that was 0.56/1000 greater using the unadjusted rate as compared to the age adjusted rate.	

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		neighborhoods of concentrated deprivation have more or less capacity to change, as many improvement initiatives focus efforts on such neighborhoods.					
2505	Emergency Department (ED) Use without Hospital Readmission during the First 30 Days of Home Health	Findings from the literature support a linkage between proposed SDS factors and ED use and hospital readmission. Individuals with lower social economic status (SES) are more likely to use EDs for primary health care services. In the home health setting, the 30-day	Medicare Claims Data: • Prior Care Setting • Age and gender interactions • Health Status (from Medicare claims) • Medicare Enrollment Status • Additional interactions	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These variables represent the underlying conceptual construct well. In addition to looking at neighborhood characteristics, the	• Medicaid Status – included in the CMS Enrollment Database (EDB) • Rural Location – determined from beneficiary address, as captured in EDB • SES Index	• A single multinomial logit model was used to predict the ED Use without Hospital Readmission During the First 30 Days of Home Health measure. • Of the 1,669,802 qualifying home health stays beginning from July 1, 2010 to June 30, 2013, a random 80 percent sample without replacement was chosen to calibrate the multinomial logit model	Age and gender are included in the original model. Additional SDS variables were not included.

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		period for re-hospitalization occurs while the patient is living in their own home, increasing the likelihood that non-medical factors, including geographic location and economic resources, will have an impact on acute care use. More specific findings regarding the documented relationship between socio-demographic factors, readmission and ED use are described below. • A recent study of 30-day hospital	between Hierarchical Condition Categories (HCCs) and Medicare Enrollment Status (income and employment) Identified additional SDS factors to be tested from Medicare Enrollment Database (EDB) and Survey data: • Race/Ethnicity (EDB) • Medicaid Status (EDB) • Rural location (EDB) • Neighborhoo	Committee highlights the importance of looking at rural location, as stated in the developer's future analysis plan.	Score – determined from beneficiary address linked to American Community Survey (ACS) data. The index is a composite of seven ACS variables: o Percentage of people in the labor force who are unemployed o Percentage of persons below US poverty line o Median household	and to estimate marginal effects for model development purposes. The remaining 20 percent of the stays were used to cross-validate the model. • To determine which risk factors should be included in the risk adjustment model, a Wald test of joint restrictions was applied to each variable in each of 1,150 bootstrap samples created using simple random sampling, with replacement, of 80 percent of all home health stays. The Wald test determined the likelihood that the change in either or both outcomes associated with each covariate was	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		readmission of elderly patients with initial discharge destination of HH care found race to be a significant predictor of readmission. • One study of 1375 patients examining differential use of EDs by various racial and ethnic groups found confounding impact by other SDS variables and concluded that programs to reduce inappropriate ED use must be sensitive to an array of complex	d characteristics (survey)		income o Median value of owner-occupied homes o Percentage of persons aged ≥ 25 years with less than a 12th-grade education o Percentage of persons aged ≥ 25 years with at least 4 years of college o Percentage of households containing one or more person per room	statistically different from zero. The current risk adjustment model includes only covariates that were significant at a level of 0.05 for either outcome in at least 80 percent of bootstrap samples. • To evaluate the impact of each risk factor, the marginal effects were calculated. The marginal effect represents the relative impact of each risk factor on the outcome. • Goodness of fit statistics were then calculated for the calibrated model and the 20 percent sample was used for cross-validation. • Once the significant risk factors were identified in the development	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		socioeconomic issues and may necessitate a substantial paradigm shift in how acute care is provided inlow SES communities. Research has also shown that ED wait time is also linked to factors related to race/ethnicity, with black patients having longer wait times than nonblack patients. • Even after adjustment for potential confounding factors, lower income is a positive predictor of				stage, the model was then calibrated using 100 percent of home health stays. • To determine the impact of SDS factors on the risk adjustment model the developer performed a number of analyses: o Prevalence of each SDS factor across home health agencies (HHA); o Distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor to determine if	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		readmission risk of patients for heart failure. • A study of community-dwelling elders with Medicare coverage discharged to home found that living alone and lower levels of education were significant predictors of readmission. • Significant disparities have been found in visits to the ED for conditions sensitive to ambulatory care by race/ethnicity, insurance status, age group, and socioeconomic				there is variation in HHA performance across populations with low/high proportions of each SDS factor; o Univariate associations between the SDS characteristics and the outcome; o C-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to improvement in	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		status.				the model's ability to differentiate between outcomes; o and HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment. • The median percentage of stays for beneficiaries with dual Medicaid eligibility is 17.7% (IQR: 8.4% to 40%). The median percentage of stays for beneficiaries who live rural locations is 2.4% (IQR: 0% to 30%). The median percentage of stays for	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						beneficiaries with high and low SES Index Scores is 25.3% (IQR: 10.7% to 46.2%) and 6.9% (IQR: 0% to 24.1%), respectively. • The developer found that in a univariate association HHAs that provide care to dual-Medicaid beneficiaries or beneficiaries classified with low SES Index score have higher unadjusted performance rates (i.e., higher readmission rates). • The c-statistic scores are similar across all variations of the risk adjustment models. The effect sizes for the SDS characteristics are modest and their inclusion in the risk	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						adjustment model has a negligible impact on the parameter estimates of the clinical characteristics. o The c-statistic for the original model is 0.6429. The c-statistic for the original model plus all SDS variables in 0.6475. • The developers found that of the 11,580 HHAs, 72 (0.62%) HHAs shift categorizations by adjusting for Medicaid Status, 240 (2.07%) HHAs shift categorizations by adjusting for rural status, and 112 (0.97%) HHAs shift categorizations by adjusting for the SDS	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						Index. Of the 11,580 HHAs, 244 (2.11%) HHAs shift categorizations by adjusting for all SDS variables.	
2510	Skilled Nursing Facility 30-Day All-Cause Readmission Measure (SNFRM)	The potential relationship between SDS risk factors and the outcome of hospital readmissions for Skilled Nursing Facility (SNF) patients is plausible; however, the literature on such relationships specific to this setting is not extensive. Research	Medicare claims data: • Age • Gender • Race • Dual Eligibility Indicator Long-Term Care Hospital (LTCH) Continuity Assessment Record & Evaluation (CARE) Data Set: • Marital status at time of	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These represent the underlying conceptual construct well. Here are additional variables that they would recommend: • County-	• Race • Dual status • Poverty • Education • Housing • Employment • Community characteristic including: median household income, percent of residents with qualification	• This measure uses a hierarchical logistic regression model developed to harmonize with NQF #1789. • The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into SNFs. • The statistical model estimates both the average predictive effect of the patient	Age, gender, and original reason for entitlement are included in the original model. Additional SDS variables were not included.

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		has found that racial and socio-demographic disparities exist both in the quality of nursing facilities as well as in hospital readmission rates. The literature suggests that race and socio-economic status are possible patient-level risk factors that should be tested.	admission • Preferred language County-level variables: (possible sources) U.S. Census data, the Health Professional Shortage Area designation database: • Median household income • Employment rate • Degree of urbanization • Median education level • Availability of primary care providers	level variables (zip code), with particular focus on frequency of updates depending on data source (annual survey or census data every 10 years) based on census data	for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment, non-English speakers, and levels of educational attainment. • provider supply and	characteristics across all SNFs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. • The sum of the probabilities of readmission of all • patients in the facility measure, including both the effects of patient characteristics and the SNF, is the“predicted number” of readmissions after adjusting for case mix. The same equation is used without the SNF effect to compute the “expected number” of readmissions for the same patients at the average SNF. The ratio of the predicted-to-	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
					access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care, specialist, and physical therapist providers per capita.	expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This SRR is then multiplied by the mean readmission rate for all SNF stays to get the risk-standardized readmission rate (RSRR) for each facility. • To test SDS factors for this measure, the developers performed a number of analyses including: assessing variation in prevalence of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. • The developer created a hierarchical logistic regression model that added patient-and county level SDS variables to the risk adjustment mode. • In order to evaluate models with all SDS variables added, the developer performed stepwise versions of	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. • The developer then evaluated the c-statistic for each model. • The stepwise regression models for the model with all patient- and county-level variables included had a c-statistic of 0.671. The original model had a c-statistic of 0.670. • The developer also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						selection was approximately -0.1 percentage points • The developers found that the impact of adjusting for dual eligibility only was small: no facilities' performance improved or declined by more than 1 percentage point. However, slightly more facilities improved (53% versus 47%). • The developers noted more change in performance after adjusting for the refined set of SDS factors. • Specifically, the performance of 5 percent of facilities improved greater than 1 percentage point, and 1 percent of facilities' scores worsened by	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						greater than 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise model). • Finally the developer examined the correlations of the original and SDS adjusted RSRRs across facilities. The developer notes that the high degree of correlation between the RSRRs (>0.96 for all three SDS-adjusted models that are the focus of this work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different. • The developer chose not to include SDS variables in the final risk	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						adjustment model.	
2512	All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)	The potential relationship between SDS risk factors and the outcome of readmissions postdischarge from Long-Term Care Hospitals (LTCHs) is plausible; however, there is a lack of literature on this topic specific to this setting. Evidence from readmission rates	Medicare claims data: • Age • Gender • Race • Dual eligibility indicator Long-Term Care Hospital (LTCH) Continuity Assessment Record & Evaluation (CARE) Data Set: • Marital status at time of	Standing Committee (SC) reviewed and was generally in agreement with the variables provided by the developer. These variables represent the underlying conceptual construct well.	• Race • Dual status • Poverty • Education • Housing • Employment • Community characteristic including: median household income, percent of residents with qualification	• This measure uses a hierarchical logistic regression model developed to harmonize with NQF #1789. • The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into LTCHs. • The statistical model estimates both the average predictive effect of the patient	Age, gender, and original reason for entitlement are included in the original model. Additional SDS variables were not included.

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
		following acute care discharge have shown disparities by race with Black beneficiaries having the highest 30-day readmission rates for acute myocardial infarction, heart failure, and pneumonia (Joynt, Orav, and Jha, 2011). Though this evidence is not specific to LTCHs, it suggests that race is one possible patient-level risk factor relevant to post-discharge readmissions that should be tested.	admission • Preferred language County-level variables: (possible sources) U.S. Census data, the Health Professional Shortage Area designation database: • Median household income • Employment rate • Degree of urbanization • Median education level • Availability of primary care providers		for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment, non-English speakers, and levels of educational attainment. • provider supply and	characteristics across all SNFs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. • The sum of the probabilities of readmission of all • patients in the facility measure, including both the effects of patient characteristics and the LTCH, is the“predicted number” of readmissions after adjusting for case mix. The same equation is used without the LTCH effect to compute the “expected number” of readmissions for the same patients at the average LTCH. The ratio of the predicted-to-	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
					access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care, specialist, and physical therapist providers per capita.	expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This SRR is then multiplied by the mean readmission rate for all LTCH stays to get the risk-standardized readmission rate (RSRR) for each facility. • To test SDS factors for this measure, the developers performed a number of analyses including: assessing variation in prevalence of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. • The developer created a hierarchical logistic regression model that added patient-and county level SDS variables to the risk adjustment mode. • In order to evaluate models with all SDS variables added, the developer performed stepwise versions of	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. • The developer then evaluated the c-statistic for each model. • The stepwise regression models for the model with all patient- and county-level variables included had a c-statistic of 0.648. The original model had a c-statistic of 0.646. • The developer also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						selection was 0.00092 percentage points • The developers found that the impact of adjusting for dual eligibility only was small: no facilities' performance improved or declined by more than 1 percentage point. However, the majority of facilities had worse performance after adjusting for dual eligibility (61% versus 39%). • The developers noted more change in performance after adjusting for the refined set of SDS factors. • Specifically, the performance of 5 percent of facilities improved greater than 1 percentage point, and	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						less than 1 percent of facilities' scores worsened by greater than 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise model). The performance for the majority of facilities appears to have declined as a result of the additional SDS adjustment. • Finally the developer examined the correlations of the original and SDS adjusted RSRRs across facilities. The developer notes that the high degree of correlation between the RSRRs (>0.97 for all three SDS-adjusted models that are the focus of this	

NQF #	Measure Title	Conceptual Relationship	Data Sources and Variables	Committee Feedback on conceptual relationship and variables	SDS Variables Tested	Empirical Relationship	SDS Variables Included in the Final Model
						work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different. • The developer chose not to include SDS variables in the final risk adjustment model.	

MEMORANDUM

To: NQF Admissions & Readmissions Standing Committee

From: James Muller, Marsida Domi, Urvi Patel & David Gifford, AHCA
Anna Nicolaou, Tom Martin & Barry Fogel, PointRight

Date: April 27th, 2016

Subject: Response to NQF SDS Trial Period analyses for NQF #2375, the PointRight® Pro 30™ short stay SNF rehospitalization measure

In August 2015, AHCA and PointRight submitted an analysis plan for our participation in NQF's Socio-Demographic Status (SDS) Trial Period project. Since then, we have conducted the work laid out in the plan, incorporating feedback NQF gave to us on the analysis plan. This memo presents the results of our work, organized into the eleven questions NQF had posed the SDS Trial Period participants.

Question 1. Enter measure # and title

Measure # 2375 PointRight ® Pro 30™

Question 2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

In our August 2015 analysis plan for the NQF SDS Trial Period, AHCA and PointRight proposed to analyze a wide array of sociodemographic factors targeting seven domains: age, sex, race, marital status, language, race and poverty. On reviewing our initial lengthy list of factors, NQF then recommended that we prune the list down to the most essential and meaningful of those variables, which we did as follows.

First, at the time of our analysis plan, the MDS requests for data that AHCA was making to calculate the measure did not include the patient's Medicaid identifier – which indicates Medicaid enrollment (a poverty measure when observed in the post-acute short stay population), and we did not expect to receive these data. To compensate, we proposed a long list of second-best proxy measures to use in lieu of a direct indicator that the patient was enrolled in Medicaid. Most of these were at the regional level (e.g., via

census and other data). However, since then, CMS has approved inclusion of the patient's Medicaid identifier in AHCA's quarterly MDS data requests. This eliminated the need for all of the proxy measures, allowing us to focus on the first-best Medicaid enrollment identifier.

Second, we initially proposed analyzing variables at three levels of analysis: the patient level, facility level, and regional level. As we proceeded with the analysis design, we arrived at a methodology that, similarly, superseded this original framework. In particular, we adopted a methodology that adjusted for patient level variance in readmission rates *excluding the facility-level variance in readmission rates*. This approach controls for the portion of variance in the rates that are beyond a facility's control and which are orthogonal to the facility's quality of care.

Third, on consideration of age and sex, both of which were already included in the measure's risk model, we concluded that their main action was clinical rather than "sociodemographic", and thus left them out of further consideration in this project, but maintaining them as clinical adjustors in the risk model.

Fourth, when we considered the inclusion of language status ("needs an interpreter") in the risk model, our clinical experts raised serious doubts about the conceptual link between needing an interpreter and SNF rehospitalization rates. Additionally, only 3% of patients in the denominator needed an interpreter. We therefore dropped language status from further consideration in this project.

Fifth, marital status was grouped as married or single (i.e., widowed, separated, divorced, never married). Marital status is considered a proxy for support availability at home (Berkman & Mreslow, 1983).

Therefore, the final list of patient-level sociodemographic variables that we had available and analyzed were:

- Marital status (married or single)
- Race (black or non black)
- Medicaid enrollment (via the patient having a non-missing Medicaid identifier)

Next, our exploration of adding these variables into the measure's risk model employed a modified form of our original risk model. The risk model for our currently-endorsed measure's NQF application uses an ordinary logistic regression, predicting the probability of rehospitalization at the stay level. As mentioned above, particularly for race and Medicaid enrollment, which correlate with lower quality facilities (see our August analysis plan for the SDS trial period), it is important to decompose the effect of the SDS factors on rehospitalizations into the between-facility component and the within-facility component. The between-facility part of the effect is the main correlate with actual facility quality, and should not be controlled for in the measure; the within-facility part of the effect, however, *may* represent differences outside the facility's control. To model this, we used a two-stage logistic model. First, we fit a logistic regression including all clinical adjustors as well as race and Medicaid enrollment, with facility fixed effects (to remove the facility effects from

the coefficient estimates). Second, we fit a second logistic regression (this time without fixed effects) including all clinical adjustors plus marital status, and included race and Medicaid with the coefficients set as those in the first regression. For a detailed description of the methodology, see our third analysis in our response to Question 5. This was our best methodological approach for then evaluating the effect of adding the SDS factors to the model.

References

Berkman L, Breslow L. *Health and Ways of Living: the Alameda County Study.* New York: Oxford University Press, 1983.

Question 3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

We performed a detailed examination of the potential value of including sociodemographic factors as risk adjusters in the Pro 30 post-acute rehospitalization measure. Specifically we addressed the question of whether adding sociodemographic adjustment would improve the validity of the measure as an indicator of the quality of post-acute care provided to SNFs. In our view, risk adjustment for patient-level sociodemographic factors of a facility-level performance measure should be done if the following conditions apply:

1) A risk adjustment model including the factors explains more variance in outcome than a model without such factors.
2) Differential outcomes for patients with different sociodemographic variables should be primarily due to otherwise-unmeasured differences in health status and not to disparities in the quality of healthcare provided to patients in particular sociodemographic groups. Risk adjustment should not "adjust away" disparities in care quality that should be the focus of quality improvement efforts.
3) The effects of sociodemographic factors in the risk adjustment model are compatible with research findings on the univariate effect of the factors and are not better explained by non-sociodemographic factors that are correlated with them.
4) Incorporating the sociodemographic factors in risk adjustment would significantly change the overall appraisal of clinical performance for a significant proportion of providers (in this case SNFs), so that including them would be necessary for the fair application of performance-based incentives and penalties.

Our response to Question 5 presents the detailed analyses to evaluate whether including SDS factors would accomplish this goal. By the end of those analyses, we had concluded than none of these four criteria were satisfied by the SDS factors, and therefore recommend that none of the sociodemographic independent variables should be added to the

PointRight® Pro 30™ risk adjustment model. In fact, adding these SDS variables could have the undesirable effect of adjusting for poor quality SNFs.

Question 4. What were the statistical results of the analyses used to select risk factors?

Noting that we recommend *not* adding any SDS factors to the PointRight® Pro 30™ risk model, here we present the approach used to select risk factors in the measure as currently endorsed by NQF, as summarized in our responses to Sections 2b4.3, 2b4.4 and 2b4.5 of the original NQF application.

High level strategy for electing and selecting risk factors, and conclusions

A clinical panel reviewed the entire MDS for skilled nursing facilities, identifying items that might be expected on clinical grounds to correlate with 30 day readmission risk, and that would be unlikely to change between the day of hospital discharge and the day of the first MDS assessment – which takes place by day 8 of the stay for all Medicare patients. Such items included demographics, chronic disease diagnoses, treatments begun in the hospital with orders to be continued in the SNF, and functional status items that change slowly when they change at all, such as the patient's needing two-person assistance for transferring and/or bed mobility. These items were screened for significant univariate associations with the dependent variable (readmission to any acute care hospital directly from the SNF within 30 days of admission). This process yielded 39 candidate variables. A logistic regression formula was then estimated utilizing the 39 candidates; this was progressively refined into one that utilized 33 independent variables. The six dropped variables from the 39 – PTSD, transfusions, tuberculosis, continuing radiation therapy, continuing ventilator status, and continuing suction did not add explained variance if added to a model that already included the 33 actually used. With the exception of ventilator status and suction, the variables all had relatively low prevalence in the model-building sample. Ventilator status and suction were strongly associated with tracheostomy care, so it was not surprising that only one of the three variables was significant in the multivariate model that we ultimately selected for risk adjustment of readmission rates.

Approach for statistical testing

A bootstrap analysis as well as a stability analysis on the variables was conducted.

We performed a bootstrap analysis of the coefficients for PointRight® Pro 30™ in the following way: We began with a sample of 585,572 admissions to SNFs from acute care hospitals with admission dates in CY2011. Data were used if the SNF involved had a discharge assessment completion rate of 95% or higher. We calculated the coefficients of the PointRight® Pro 30™ logistic regression model on 1000 subsamples of 292,786 admissions. The distributions for each of the coefficients are displayed in the following table (Table 9) and compared with the coefficients used in the PointRight® Pro 30™ model, which was developed using a slightly different sample comprising 600,000 admissions to SNFs.

The PointRight® Pro 30™ model is based on the assumption that its independent variables rarely change between the day of admission and the assessment reference date of the first MDS assessment. While we cannot assess this directly we can look at the change from the first to the second PPS assessment of Medicare patients who remain in the facility long enough for two assessments. Typically this will be the change from day 7 to day 14 of a post-acute stay. This provides a rough estimate of variable stability. Table 2 shows the rates of change between assessments that were 7 days apart (N= 203,386). Note that only four variables show rates of change – usually in the direction of improvement – of greater than 10%. These variables are those for cognitive impairment, total bowel incontinence, two-person assist, and continued oxygen therapy. For these four variables the table shows the prevalence of 1s in the model building sample and the coefficient in the PointRight® Pro 30™ model. Considering all of the facts, it appears that facility-level estimates of expected readmission rates are unlikely to be affected greatly by variable instability. When the PointRight® Pro 30™ model is applied to data collected on the day of admission it will slightly overestimate the expected risk, because some patients with values of 1 on the least stable IVs will become zeroes by the day of the first MDS assessment.

Results from statistical testing

Bootstrap:

Table 1 shows the difference between the PointRight® Pro 30™ coefficients and the mean coefficients from the bootstrap analysis, expressed as actual values, standard deviation (S.D.) and percentage. It is evident that only a few variables have more than 10% variation from the bootstrap mean; for those variables the absolute value and/or the number of standard deviations is clinically acceptable.

Table 1. PointRight® Pro 30™ Coefficients Compared with Mean from Bootstrap Sampling

Variable Type	Independent Variable	PointRight® Pro 30™ Coefficient	Bootstrap Mean	S.D.	Difference	Difference in S.D.	Difference in %
Intercept	Intercept	-2.825	-2.819	0.019	-0.006	-0.32	0.2%
Type of Admission	Medicare	0.554	0.555	0.015	0.000	-0.03	-0.1%
	Re-entry	0.140	0.125	0.011	0.015	1.30	10.6%
Demographics	Male	0.162	0.158	0.010	0.005	0.48	2.9%
	Age Under 65	0.177	0.177	0.013	0.000	0.02	0.2%
Diagnoses	Anemia	0.092	0.092	0.010	0.000	0.02	0.2%
	Asthma	0.103	0.105	0.011	-0.002	-0.16	-1.7%
	Diabetes Mellitus	0.046	0.062	0.014	-0.016	-1.15	-34.6%

Diagnoses	Diabetic Foot Ulcer	0.146	0.139	0.044	0.007	0.17	5.0%
	Heart Failure	0.200	0.206	0.012	-0.006	-0.51	-3.0%
	Internal Bleeding	0.892	0.912	0.040	-0.020	-0.49	-2.2%
	Pressure Ulcer (Stage 2)	0.167	0.181	0.016	-0.014	-0.86	-8.2%
	Pressure Ulcer (Stage 3)	0.133	0.197	0.030	-0.063	-2.12	-47.5%
	Pressure Ulcer (Stage 4)	0.157	0.146	0.037	0.011	0.29	6.8%
	Pressure Ulcer (Unstageable)	0.181	0.163	0.020	0.018	0.92	10.2%
	Respiratory Failure	0.116	0.163	0.025	-0.047	-1.86	-40.6%
	Septicemia	0.089	0.121	0.029	-0.032	-1.09	-35.7%
	Vascular Ulcer	0.186	0.181	0.027	0.006	0.21	3.0%
	Viral Hepatitis	0.402	0.310	0.049	0.092	1.87	22.8%
Symptom	Daily Pain	0.061	0.054	0.017	0.007	0.40	11.1%
Functional Status	Bowel Incontinence (Total)	0.185	0.176	0.011	0.009	0.77	4.7%
	Cognition Not Intact	0.333	0.331	0.011	0.001	0.14	0.4%
	Eating Dependence	0.472	0.430	0.017	0.042	2.48	8.9%
	Two-Person Assist for Any ADL	0.239	0.226	0.011	0.013	1.21	5.3%
Treatments Continued from Hospital	Cancer Chemotherapy	0.600	0.595	0.050	0.005	0.10	0.8%
	Dialysis	0.604	0.606	0.021	-0.002	-0.09	-0.3%
	Insulin	0.178	0.159	0.015	0.018	1.21	10.3%
	IV Fluids or Meds	0.188	0.179	0.017	0.009	0.52	4.7%
	Ostomy Care	0.326	0.349	0.026	-0.023	-0.87	-6.9%
	Oxygen	0.340	0.346	0.012	-0.007	-0.56	-2.0%
	Radiation Therapy	0.611	0.489	0.069	0.122	1.77	19.9%
Treatments Continued from Hospital	Tracheostomy Care	0.134	0.170	0.040	-0.037	-0.91	-27.5%

Mitigating Factors	End-Stage Prognosis	-0.785	-0.729	0.056	-0.056	-1.00	7.1%
	Hospice Care	-1.509	-1.423	0.098	-0.086	-0.87	5.7%

Variable Stability:

Table 2. Variable Stability between Two Assessments Seven Days Apart

Variable	% Changing from 0 to 1	% Changing from 1 to 0	% Unchanged	Prevalence of 1s in Validation Sample	Coefficient in Model
Medicare	0%	0%	100%		
Re-entry	1%	1%	99%		
Male	0%	0%	100%		
Age Under 65	0%	0%	100%		
Anemia	2%	2%	98%		
Asthma	1%	2%	99%		
Diabetes Mellitus	1%	1%	99%		
Diabetic Foot Ulcer	0%	0%	100%		
Heart Failure	1%	1%	99%		
Internal Bleeding	0%	0%	100%		
Pressure Ulcer Stage 2	0%	2%	100%		
Pressure Ulcer Stage 3	0%	0%	100%		
Pressure Ulcer Stage 4	0%	0%	100%		
Pressure Ulcer Unstageable	0%	1%	100%		
Respiratory Failure	0%	1%	100%		
Septicemia	0%	1%	100%		
Vascular Ulcer	0%	0%	100%		
Viral Hepatitis	0%	0%	100%		
Daily Pain	2%	4%	98%		
Bowel Incontinence (Total)	7%	9%	93%	49%	0.185
Cognition Not Intact	4%	8%	96%	66%	0.333
Eating Dependence	1%	1%	99%		
Two-Person Assist	4%	14%	96%	57%	0.239
Chemotherapy	0%	1%	100%		
Dialysis	0%	3%	100%		

Insulin	1%	2%	99%		
IV Fluids or Medications	0%	6%	100%		
Ostomy Care	0%	0%	100%		
Oxygen	0%	18%	100%	22%	0.34
Radiation Therapy	0%	0%	100%		
Tracheostomy Care	0%	1%	100%		
End-Stage Prognosis	0%	0%	100%		
Hospice Care	0%	0%	100%		

Our original Pro 30 model was most recently refit using hospital admissions to the SNF in CY 2014. Our sample consisted of 2,760 SNFs that consistently submit MDS data to PointRight and had more than 30 admissions to the SNF from the hospital in the 12 month denominator window. The revised coefficients are presented in Table 3 below.

Table 3. Current Pro 30 Model (Ordinary Logistic Regression)

Category of Independent Variable	Independent Variable	Estimates (standard error)	P-Value
Constant	Intercept	-2.9658 (0.0114)	<.0001
Active Diagnoses	Anemia	0.1188 (0.0067)	<.0001
Active Diagnoses	Asthma, COPD or Chronic Lung Disease	0.1125 (0.0074)	<.0001
Active Diagnoses	Diabetes Mellitus	0.0711 (0.0087)	<.0001
Active Diagnoses	Diabetic Foot Ulcer(s)	0.1389 (0.0267)	<.0001
Active Diagnoses	End Stage Prognosis	-0.7109 (0.042)	<.0001
Active Diagnoses	Heart Failure	0.1934 (0.0073)	<.0001
Active Diagnoses	Internal Bleeding	1.0899 (0.026)	<.0001
Active Diagnoses	Respiratory Failure	0.1729 (0.0141)	<.0001
Active Diagnoses	Septicemia	0.0407 (0.0184)	0.0273
Active Diagnoses	Venous or Arterial Ulcer	0.183 (0.0177)	<.0001
Active Diagnoses	Viral Hepatitis	0.3793 (0.0292)	<.0001
Cognition	Cognition Not Completely Intact	0.3421 (0.007)	<.0001
Demographics	Age >= 65	0.0619 (0.0063)	<.0001
Demographics	Male	0.1465 (0.0063)	<.0001
Functional Status	Eating Dependency	0.5957 (0.0121)	<.0001
Functional Status	Two Person Physical Assist Needed for Any ADL	0.2364 (0.007)	<.0001
Hospice Status	Hospice Care	-1.4028 (0.0716)	<.0001
Incontinence	Total Bowel Incontinence	0.197 (0.007)	<.0001
Payer	Medicare Beneficiary	0.4894 (0.0089)	<.0001
Skin	Pressure Ulcer(s) Stage 2	0.1816 (0.0113)	<.0001
Skin	Pressure Ulcer(s) Stage 3	0.1558 (0.0196)	<.0001
Skin	Pressure Ulcer(s) Stage 4	0.0971 (0.0258)	0.0002
Skin	Pressure Ulcer(s) Unstageable	0.1907 (0.0124)	<.0001
Stay History	In this SNF Prior to the Acute Hospitalization	0.2443 (0.0077)	<.0001
Symptoms	Daily Pain	0.094 (0.0126)	<.0001
Treatments	Chemotherapy	0.5697 (0.0303)	<.0001
Treatments	Dialysis	0.6328 (0.0135)	<.0001
Treatments	IV Medications	0.1899 (0.011)	<.0001
Treatments	Ostomy Care	0.3993 (0.0166)	<.0001
Treatments	Oxygen Therapy	0.3394 (0.0078)	<.0001
Treatments	Radiation Therapy	0.5066 (0.0447)	<.0001
Treatments	Receiving Insulin	0.1772 (0.0095)	<.0001
Treatments	Tracheostomy Care	0.0697 (0.0271)	0.0101

Question 5. Describe the analyses and interpretation resulting in the decision to select SDS factors (e.g. prevalence of the factor across measured entities, empirical association with the outcome, contribution of unique variation in the outcome, assessment of between-unit effects and within-unit effects).

We undertook a detailed examination of the potential value of including sociodemographic factors as risk adjusters in the Pro 30 post-acute rehospitalization measure. Specifically we addressed the question of whether adding sociodemographic adjustment would improve

the validity of the measure as an indicator of the quality of post-acute care provided to SNFs.

Our exploratory data analyses used MDS data from 2,790 SNFs that consistently submitted data to PointRight and had more than 30 admissions from the hospital in 2014. All post-acute admissions to these facilities during CY2014 were included in the analyses, resulting in a total of 745,832 admissions from acute care hospitals. The 30-day rehospitalization rate for this patient group as a whole was 18.3%.

In our view, risk adjustment for patient-level sociodemographic factors of a facility-level performance measure should be done if the following conditions apply:

1) A risk adjustment model including the factors explains more variance in outcome than a model without such factors.
2) Differential outcomes for patients with different sociodemographic variables should be primarily due to otherwise-unmeasured differences in health status and not to disparities in the quality of healthcare provided to patients in particular sociodemographic groups. Risk adjustment should not "adjust away" disparities in care quality that should be the focus of quality improvement efforts.
3) The effects of sociodemographic factors in the risk adjustment model are compatible with research findings on the univariate effect of the factors and are not better explained by non-sociodemographic factors that are correlated with them.
4) Incorporating the sociodemographic factors in risk adjustment would significantly change the overall appraisal of clinical performance for a significant proportion of providers (in this case SNFs), so that including them would be necessary for the fair application of performance-based incentives and penalties.

The data analyses conducted on the CY2014 dataset showed that none of the four criteria are met for the three new sociodemographic factors considered here. In the following analyses we utilized the two-level fixed effects framework to apportion the impact of sociodemographic factors between the facility level and the individual patient level.

1. First, we tested the variation of the standardized risk ratios (SRRs) across facilities by a) the proportion of Medicaid patients, and b) the proportion of black patients. Table 4 presents the SRRs for SNFs with less than 15% Medicaid enrolled patients in the measure denominator, those with 15-40%, and those with 40% or more; and SNFs with less than 1% black patients in the denominator, those with 1-15%, and those with 15% or more. Therefore, at the facility level a higher proportion of black patients and/or a higher proportion of Medicaid patients are associated with higher risk-adjusted rehospitalization rates.

Table 4. Standardized Risk Ratios (SRRs) = Observed Rate/Expected Rate

Facility Population Characteristic ==>	Medicaid Proportion < 15%	Medicaid Proportion Between 15% and 40%	Medicaid Proportion >40%	Proportion Black <1%	Proportion Black Between 1% and 15%	Proportion Black Over 15%
Number of SNFs	718	1366	676	661	1353	746
Number of Admissions	289,786	342,317	113,729	126,518	418,580	200,734
Maximum	1.74	2.61	2.03	2.61	1.97	2.03
90th Percentile	1.24	1.29	1.34	1.18	1.29	1.39
75th Percentile	1.09	1.14	1.18	0.99	1.13	1.22
50th Percentile	0.94	0.96	0.99	0.84	0.96	1.06
25th Percentile	0.77	0.80	0.83	0.67	0.80	0.91
10th Percentile	0.64	0.62	0.63	0.53	0.65	0.76
Minimum	0.17	0.07	0.15	0.07	0.11	0.20

2. Second, we examined the effect of adding sociodemographic factors on the variance explained by the ordinary logistic risk adjustment model. This is the same model form as currently used in the NQF-endorsed measure; Table 3 presents the regression results. Here we observed that all 3 of the added SES variables had significant terms, but there was no improvement in the model's c-statistic. The c-statistic of the current PointRight® Pro 30™ risk adjustment predictive model, an ordinary logistic regression with the MDS as the sole source of independent variables, is 0.676. The c-statistic of an ordinary logistic regression estimated after adding the three above candidate IVs was also 0.676. In other words, all of the variance in rehospitalization rates explainable by suitably reliable and stable MDS variables could be accounted for without the use of the three candidate sociodemographic IVs.

Table 5. Logistic Regression with Three Added SDS Variables

Category of Independent Variable	Independent Variable	Estimates (standard error)	P-Value
Constant	Intercept	-2.9793 (0.0117)	<.0001
Active Diagnoses	Anemia	0.1158 (0.0067)	<.0001
Active Diagnoses	Asthma, COPD or Chronic Lung Disease	0.1212 (0.0074)	<.0001
Active Diagnoses	Diabetes Mellitus	0.0669 (0.0087)	<.0001
Active Diagnoses	Diabetic Foot Ulcer(s)	0.1461 (0.0267)	<.0001
Active Diagnoses	End Stage Prognosis	-0.705 (0.042)	<.0001
Active Diagnoses	Heart Failure	0.1936 (0.0073)	<.0001
Active Diagnoses	Internal Bleeding	1.0901 (0.026)	<.0001
Active Diagnoses	Respiratory Failure	0.1758 (0.0141)	<.0001
Active Diagnoses	Septicemia	0.0437 (0.0184)	0.0179
Active Diagnoses	Venous or Arterial Ulcer	0.1822 (0.0177)	<.0001
Active Diagnoses	Viral Hepatitis	0.3765 (0.0293)	<.0001
Cognition	Cognition Not Completely Intact	0.3428 (0.007)	<.0001
Demographics	Age >= 65	0.0527 (0.0064)	<.0001
Demographics	Male	0.1339 (0.0065)	<.0001
Functional Status	Eating Dependency	0.5884 (0.0122)	<.0001
Functional Status	Two Person Physical Assist Needed for Any ADL	0.2367 (0.007)	<.0001
Hospice Status	Hospice Care	-1.3921 (0.0716)	<.0001
Incontinence	Total Bowel Incontinence	0.1934 (0.0071)	<.0001
Payer	Medicare Beneficiary	0.4907 (0.009)	<.0001
Skin	Pressure Ulcer(s) Stage 2	0.1773 (0.0113)	<.0001
Skin	Pressure Ulcer(s) Stage 3	0.1467 (0.0197)	<.0001
Skin	Pressure Ulcer(s) Stage 4	0.0868 (0.0258)	0.0008
Skin	Pressure Ulcer(s) Unstageable	0.188 (0.0124)	<.0001
Stay History	In this SNF Prior to the Acute Hospitalization	0.2614 (0.008)	<.0001
Symptoms	Daily Pain	0.1014 (0.0126)	<.0001
Treatments	Chemotherapy	0.5632 (0.0303)	<.0001
Treatments	Dialysis	0.6112 (0.0136)	<.0001
Treatments	IV Medications	0.1931 (0.011)	<.0001
Treatments	Ostomy Care	0.4042 (0.0166)	<.0001
Treatments	Oxygen Therapy	0.3434 (0.0078)	<.0001
Treatments	Radiation Therapy	0.5015 (0.0447)	<.0001
Treatments	Tracheostomy Care	0.0594 (0.0271)	0.0285
Treatments	Receiving Insulin	0.1763 (0.0095)	<.0001
Added Sociodemographic Variable	Married	0.0484 (0.0069)	<.0001
Added Sociodemographic Variable	Medicaid	-0.0691 (0.0078)	<.0001
Added Sociodemographic Variable	Black Race	0.1545 (0.0091)	<.0001

3. Third, to study the extent to which health care disparities between different socio-economic groups are the result of differential care within the nursing home or are due to differences resulting from unequal quality of care across nursing homes, we compared the Pro-30 model with a conditional fixed-effects logistic regression model, and then used the SDS factor coefficients as the first stage of a two-stage logistic regression approach.

   Conditional fixed-effects models account for the heterogeneity of facilities. Including facility specific intercepts i.e. the fixed effects, removes any potential confounding in facility outcomes if one social group tended to be associated with facilities with better or poorer quality of care. If there are no across facility differences, the estimates of the coefficients of the standard logistic model (Pro 30) should be very close to the estimates of the conditional fixed effects model.

The difference in the estimates between these two models indicates the existence of heterogeneity across facilities (Cai et al. 2010, Grabowski et al., 2009).

In the first stage, we fit the conditional logistic regression model including all clinical adjustors as well as race and Medicaid enrollment, with facility fixed effects (to remove the facility effects from the coefficient estimates). Tables 5 and 6 present the results from the base and the conditional logistic regression models respectively. The coefficient of the variable "Black" declines from 0.1545 (p-value = 0.0091) in the base logistic model, to 0.0574 (p-value = 0.0105) in the conditional fixed effects model. That is, 63% of the variance related to race black was subsumed by the fixed effects, leaving just 37% of the total effect. The effect of race estimated by the conditional maximum likelihood estimate represents the within facility differences in the risk of re-hospitalization between Black and non-Black residents. The difference between the estimates of the two models is much higher, suggesting that the difference in the re-hospitalization risk detected in the base model, is primarily due to heterogeneity of facilities rather than to differential treatment between Black and non-Black residents within the same facility. This represented strong evidence against including black race in risk adjustment for Pro 30, which was then amplified repeatedly in our other analyses.

For Medicaid status, the coefficients changed less between the ordinary logistic model (-0.0691) and the model with facility fixed effects (-0.0814), however there is still a small between-facility effect beyond the within-facility effect. In particular, the between-facility effect of Medicaid status appears to be positive, and removing it causes the coefficient to become more negative (-0.0814) than the total effect (-0.0691). This suggests the between facility effect is about -15% of the within-facility effect.

Similarly, the coefficient for marital status changed less between the ordinary logistic regression model (0.0484) and the model with fixed effects (0.0560). Again this suggests the between facility effect is about 15% of the within-facility effect.

In the second stage, we fit an ordinary logistic regression (this time without fixed effects) including all clinical adjustors and marital status, and included race and Medicaid with the coefficients set as those in the first regression. This took the coefficients from the fixed effects model for Medicaid and race black and restricted these variables as we allowed the other covariates to be refit in a new logistic regression model. We consider the restricted coefficient of Medicare and race black to be the patient level effects excluding facility level effects. Furthermore, we decided to allow the marital status SDS variable coefficient to be refit as there was no conceptual reason to control away the between-facility effect of marital status, and less evidence to suggest that facility level effects

were confounded with the married/single effect. The estimates of the second stage are presented in Table7.

This second stage model with the restricted coefficients from our first stage, fixed-effects model, is our version of the Pro 30 model that takes into account for SDS factors – that is, if we had chosen to include the factors, this is the model we would have proposed to adopt for the measure.

Table 6. Fixed Effects Logistic Regression with Three Added SDS Variables

Category of Independent Variable	Independent Variable	Estimate (Standard Error)	P-Value
Constant	Intercept	.	.
Active Diagnoses	Anemia	0.1362 (0.0069)	<.0001
Active Diagnoses	Asthma, COPD or Chronic Lung Disease	0.1175 (0.0075)	<.0001
Active Diagnoses	Diabetes Mellitus	0.0682 (0.0088)	<.0001
Active Diagnoses	Diabetic Foot Ulcer(s)	0.1521 (0.027)	<.0001
Active Diagnoses	End Stage Prognosis	-0.6639 (0.0425)	<.0001
Active Diagnoses	Heart Failure	0.1924 (0.0074)	<.0001
Active Diagnoses	Internal Bleeding	1.168 (0.0266)	<.0001
Active Diagnoses	Respiratory Failure	0.1822 (0.0145)	<.0001
Active Diagnoses	Septicemia	0.0771 (0.0188)	<.0001
Active Diagnoses	Venous and Arterial Ulcers	0.1885 (0.0179)	<.0001
Active Diagnoses	Viral Hepatitis	0.3644 (0.0298)	<.0001
Cognition	Cognition Not Completely Intact	0.3679 (0.0073)	<.0001
Demographics	Age >= 65	0.0526 (0.0065)	<.0001
Demographics	Male	0.1288 (0.0066)	<.0001
Functional Status	Eating Dependency	0.5765 (0.0125)	<.0001
Functional Status	Two Person Physical Assist Needed for Any ADL	0.2749 (0.0075)	<.0001
Hospice Status	Hospice Care	-1.4259 (0.0721)	<.0001
Incontinence	Total Bowel Incontinence	0.151 (0.0074)	<.0001
Payer	Medicare Beneficiary	0.5109 (0.0096)	<.0001
Skin	Pressure Ulcer(s) Stage 2	0.1832 (0.0115)	<.0001
Skin	Pressure Ulcer(s) Stage 3	0.121 (0.0199)	<.0001
Skin	Pressure Ulcer(s) Stage 4	0.0601 (0.0262)	0.0217
Skin	Pressure Ulcer(s) Unstageable	0.1788 (0.0127)	<.0001
Stay History	In this SNF Prior to the Acute Hospitalization	0.2083 (0.0082)	<.0001
Symptoms	Daily Pain	0.1292 (0.0132)	<.0001
Treatments	Chemotherapy	0.5829 (0.0306)	<.0001
Treatments	Dialysis	0.6111 (0.014)	<.0001
Treatments	IV Medications	0.2144 (0.0113)	<.0001
Treatments	Ostomy Care	0.418 (0.0168)	<.0001
Treatments	Oxygen Therapy	0.3959 (0.0082)	<.0001
Treatments	Radiation Therapy	0.4916 (0.0452)	<.0001
Treatments	Tracheostomy Care	0.0075 (0.0286)	0.7931
Treatments	Receiving Insulin	0.1644 (0.0096)	<.0001
Added Sociodemographic Variable	Married	0.056 (0.007)	<.0001
Added Sociodemographic Variable	Medicaid	-0.0814 (0.0084)	<.0001
Added Sociodemographic Variable	Black Race	0.0574 (0.0105)	<.0001

Table 7. Logistic Regression with Plugged in SDS Conditional Maximum Likelihood Coefficients

Category of Independent Variable	Parameter	Estimate (Standard Error)	P-Value
Constant	Intercept	-2.9637 (0.0115)	<.0001
Active Diagnoses	Anemia	0.1185 (0.0067)	<.0001
Active Diagnoses	Asthma, COPD or Chronic Lung Disease	0.12 (0.0074)	<.0001
Active Diagnoses	Diabetes Mellitus	0.0724 (0.0087)	<.0001
Active Diagnoses	Diabetic Foot Ulcer(s)	0.144 (0.0267)	<.0001
Active Diagnoses	End Stage Prognosis	-0.7084 (0.042)	<.0001
Active Diagnoses	Heart Failure	0.1935 (0.0073)	<.0001
Active Diagnoses	Internal Bleeding	1.0875 (0.026)	<.0001
Active Diagnoses	Respiratory Failure	0.1757 (0.0141)	<.0001
Active Diagnoses	Septicemia	0.0429 (0.0184)	0.02
Active Diagnoses	Venous and Arterial Ulcers	0.1834 (0.0177)	<.0001
Active Diagnoses	Viral Hepatitis	0.3926 (0.0292)	<.0001
Cognition	Cognition Not Completely Intact	0.3433 (0.007)	<.0001
Demographics	Age >= 65	0.0533 (0.0064)	<.0001
Demographics	Male	0.1347 (0.0065)	<.0001
Functional Status	Eating Dependency	0.5971 (0.0121)	<.0001
Functional Status	Two Person Physical Assist Needed for Any ADL	0.2348 (0.007)	<.0001
Hospice Status	Hospice Care	-1.3928 (0.0716)	<.0001
Incontinence	Total Bowel Incontinence	0.1984 (0.007)	<.0001
Payer	Medicare Beneficiary	0.486 (0.0089)	<.0001
Skin	Pressure Ulcer(s) Stage 2	0.1794 (0.0113)	<.0001
Skin	Pressure Ulcer(s) Stage 3	0.1533 (0.0196)	<.0001
Skin	Pressure Ulcer(s) Stage 4	0.0984 (0.0258)	0.0001
Skin	Pressure Ulcer(s) Unstageable	0.1885 (0.0124)	<.0001
Stay History	Reentry to SNF	0.2665 (0.0077)	<.0001
Symptoms	Daily Pain	0.0992 (0.0126)	<.0001
Treatments	Chemotherapy	0.5639 (0.0303)	<.0001
Treatments	Dialysis	0.6284 (0.0135)	<.0001
Treatments	IV Medications	0.1919 (0.011)	<.0001
Treatments	Ostomy Care	0.4008 (0.0166)	<.0001
Treatments	Oxygen Therapy	0.3387 (0.0078)	<.0001
Treatments	Radiation Therapy	0.5042 (0.0447)	<.0001
Treatments	Tracheostomy Care	0.0666 (0.0271)	0.014
Treatments	Receiving Insulin	0.1774 (0.0095)	<.0001
Added Sociodemographic Variable	Married	0.0406 (0.0068)	<.0001
Added Sociodemographic Variable	Medicaid	-0.0814*	N/A
Added Sociodemographic Variable	Race - Black	0.0574*	N/A

Coefficients labeled with (*) are plugged in from the fixed effects model.

4. Fourth, we analyzed the structural causes of sociodemographic effects on the risk model. The association of married status with a higher readmission rate can be explained by the hypothesis that married patients are more likely to have resources for care at home than non-married patient, and therefore as a group married patients referred to SNFs rather than home-based care have a higher level of illness, functional impairment or need for specialized care than non-

married patients. This would warrant adding marital status to the risk adjustment model if it added to the explained variance in outcome, but it does not.

The association of Medicaid status with a lower rate of rehospitalization seems paradoxical, because lower-income individuals are known to have worse health than those with higher incomes (Hu, Gonsahn and Nerenz, 2014; Calvillo-King et al., 2013), and facilities with a high Medicaid census tend to deliver worse care than those funded primarily by Medicare, commercial insurance, and private payment. (In our sample facilities with a high proportion of Medicaid residents in fact had a higher risk-adjusted rehospitalization rate, whether or not the risk-adjustment included a facility effect). The effect of Medicaid beneficiary status on reducing the expected rehospitalization rate at the individual patient level is roughly the same size and direction in ordinary logistic regression and in the two-level fixed effects model.

The explanation for this paradox lies in the association between Medicaid beneficiary status and long-term SNF residence – the "spend-down" phenomenon. Many SNF residents are not poor when they are admitted to a SNF, but eventually exhaust their resources paying for residential care in the SNF and join the Medicaid rolls. Such residents would not be expected to show worse health than non-Medicaid beneficiaries. Moreover, the fact that a SNF patient was in the same facility six months earlier makes it more likely the patient does not have a terminal condition or one leading to prolonged hospitalizations, and the fact that a patient had a prior SNF stay of more than three months makes it less likely that the patient's condition is one causing frequent hospitalizations. In fact, we found the effect of Medicaid status on rehospitalization risk became non-significant once variables were added to the risk-adjustment model that captured these aspects of a patient's residential history. These were binary variables capturing (1) being present in the same facility six months earlier, and (2) having a length of stay greater than 90 days for the SNF stay prior to the hospitalization immediately before the post-acute admission.

Variables capturing patients' prior residential history might be considered in future updates of the model, but due to the indirectness of the relationship between prior residential history and rehospitalization risk we would not advocate adding them unless they added significantly to the overall explained variance of the model – which they don't do. .

5. Fifth, we measured the effect on classification of facility performance of applying our revised risk model with SDS factors. For both the current Pro 30 risk-adjustment model (an ordinary logistic regression) and a model including sociodemographic factors (a logistic regression in which the coefficients for black race and Medicaid status were determined by a fixed effects model and thus eliminated facility-level effects), we ranked facilities according to the

observed over expected (O/E) ratio, then classified the facility's performance by decile of O/E. We then examined the 10x10 matrix that relates each facility's original decile rank with its decile rank in the new model with sociodemographic adjustment. (See Table 8 in our response to Question 10.) In only one of 2760 cases did a facility's decile rank change by more than one between the old and the new risk adjustment method.

The coefficient for marital status in a model that incorporates race and Medicaid status as well as the original risk adjustment IVs is 0.04. The smallness of the coefficient, its indirect relationship to the outcome of rehospitalization, and the fact that it does not contribute to explained variance of the predictive model all argue against changing the PointRight® Pro 30™ risk adjustment model to include it.

Ultimately we choose not to include the SDS variables because they failed to meet the four criteria outlined in Question 3.

References

Cai S, Mukamel DB, Temkin-Greener H. Pressure ulcer prevalence among black and white nursing home residents in New York state: evidence of racial disparity? Med Care 2010;48:233-9.
Calvillo-King L, Arnold D, Eubank KJ, Lo M, Yunyongying P, Stieglitz H, et al. Impact of social factors on risk of readmission or mortality in pneumonia and heart failure: systematic review. J Gen Intern Med. 2013;28(2):269–82.
Grabowski DC, McGuire TG. "Black-White Disparities in Care in Nursing Homes" Atlantic Economic Journal. 2009;37(3):299–314.
Hu J, Gonsahn M, Nerenz D. Socioeconomic Status and Readmission: Evidence from an Urban Teaching Hospital. Health Affairs 33, No. 5 (2014): 778–785.

Question 6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach (describe the steps—do not just name a method; what statistical analysis was used).

We conducted three additional tests of the adequacy of the PointRight® Pro 30™ risk model, in addition to the extensive reliability and validity testing performed in the original NQF application. First, we reviewed the C-statistic for the measure as currently specified, under all versions of the risk model discussed in this submission; these results were also those used in our response to Question 5. Second, just on the non-SDS model, we re-reviewed the model fit for the currently-endorsed measure across the spectrum of observed rates for the measure. Third, again just on the non-SDS model, we reviewed the stability of the risk model when calibrated on CY2014 data and applied to CY2015 data. We did not examine the SDS versions of the models in our second and third analyses as the analyses performed for Question 5 had already led us to conclude the SDS factors should not be included in the model.

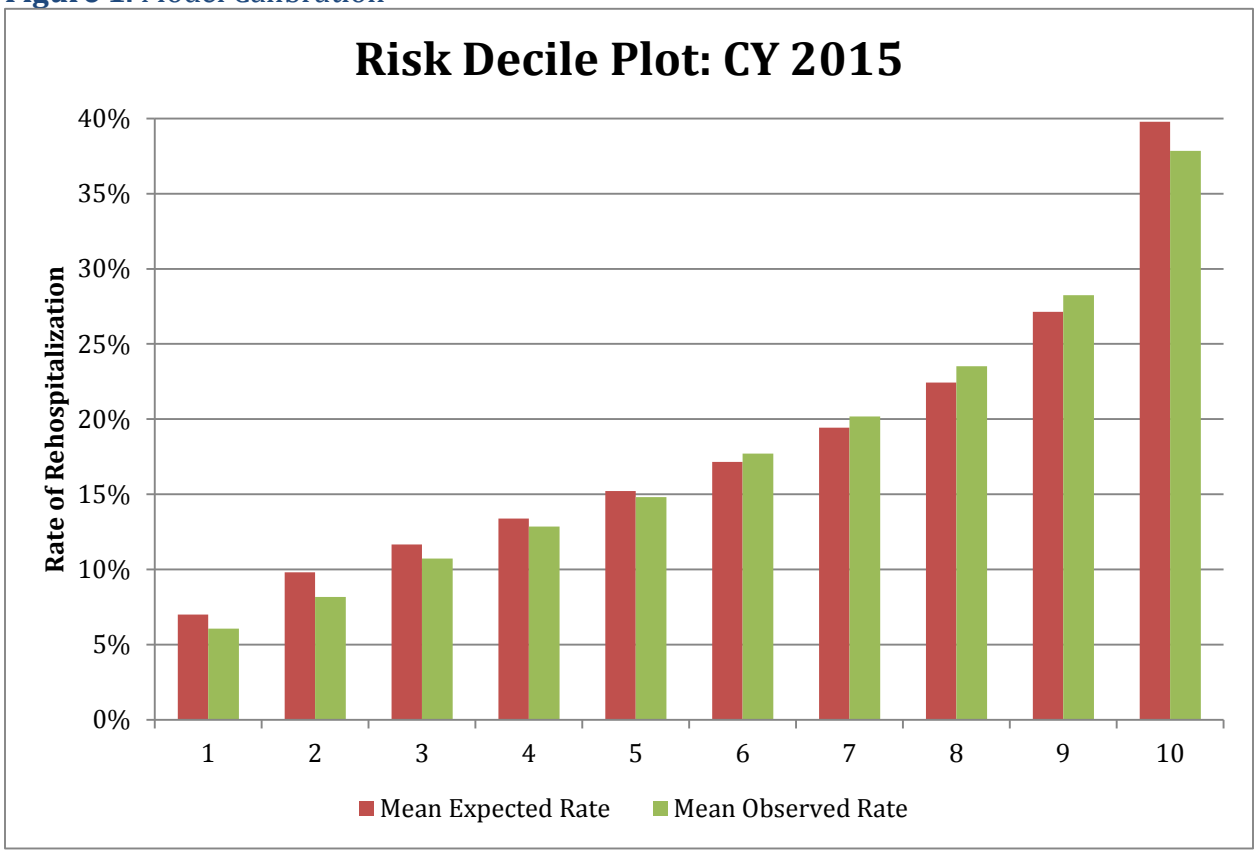
1. We reviewed the C statistic, or the area under the receiver operating characteristic (ROC) curve for all of the models and present the results below. The c-statistics were identical throughout all the models, suggesting that the models' discrimination ability remains unchanged from the current PointRight® Pro 30™ model.

Table 8. C-Statistic of Pro 30 Model Forms

Pro30 Rehospitalization Models	C-Statistic
Ordinary Logistic Regression	0.676
Ordinary Logistic Regression + SDS	0.676
Fixed-Effects Logistic Regression Model + SDS	0.676
Ordinary Logistic Regression + restricted SDS coefficients	0.676

2. We received the decile plot for predictive ability across the spectrum of observed rehospitalization rates and present the results in Figure 1 below. The risk model predicts accurately, with very minimal bias up or down, across the full spectrum of observed rehospitalization rates.

Figure 1. Model Calibration



We assessed whether rates were consistent across time and present the results in Table 9. To do this, expected rates were calculated by the model that was trained on CY2014 admissions (N=745,832 admissions), and observed rates were calculated from admissions in CY2015 (N=616,544 admissions). The Table shows very little change in the SRRs between the training and validation samples, indicating appropriateness of the risk model for use in the field.

Table 9. Comparison of standardized rehospitalization rates in CY2014 training vs, CY2015 validation samples

Denominator Size	Number of Facilities	Variable	Mean	Standard Deviation	5th Percentile	95th Percentile
30-149	648	SRR CY2014	0.93	0.30	0.45	1.46
		SRR CY2015	0.93	0.32	0.45	1.46
		Changes is SRR (2014 minus 2015)	0.00	0.34	-0.56	0.53
150-349	851	SRR CY2014	0.99	0.25	0.60	1.40
		SRR CY2015	0.99	0.24	0.61	1.40
		Difference (2014 - 2015)	0.00	0.23	-0.35	0.40
350+	623	SRR CY2014	0.98	0.22	0.61	1.35
		SRR CY2015	1.01	0.21	0.67	1.36
		Difference (2014 - 2015)	-0.03	0.18	-0.26	0.33

In conclusion, the currently-endorsed PointRight® Pro 30™ risk model exhibits very robust statistical properties for its use in the measure.

Question 7. Discuss the risks for misuse of the specified performance measure. This discussion could include information on the known limitations of the performance measure that could impact its use in accountability programs.

Through the life of this measure to date, we have not identified risks for misuse of the measure, either relating to or not relating to sociodemographic mix. Users and stakeholders of the measure have, however, occasionally enquired whether SDS factors should be added to the measure (not advocating that they should, but just raising the question); and have occasionally asked whether planned readmissions can be excluded from the measure (because during initial development, the MDS item for planned discharges did not exist). While neither of these represents a risk for misuse, per-se, the question of whether SDS factors should be added to the risk model led us to participate in the NQF trial period, and we plan to examine the question of planned readmissions as we evaluate our measure for its next measure maintenance cycle.

Question 8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables. This information may include the stratification variables, definitions, specific data

collection items/responses, code/value sets, and the risk-model covariates and coefficients for the clinically-adjusted version of the measure when appropriate.

N/A

Question 9. Please enter the details of the final statistical risk model and variables here.

Because we have elected to *not* include SDS factors into our risk model, here we present the original risk model as specified in our endorsed NQF application. Note that the coefficients presented here are those from our NQF application (from an earlier time period) rather than those re-calculated for the comparisons presented in this memo.

The formula for adjusting facility's adjusted rehospitalization rate is as follows:

Facility_Adjusted_Rate = Facility_Observed_Rate*National_Mean/Facility_Expected_Rate,

where Facility_Expected_Rate is the mean of stay-level predictions for the facility, over the rolling 12 month performance window, applying the sample selection methodology and denominator exclusions described in the original NQF application for NQF #2375. The Expected Rate Calculation for each stay is in turn:

VARIABLE CALCULATION
Age Under 65: if age<65 then Variable=1; else Variable=0; (If Date of Birth is missing, then Variable=0)
End Stage Prognosis:if J1400=1 then Variable=1; else Variable=0;
Hospice Care: if O0100K2=1 then Variable=1; else Variable=0;
Male: if A0800=1 then Variable=1; else Variable=0;
Medicare: if A0310B = 01 or 06, then Variable=1;else Variable=0;
SNF Admission is Return to Same SNF Following Hospitalization: if A0310B=06 AND A1600 minus A2000 (on a previous MDS where
A2100=3) < 30 then Variable=1; else if A1700=2 then Variable=1; else Variable=0;
Diagnoses
Anemia: if I0200=1 then Variable=1; else Variable=0;
Asthma: if I6200=1 then Variable=1; else Variable=0;
Diabetes Mellitus: if I2900=1 then Variable=1; else Variable=0;
Diabetic Foot Ulcer: if M1040B=1 then Variable=1; else Variable=0;
Pressure Ulcer Stage 2: if M0300B2>0 then Variable=1; else Variable=0;
Pressure Ulcer Stage 3: if M0300C2>0 then Variable=1; else Variable=0;
Pressure Ulcer Stage 4: if M0300D2>0 then Variable=1; else Variable=0;
Pressure Ulcer Unstageable: if M0300E2>0 or M0300F2>0 or M0300G2>0 then Variable=1; else Variable=0;
Respiratory Failure: if I6300=1 then Variable=1; else Variable=0;
Septicemia: if I2100=1 then Variable=1; else Variable=0;
Vascular Ulcer: if M1030>0 then Variable=1; else Variable=0;
Viral Hepatitis: if I2400=1 then Variable=1; else Variable=0;

Heart Failure: if I0600=1 then Variable=1; else Variable=0;
Internal Bleeding:if J1550D=1 then Variable=1; else Variable=0;
Functional Status
Daily Pain: if J0400=1 or J0850=3 then Variable=1; else Variable=0;
Eating Dependence- Total: if G0110H1 = 4,7, or 8, then Variable=1; else Variable=0;
Two Person assist Needed with One or More ADLs: if G0110A2=3 or G0110B2=3 or G0110C2=3 or G0110D2=3 or G0110E2=3 or
G0110F2=3 or G0110G2=3 or G0110H2=3 or G0110I2=3 or G0110J2=3 then Variable=1; else Variable=0;
Cognition not Completely Intact: if C0100=1 AND if C0500=15 then Variable=0;
if C0100=1 AND if C0500 <>15 then Variable=1;if C0100=0 AND if C0700=0 AND C0800=0 AND C1000=0 AND C0900A=1 AND C0900B=1
AND C0900C=1 AND C0900D=1 then Variable=0; else Variable=1;
Total Bowel Incontinence: if H0400>0 then Variable=1; else Variable=0;
Treatment
Cancer Chemotherapy: if O0100A1=1 then Variable=1; else Variable=0;
Dialysis: if O0100J1=1 then Variable=1; else Variable=0;
Insulin: if N0350A>0 or N0350B>0 then Variable=1; else Variable=0;
IV Medications Continuing from Hospital: if O0100H1=1 and O0100H2=1 then Variable=1; else Variable=0;
Ostomy Care: if H0100C=1 then Variable=1; else Variable=0;
Oxygen Continuing from Hospital: if O0100C1=1 and O0100C2=1 then Variable=1; else Variable=0;
Radiation Therapy: if O0100B1=1 then Variable=1; else Variable=0;
Tracheostomy Continuing from Hospital: if O0100E1=1 and O0100E2=1 then Variable=1; else Variable=0;
FORMULA

LogOdds =		-2.9658 +
End Stage Prognosis	*	-0.7109+
Hospice Care	*	-1.4028+
Anemia	*	0.1188+
Asthma	*	0.1125+
Daily Pain	*	0.0940+
Diabetes Mellitus	*	0.0711+
Diabetic Foot Ulcer	*	0.1389+
Dialysis	*	0.6328+
Insulin	*	0.1772+
Ostomy Care	*	0.3993+
Pressure Ulcer Stage 2	*	0.1816+
Pressure Ulcer Stage 3	*	0.1558+
Pressure Ulcer Stage 4	*	0.0971+
Pressure Ulcer Unstageable	*	0.1907+
Septicemia	*	0.0407+
Total Bowel Incontinence	*	0.1970+
Venous Arterial Ulcer	*	0.1830+
Viral Hepatitis	*	0.3793+

Age Under 65	*	0.0619+
Chemotherapy	*	0.5697+
IV Medication Continued from Hospital	*	0.1899+
Oxygen Continuing from Hospital	*	0.3394+
Tracheostomy Continuing from Hospital	*	0.0697+
Eating Dependency	*	0.5957+
Heart Failure	*	0.1934+
Internal Bleeding	*	1.0899+
Male	*	0.1465+
Return to Same SNF Following Hospitalizations	*	0.2443+
Medicare	*	0.4894+
Two Person Assist Required for One or More ADLs	*	0.2364+
Radiation Therapy	*	0.5066+
Respiratory Failure	*	0.1729+
Cognition Not Completely Intact	*	0.3421;

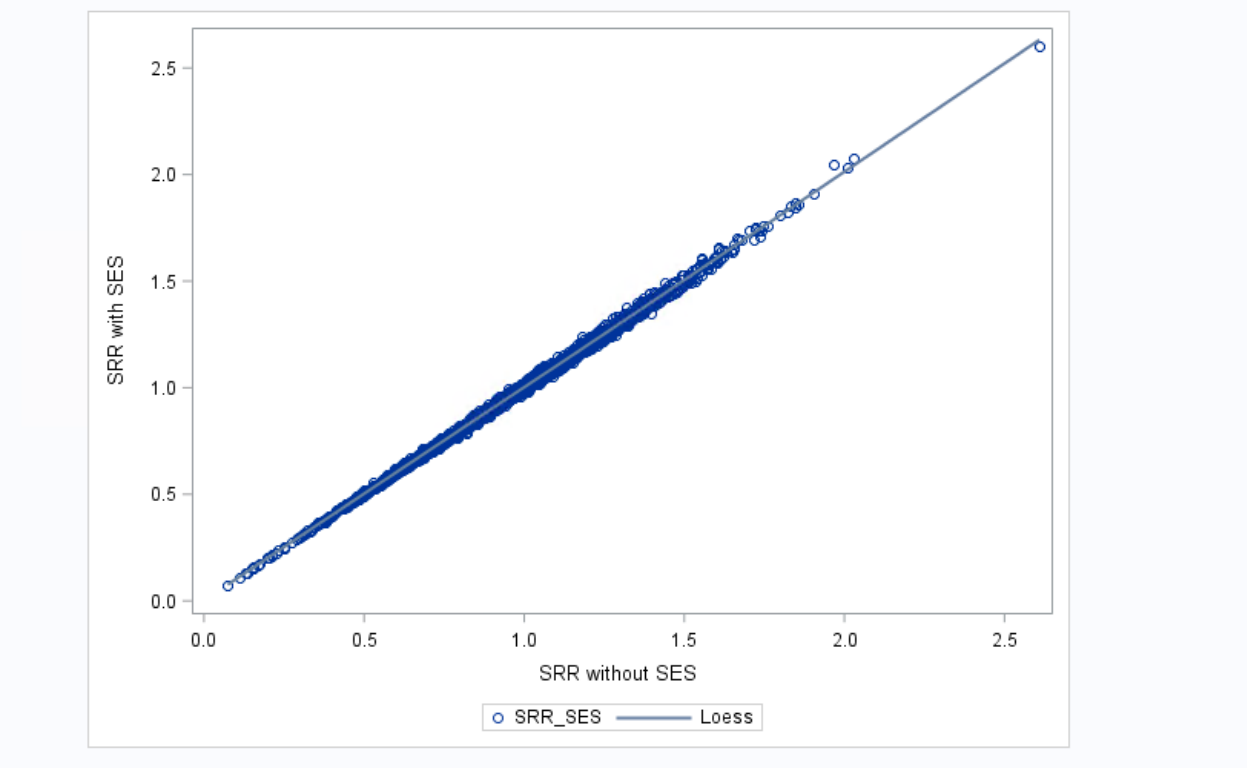
30day_Rehosp_Risk_Probability= 1/(1+exp(-LogOdds))

Question 10. Compare measure performance scores with and without SDS factors in the risk adjustment model. Include the method of testing conducted to compare performance scores with and without SDS factors in the risk adjustment model for the same entities, the statistical results from testing the differences in the performance scores with and without SDS factors in the risk adjustment model. (e.g., correlation, rank order) and provide an interpretation of your results in terms of the differences in performance scores with and without SDS factors in the risk adjustment model for the same entities.

We performed three comparisons of the risk adjusted rates of the PointRight® Pro 30™ model as it is currently specified versus implementing our two-stage risk model including the SDS factors married, Medicaid enrollment, and black. First, a simple scatter plot between the rates. Second, a simple correlation between the plots. Third, a cross-tabulation of the decile ranking under the two methodologies.

First, Figure 2 presents a scatter plot of the risk adjusted rates without the SDS factors (X-axis) against those with the SDS factors (Y-axis). The facilities form an almost perfect line along the least squares line.

Figure 2. Scatter plot of SNF-level risk adjusted Pro 30 rates without (X) vs with (Y) SDS factors



Second, we calculated the correlation coefficient between the two versions of rates. The Pearson's correlation coefficient was 0.99900 with a p-value < 0.0001. This is an almost perfect match between the rates without vs with SDS factors.

Third, we produced a cross-tabulation of the facility decile rankings under without vs with SDS factors. See Table 10. Replacing the existing Pro 30 risk adjustment model with a logistic regression that includes black race, Medicaid status and marital status, with coefficients for race and Medicaid plugged in from a fixed effects model, has minimal effect on the qualitative classification of facilities as under-performing or over-performing. Only one of 2760 facilities changes by more than one decile - a single facility went from 6th decile under the old model to 4th decile under the new one. 499 of the 2,760 facilities tested move 1 decile in their SRR rank. Only 1 SNF has a jump of two deciles.

Table 10. Comparison of SRR Distribution between Original Pro 30 and Pro 30 with SDS

		Decile of SRR (O/E) With Plug-In Model Including New SDS Variables for Risk Adjustment										
		1	2	3	4	5	6	7	8	9	10	Total
Decile of SRR Using the Current Pro30 Model	1	260	16	0	0	0	0	0	0	0	0	276
	2	16	233	27	0	0	0	0	0	0	0	276
	3	0	27	223	26	0	0	0	0	0	0	276
	4	0	0	26	212	38	0	0	0	0	0	276
	5	0	0	0	37	195	44	0	0	0	0	276
	6	0	0	0	1	43	195	37	0	0	0	276
	7	0	0	0	0	0	37	206	33	0	0	276
	8	0	0	0	0	0	0	33	217	26	0	276
	9	0	0	0	0	0	0	0	26	234	16	276
	10	0	0	0	0	0	0	0	0	16	260	276
	Total	276	276	276	276	276	276	276	276	276	276	2760

These three analyses confirm that adding SDS factors does almost nothing to the risk adjusted rates generated by the measure.

Question 11. Appendix (includes literature review, reference list, etc.)

N/A

TO: NQF Staff
From: Abt Associates
DATE: April 27, 2016
SUBJECT: **[NQF] Admissions and Readmissions NQF# 2380 Developer Questionnaire**

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1. Enter measure # and title.

NQF# 2380: Rehospitalization during the First 30 days of Home Health

2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

The current model already includes the demographic characteristics of age and sex. Additionally, the prior care setting risk factors likely account for some of the impact that additional SDS factors have on acute care utilization. Finally, Medicare Enrollment Status indicators identify beneficiaries who are disabled and disability may act as both a clinical risk factor and a socio-demographic factor due to correlation with income or employment.

Our team identified several additional socio-demographic factors that can be reliably and feasibly captured using existing data sources. These include:

- Medicaid Status – included in the CMS Enrollment Database (EDB)
- Rural Location – determined from beneficiary address, as captured in EDB
- SES Index[1] Score – determined from beneficiary address linked to American Community Survey (ACS) data. The index is a composite of seven ACS variables:
  - Percentage of people in the labor force who are unemployed
  - Percentage of persons below US poverty line
  - Median household income
  - Median value of owner-occupied homes
  - Percentage of persons aged ≥ 25 years with less than a 12th-grade education
  - Percentage of persons aged ≥ 25 years with at least 4 years of college
  - Percentage of households containing one or more person per room

[1] For more information on the construction of the SES Index please refer to the Agency for Healthcare Research and Quality's (AHRQ) publication Chapter 3: Creation of New Race-Ethnicity Codes and SES Indicators for Medicare Beneficiaries - Chapter 3. January 2008. Agency for Healthcare Research and Quality, Rockville, MD. http://archive.ahrq.gov/research/findings/final-reports/medicareindicators/medicareindicators3.html

3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

We do not recommend including SDS factors in the final risk adjustment model for NQF measure # 2380: Rehospitalization during the First 30 days of Home Health.

4. What were the statistical results of the analyses used to select risk factors?

In this section we describe the approach used to select clinical risk factors and the results of that approach for the endorsement of the Rehospitalization measure. A single multinomial logit model was used to predict both the Rehospitalization During the First 30 Days of Home Health measure and the ED Use without Hospital Readmission During the First 30 Days of Home Health measure. Of the 1,669,802 qualifying home health stays beginning from July 1, 2010 to June 30, 2013, a random 80 percent sample without replacement was chosen to calibrate the multinomial logit model and to estimate marginal effects for model development purposes. The remaining 20 percent of the stays were used to cross-validate the model.

Risk factors included in the model included prior care setting, health status (measured using hierarchical condition categories (HCC), diagnostic related groupings (DRG), and activity of daily living scores (ADL), demographic information (measured using age-gender interactions), enrollment status (end stage renal disease (ESRD) and disability), and interactions between one set of the health status covariates. To determine which risk factors should be included in the risk adjustment model, a Wald test of joint restrictions was applied to each variable in each of 1,150 bootstrap samples created using simple random sampling, with replacement, of 80 percent of all home health stays. The Wald test determined the likelihood that the change in either or both outcomes associated with each covariate was statistically different from zero. The current risk adjustment model includes only covariates that were significant at a level of 0.05 for either outcome in at least 80 percent of bootstrap samples. This restriction reduces the number of variables included in the current model, thus streamlining the model and avoiding over-fitting.

To evaluate the impact of each risk factor, the marginal effects were calculated. The marginal effect represents the relative impact of each risk factor on the outcome. Each risk factor has an associated marginal effect value that can be interpreted as the change in the population value of the measure if all patients in the population had the risk factor but had the observed distribution of all other risk factors. Goodness of fit statistics were then calculated for the calibrated model and the 20 percent sample was used for cross-validation.

Once the significant risk factors were identified in the development stage, the model was then calibrated using 100 percent of home health stays. This model would be used to calculate the

predicted probabilities of the two outcomes for each home health stay for the home health quality reporting program.

In May 2014, the measure developer re-calibrated the model using three years of data (i.e., all home health stays beginning between July 1, 2010 and June 30, 2013) to reflect the three-year reporting period planned for the public reporting of the *Rehospitalization* and the *ED Use without Hospital Readmission* measures. The coefficients and marginal effects for each risk factor in the model calibrated using all home health stays beginning between July 1, 2010 and June 30, 2013 are available on CMS's Quality Measures webpage[2].

5. Describe the analyses and interpretation resulting in the decision to select SDS factors (e.g. prevalence of the factor across measured entities, empirical association with the outcome, contribution of unique variation in the outcome, assessment of between-unit effects and within-unit effects).

Acumen performed multiple analyses in accordance with NQF's guidance. Specifically:

- Prevalence of each SDS factor across home health agencies (HHA);
- Distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor to determine if there is variation in HHA performance across populations with low/high proportions of each SDS factor;
- Univariate associations between the SDS characteristics and the outcome;
- C-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to improvement in the model's ability to differentiate between outcomes; and
- HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment.

[2] To access the parameter estimates for the Rehospitalization measures, please refer to the *Home Health Rehospitalization Measures Technical Documentation and Risk Adjustment Model* link under Downloads: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html

Results:

Table 1 summarizes the prevalence of each SDS factor across HHAs. The median percentage of stays for beneficiaries with dual Medicaid eligibility is 17.7% (IQR: 8.4% to 40%). The median percentage of stays for beneficiaries who live rural locations is 2.4% (IQR: 0% to 30%). The median percentage of stays for beneficiaries with high and low SES Index Scores is 25.3% (IQR: 10.7% to 46.2%) and 6.9% (IQR: 0% to 24.1%), respectively.

Table 1: Proportion of SDS Factors across HHAs

Data Element	Medicaid	Rural	High SES Index Score (SES Index >= 57.1)	Low SES Index Score (SES Index Score <= 50.1)
Total # of HHAs	11,580			
Maximum	100%	100%	100.0%	100.0%
75th percentile	40%	30%	46.2%	24.1%
Mean	27.7%	23.2%	30.9%	15.3%
Median	17.7%	2.4%	25.3%	6.9%
25th percentile	8.4%	0%	10.7%	0.0%
Minimum	0%	0%	0.0%	0.0%

Figure 1 provides the distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor. Risk-adjusted performance rates tend to be lower among HHAs that treat a lower proportion of beneficiaries dually enrolled in Medicaid, a higher proportion of beneficiaries residing in rural locations, a higher proportion of beneficiaries who have a high SES Index score, and a lower proportion of beneficiaries who have a low SES Index score.

Figure 1: Distribution of Risk-Adjusted Rates, by Proportion of SDS Factor

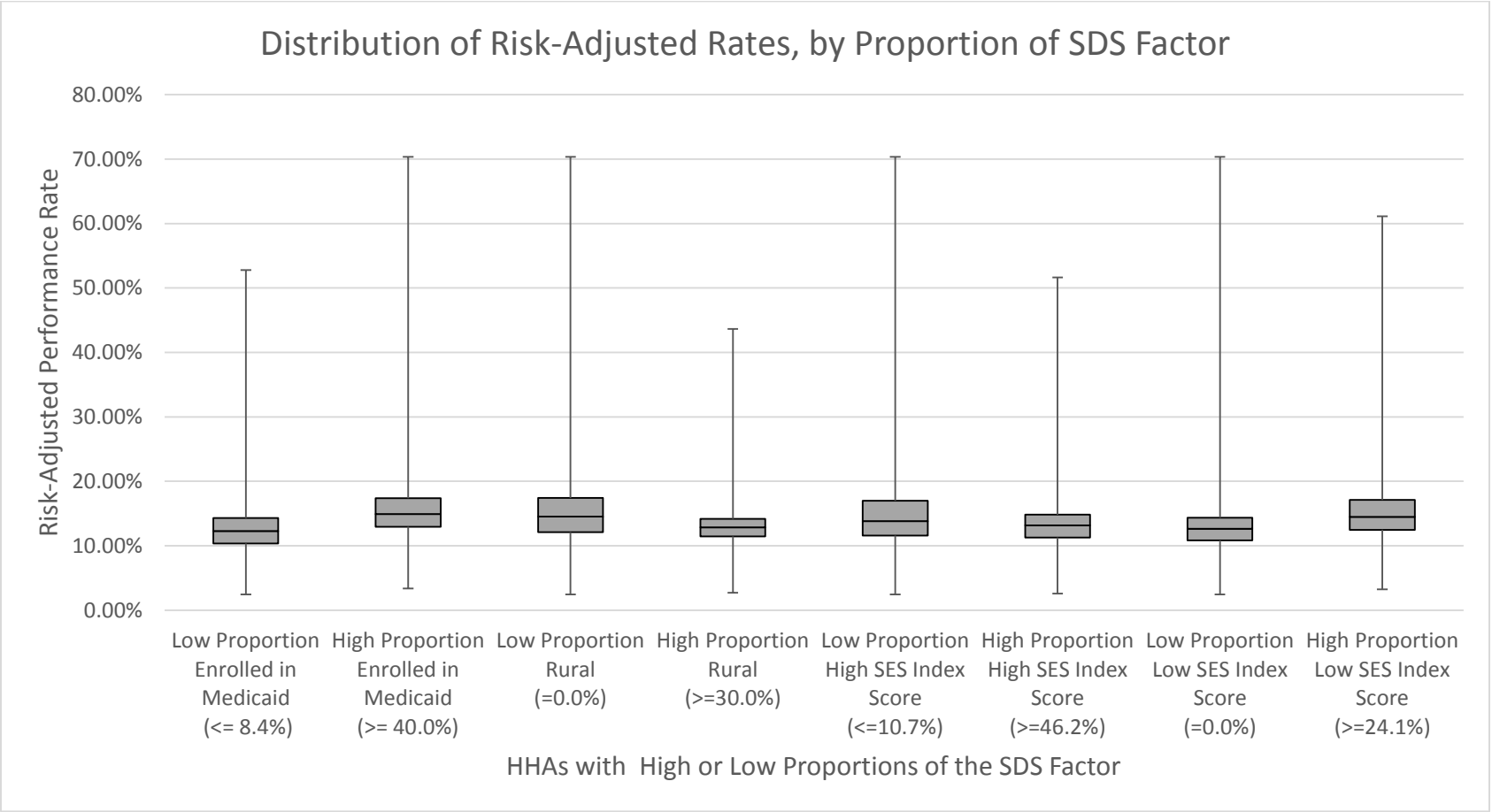


Table 2 displays the univariate association with the unadjusted performance rate. HHAs that provide care to dual-Medicaid beneficiaries or beneficiaries classified with low SES Index score have higher unadjusted performance rates (i.e., higher readmission rates).

Table 2: Unadjusted Performance Rates, by SDS Factor

Factor	Observed Rate
Dual Medicaid Status	
Yes	15.93%
No	12.11%
Urban - Rural Status	
Urban	12.76%
Rural	12.67%
SES Index	
Low SES Index Score (SES Index Score <= 50.1)	14.11%
High SES Index Score (SES Index >= 57.1)	11.32%

Table 3 provides the c-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to improvement in the model's ability to differentiate between outcomes. The c-statistic scores are similar across all variations of the risk adjustment models. The parameter estimates for the multivariate risk adjustment models including the clinical covariates and the various SDS characteristics are provided in the appendix. The effect sizes for the SDS characteristics are modest and their inclusion in the risk adjustment model has a negligible impact on the parameter estimates of the clinical characteristics.

Table 3: Comparison of Model Fit across Models

Model	C- Statistic
Original Model	0.7119
Original Model + Dual Medicaid Status	0.7120
Original Model + Rural Status	0.7119
Original Model + SES Index	0.7120
Original Model + All SDS Variables	0.7120

Tables 4 – 7 provide the HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment.

Table 4: HHA Categorizations - Before and After Adjustment for Medicaid Status

Original Model	**Original Model + Dual Medicaid Status**							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	443	3.83%	3	0.03%	-	-	-	-
Same As Expected	8	0.07%	6209	53.62%	6	0.05%	-	-
Better than Expected	-	-	4	0.03%	453	3.91%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 21 (0.18%) HHAs shift categorizations by adjusting for Medicaid Status.

Table 5: HHA Categorizations - Before and After Adjustment for Rural Status

Original Model	**Original Model + Rural Status**							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	445	3.84%	1	0.01%	-	-	-	-
Same As Expected	4	0.03%	6219	53.70%	-	-	-	-
Better than Expected	-	-	-	-	457	3.95%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 5 (0.04%) HHAs shift categorizations by adjusting for Rural Status.

Table 6: HHA Categorizations - Before and After Adjustment for SES Index

Original Model	Original Model + SES Index							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	436	3.77%	11	0.09%	-	-	-	-
Same As Expected	10	0.09%	6200	53.54%	6	0.05%	-	-
Better than Expected	-	-	12	0.10%	451	3.89%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 39 (0.34%) HHAs shift categorizations by adjusting for the SDS Index.

Table 7: HHA Categorizations - Before and After Adjustment for All SDS Variables

Original Model	Original Model + All SDS Variables							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	435	3.76%	13	0.11%	-	-	-	-
Same As Expected	11	0.09%	6200	53.54%	11	0.09%	-	-
Better than Expected	-	-	10	0.09%	446	3.85%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 45 (0.39%) HHAs shift categorizations by adjusting for all SDS variables.

6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach (describe the steps—do not just name a method; what statistical analysis was used).

In this section we describe the methods that were implemented to validate the adequacy of the statistical model during initial measure development. The predictive power of the risk adjustment model was evaluated using two measures of predictive power on both the development sample and the validation sample. The two measures of predictive power are the c-statistic and the range of predicted probabilities. Evaluating the model's predictive power on the development sample shows how well the model predicts outcomes in the data on which it was developed, while evaluating the model using the validation sample shows how well the model predicts outcomes outside the data on which it was developed.

A version of the area under the receiver operating curve (AUC) statistic, also known as the c-statistic, was calculated for each individual logit and for the model overall. The c-statistic measures the ability of a risk adjustment model to differentiate between outcomes without resorting to an arbitrary cutoff point. This analysis averages pair-wise comparisons to extend the standard two-class case to the multi-class form.[3] A model that perfectly discriminates between outcomes would have a c-statistic of 1, while a model that has no predictive power would have a c-statistic of 0.5. To calculate c-statistics for binomial outcomes (i.e., acute care rehospitalization vs. no event and ED use without hospital readmission v. no event), the outlying event was omitted and a generalized logistic estimated on the remaining two outcomes using all the risk factors in the model. A generalized logistic model omitting one event leads to the same coefficients as the full multinomial model. The average of the c-statistics for all possible binomial logistic regressions produces the AUC for the full multinomial model.

The c-statistic for the rehospitalization development sample is 0.693, which is identical to the validation sample value of 0.693, showing that the model differentiates between outcomes as well on new data as it does on the development data. For ED use without hospital readmission, the c-statistic for the development sample is 0.643, which is similar to the validation sample value of 0.642. Finally, the total AUC for the model in the development sample is 0.660, which is comparable to the validation sample value of 0.645.[4] The table below presents these values.

AUC Statistics

AUC Statistic	Development Sample	Validation Sample
Rehospitalization During the First 30 Days of	0.693	0.693

[3] For more information on this extension of the c-statistic, please refer to: David J. Hand and Robert J. Till, "A Simple Generalisation of the Area Under the ROC Curve for Multiple Class Classification Problems." Ed. David W. Aha. *Machine Learning* 45 (2001): 171-186.

[4] The total area under the curve is an assessment of the overall model fit obtained by averaging the c-statistics for the individual logits, which in this case is the two c-statistics shown as well as the c-statistic between rehospitalization and ED use without hospital readmission, which is not shown. For more information on this statistic, refer to the footnote above.

AUC Statistic	Development Sample	Validation Sample
Home Health c-statistic		
ED Use without Hospital Readmission During the First 30 Days of Home Health c-statistic	0.643	0.642
Total AUC	0.660	0.645

To further evaluate the predictive power of the model, the range of differences between the 90th and 10th percentile of predicted probabilities were calculated. In this case, a larger range of predicted values indicates that the model is better at discriminating between beneficiaries at high risk for rehospitalization. In the development sample for the multinomial logit model, the range of predicted probabilities for rehospitalization was 4.6 percent to 22.7 percent, and the range was identical in the validation sample. The table below presents these ranges.

Range of Differences between 90th and 10th Percentile of Predicted Probabilities

Measure	Development Sample		Validation Sample	
	Minimum (%)	Maximum (%)	Minimum (%)	Maximum (%)
Rehospitalization During the First 30 Days of Home Health	4.6	22.7	4.6	22.7

Finally, the measure developer evaluated the extent to which differences in case-mix would lead to differences in observed rates of rehospitalization. The table below shows the distribution of expected agency rates of rehospitalization, by agency size. The interquartile ranges, by agency size, range from 1.9 percent for large agencies with 1000+ stays to 3.3 percent for small agencies with 20-49 stays.

Impact of Risk Adjustment on Rates of Rehospitalization, By Agency Size

Total Stays	# HHAs	Mean	St. Dev.	Min	10th	25th	50th	75th	90th	Max	Inter. Range
20-49	1655	14.2%	2.6%	5.0%	11.1%	12.5%	14.2%	15.8%	17.4%	24.4%	3.3%
50-99	1486	13.6%	2.2%	6.0%	11.0%	12.3%	13.5%	15.0%	16.2%	24.3%	2.7%
100–199	1385	13.4%	1.9%	5.0%	11.0%	12.3%	13.4%	14.6%	15.8%	19.9%	2.3%
200 – 399	1244	13.1%	1.9%	5.4%	10.7%	12.1%	13.3%	14.3%	15.3%	20.1%	2.2%
400 – 999	1115	12.9%	1.8%	4.6%	10.7%	12.0%	13.2%	14.1%	14.9%	17.5%	2.1%
1000+	680	13.0%	1.6%	5.3%	10.9%	12.1%	13.2%	14.0%	14.7%	17.4%	1.9%

Over-fitting occurs when a model can describe the relationship between the covariates and the outcome in the development data set but cannot successfully predict the outcome on a new data set. To compute the over-fitting indices, the coefficients of the model were first estimated using the development sample. A logistic regression was then estimated on the validation sample with an intercept and the linear predictor for the probability of an event for a given home health stay in the validation sample. Values of the intercept far from 0 and values of

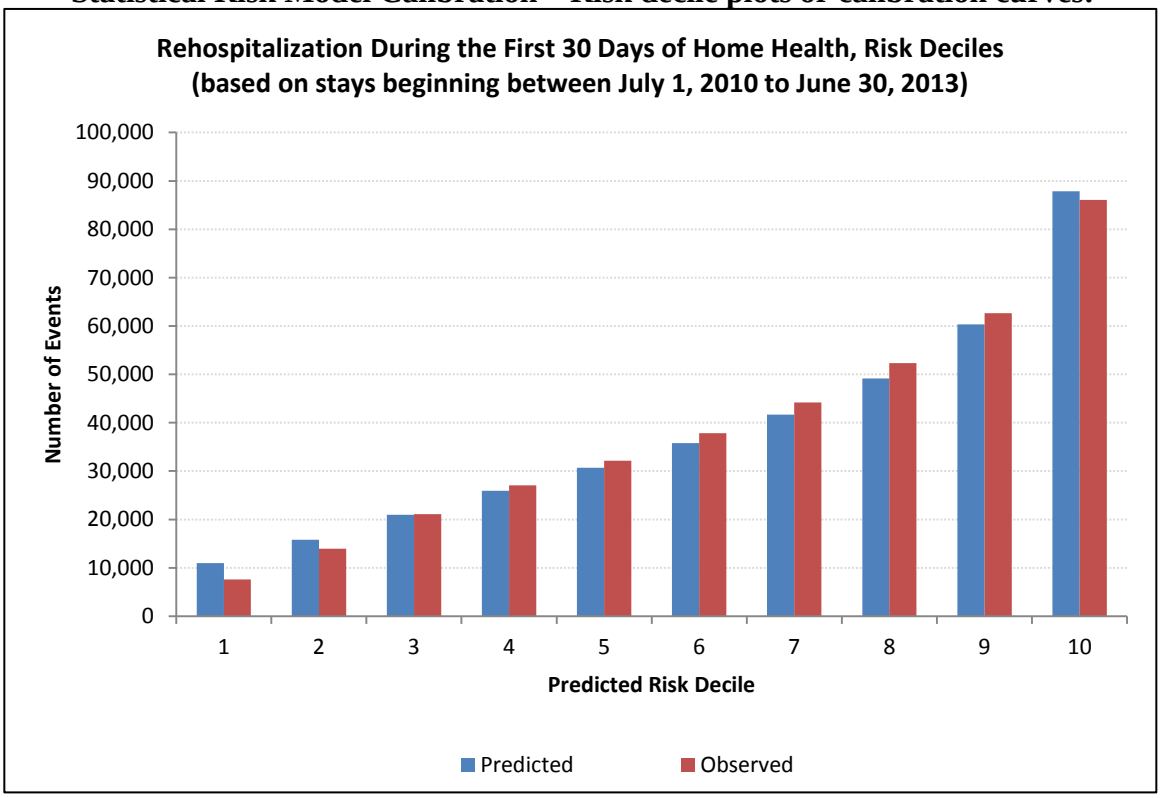
the coefficient far from 1 provide evidence of over-fitting. Over-fitting indices were computed separately for the multinomial logit model and the hierarchical-multinomial logit model.

Over-fitting indices were computed and showed no indication that the model was over-fit. The calibration statistic for rehospitalization produced an intercept of -0.006 and a coefficient of 0.995. With t-statistics of 0.456 and 0.585, these values are not significantly different from 0 and 1, respectively, at the 95% confidence level. In other words, there is no evidence that the model is over-fitting the data for the outcome.

Over-Fitting Indices

Measure	Intercept		Coefficient	
	Value	Statistically different from 0 at 95% confidence?	Value	Statistically different from 1 at 95% confidence?
Rehospitalization During the First 30 Days of Home Health	-0.006	No	0.995	No

Statistical Risk Model Calibration – Risk decile plots or calibration curves:



7. Discuss the risks for misuse of the specified performance measure. This discussion could include information on the known limitations of the performance measure that could impact its use in accountability programs.

The measure developers have not identified any risks for misuse throughout the measure development process.

8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables. This information may include the stratification variables, definitions, specific data collection items/responses, code/value sets, and the risk-model covariates and coefficients for the clinically-adjusted version of the measure when appropriate.

N/A

9. Please enter the details of the final statistical risk model and variables here.

The final risk adjustment model[5] for NQF 2380 relies on five categories of risk factors:

(1) Prior Care Setting including: acute care received in 30 days prior to HH, acute care received in 6 months prior to HH, and length of index hospitalization

(2) Age and sex interactions

(3) Health Status as measures by: Hierarchical Condition Categories (HCCs) based on past 6 months of Medicare claims, Diagnosis-Related Grouping (DRGs) on index hospitalization, and activities of daily living indicators, as captured on HH claims

(4) Medicare Enrollment Status, which identifies beneficiaries who are eligible for Medicare due to End-Stage Renal Disease (ESRD) or who were originally eligible due to disability

(5) Additional interactions between HHCs and Medicare Enrollment Status

[5] To access the parameter estimates for the Rehospitalization measures, please refer to the *Home Health Rehospitalization Measures Technical Documentation and Risk Adjustment Model* link under Downloads: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html

10. Compare measure performance scores with and without SDS factors in the risk adjustment model. Include the method of testing conducted to compare performance scores with and without SDS factors in the risk adjustment model for the same entities, the statistical results from testing the differences in the performance scores with and without SDS factors in the risk adjustment model. (e.g., correlation, rank order) and provide an interpretation of your results in terms of the differences in performance scores with and without SDS factors in the risk adjustment model for the same entities.

As previously mentioned in question 5, Tables 4 – 7 provide the HHA categorizations before and after the adjustment of each SDS factor. Adjusting for each SDS factor and all SDS factors had a minimal effect on HHA performance.

11. Appendix (includes literature review, reference list, etc.)

Tables 8 - 15 provide risk adjustment model results.

Table 8: Risk Adjustment Model - Prior Care Settings

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Intercept	-3.641	0.000	-3.642	0.000	-3.646	0.000	-3.641	0.000	-3.645	0.000
Skilled Nursing Facility In 30 Days Before Home Health Stay	0.026	0.027	0.027	0.019	0.026	0.027	0.026	0.028	0.027	0.020
Multiple Inpatient Admissions in the Past 30 Days From Home Health Stay	0.299	0.000	0.300	0.000	0.298	0.000	0.298	0.000	0.299	0.000
Emergency Room Visit, Single, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.167	0.000	0.166	0.000	0.166	0.000	0.165	0.000	0.163	0.000
Emergency Room Visit, Multiple, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.420	0.000	0.416	0.000	0.417	0.000	0.415	0.000	0.412	0.000

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Inpatient Admission, Surgical Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	-0.039	0.000	-0.038	0.000	-0.039	0.000	-0.039	0.000	-0.038	0.000
Inpatient Admission, Medicine Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.180	0.000	0.180	0.000	0.180	0.000	0.180	0.000	0.179	0.000
Inpatient Admission, Cardiovascular Disease Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.132	0.000	0.131	0.000	0.132	0.000	0.131	0.000	0.131	0.000

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Inpatient Admission, Chronic Renal Failure Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.254	0.000	0.253	0.000	0.254	0.000	0.253	0.000	0.253	0.000
Inpatient Admission, Neurology Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.136	0.000	0.136	0.000	0.137	0.000	0.136	0.000	0.136	0.000
Length of Index Hospital Stay, One to Two Weeks (July 1, 2010 to June 30, 2013)	0.196	0.000	0.196	0.000	0.196	0.000	0.196	0.000	0.196	0.000
Length of Index Hospital Stay, Greater than Two Weeks	0.329	0.000	0.329	0.000	0.329	0.000	0.328	0.000	0.328	0.000

Table 9: Risk Adjustment Model - Demographics

Demographics Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
0-34 Years, Female	0.505	0.000	0.476	0.000	0.507	0.000	0.500	0.000	0.475	0.000
0-34 Years, Male	0.250	0.000	0.220	0.000	0.252	0.000	0.247	0.000	0.219	0.000
35-44, Female	0.349	0.000	0.328	0.000	0.350	0.000	0.344	0.000	0.325	0.000
35-44, Male	0.185	0.000	0.163	0.000	0.186	0.000	0.181	0.000	0.162	0.000
45-54, Female	0.170	0.000	0.154	0.000	0.171	0.000	0.166	0.000	0.151	0.000
45-54, Male	0.168	0.000	0.152	0.000	0.168	0.000	0.165	0.000	0.151	0.000
55-59, Female	0.059	0.001	0.048	0.009	0.060	0.001	0.056	0.002	0.046	0.012
55-59, Male	0.117	0.000	0.108	0.000	0.118	0.000	0.115	0.000	0.107	0.000
60-64, Female	0.045	0.008	0.039	0.023	0.045	0.008	0.043	0.012	0.037	0.029
60-64, Male	0.051	0.002	0.046	0.005	0.051	0.002	0.049	0.003	0.045	0.006
65-69, Female	-0.037	0.002	-0.040	0.001	-0.037	0.002	-0.039	0.001	-0.041	0.001
70-74, Female	-0.018	0.124	-0.019	0.101	-0.018	0.122	-0.019	0.108	-0.020	0.090
70-74, Male	0.034	0.002	0.035	0.001	0.033	0.003	0.034	0.002	0.035	0.001
75-79, Female	0.012	0.305	0.011	0.343	0.012	0.309	0.011	0.330	0.010	0.366
75-79, Male	0.058	0.000	0.060	0.000	0.057	0.000	0.058	0.000	0.060	0.000
80-84, Female	0.037	0.001	0.037	0.001	0.037	0.001	0.038	0.001	0.038	0.001
80-84, Male	0.061	0.000	0.064	0.000	0.060	0.000	0.062	0.000	0.065	0.000
85-89, Female	0.063	0.000	0.063	0.000	0.063	0.000	0.065	0.000	0.066	0.000
85-89, Male	0.080	0.000	0.085	0.000	0.080	0.000	0.083	0.000	0.087	0.000
90-94, Female	0.093	0.000	0.094	0.000	0.093	0.000	0.096	0.000	0.097	0.000
90-94, Male	0.102	0.000	0.106	0.000	0.102	0.000	0.106	0.000	0.110	0.000
95+, Female	0.089	0.000	0.089	0.000	0.090	0.000	0.094	0.000	0.093	0.000
95+, Male	0.102	0.000	0.106	0.000	0.103	0.000	0.108	0.000	0.111	0.000

Table 10: Risk Adjustment Model - Hierarchical Condition Categories (HCCs)

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
2 Septicemia/Shock	-0.005	0.651	-0.006	0.542	-0.004	0.658	-0.004	0.654	-0.006	0.556
5 Opportunistic Infections	0.178	0.000	0.179	0.000	0.178	0.000	0.178	0.000	0.180	0.000
6 Other Infectious Diseases	0.018	0.000	0.017	0.000	0.019	0.000	0.020	0.000	0.019	0.000
7 Metastatic Cancer and Acute Leukemia	0.481	0.000	0.482	0.000	0.481	0.000	0.482	0.000	0.483	0.000
8 Lung/Upper Digestive/Oth Sev Cancer	0.248	0.000	0.248	0.000	0.248	0.000	0.249	0.000	0.250	0.000
9 Lymphatic/Head/Neck/ Brain/Maj Cancer	0.155	0.000	0.156	0.000	0.155	0.000	0.157	0.000	0.157	0.000
10 Breast/Prostate/Colorectal/Oth Cancer	0.002	0.837	0.002	0.771	0.002	0.806	0.002	0.752	0.003	0.689
14 Ben Neoplasms of Skin, Breast, Eye	-0.031	0.000	-0.028	0.000	-0.030	0.000	-0.027	0.000	-0.024	0.000
15 Diabetes with Renal Manifestation	0.099	0.000	0.095	0.000	0.099	0.000	0.097	0.000	0.094	0.000
16 Diabs w/ Neurol/Periph Circ Manifest	0.114	0.000	0.111	0.000	0.114	0.000	0.112	0.000	0.109	0.000
18 Diab w/ Ophthalmologic Manifestation	0.114	0.000	0.110	0.000	0.114	0.000	0.112	0.000	0.108	0.000
19 Diabetes w/ No/Unspecified comp	0.043	0.000	0.040	0.000	0.043	0.000	0.041	0.000	0.038	0.000
21 Protein-Calorie Malnutrition	0.105	0.000	0.105	0.000	0.105	0.000	0.104	0.000	0.103	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
22 Oth Significant Endocrine/Metabolic	0.043	0.000	0.043	0.000	0.043	0.000	0.044	0.000	0.044	0.000
23 Fluid/Electrolyte/Acid-Base Balance	0.092	0.000	0.093	0.000	0.092	0.000	0.093	0.000	0.093	0.000
25 End-Stage Liver Disease	0.322	0.000	0.322	0.000	0.322	0.000	0.322	0.000	0.321	0.000
26 Cirrhosis of Liver	0.131	0.000	0.129	0.000	0.131	0.000	0.130	0.000	0.129	0.000
29 Other Hepatitis and Liver Disease	0.050	0.000	0.049	0.000	0.051	0.000	0.051	0.000	0.050	0.000
31 Intestinal Obstruction/Perforation	0.040	0.000	0.040	0.000	0.040	0.000	0.040	0.000	0.040	0.000
32 Pancreatic Disease	0.084	0.000	0.084	0.000	0.084	0.000	0.085	0.000	0.085	0.000
33 Inflammatory Bowel Disease	0.162	0.000	0.164	0.000	0.162	0.000	0.165	0.000	0.166	0.000
34 Peptic Ulcer/Hemorrhage/Oth Spec GI	0.090	0.000	0.090	0.000	0.090	0.000	0.090	0.000	0.090	0.000
36 Other Gastrointestinal Disorders	0.044	0.000	0.043	0.000	0.044	0.000	0.043	0.000	0.043	0.000
38 Rheum Arthritis/Inflam Conn Tissue	0.094	0.000	0.096	0.000	0.094	0.000	0.095	0.000	0.096	0.000
39 Disorders of Vertebrae/Spinal Discs	0.021	0.000	0.022	0.000	0.021	0.000	0.021	0.000	0.023	0.000
40 Osteoarthritis of Hip or Knee	-0.196	0.000	-0.195	0.000	-0.196	0.000	-0.195	0.000	-0.195	0.000
43 Oth Musculoskeletal/connect Tissue	-0.014	0.011	-0.015	0.007	-0.014	0.012	-0.014	0.011	-0.015	0.007

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
44 Severe Hematological Disorders	0.172	0.000	0.173	0.000	0.172	0.000	0.173	0.000	0.174	0.000
46 Coagulation defs/Oth Spec Hematologic	0.026	0.000	0.026	0.000	0.026	0.000	0.026	0.000	0.027	0.000
47 Iron Defic, Oth/Unspec Anemias/Blood	0.089	0.000	0.088	0.000	0.089	0.000	0.089	0.000	0.089	0.000
49 Dementia/Cerebral Degeneration	-0.014	0.028	-0.016	0.012	-0.013	0.034	-0.013	0.037	-0.015	0.018
53 Drug/Alcohol Abuse, W/out Dependence	0.061	0.000	0.059	0.000	0.061	0.000	0.059	0.000	0.057	0.000
55 Major Depressive, Bipolar, Paranoid	0.055	0.000	0.054	0.000	0.056	0.000	0.058	0.000	0.056	0.000
56 Reactive and Unspecified Psychosis	0.045	0.000	0.046	0.000	0.045	0.000	0.045	0.000	0.045	0.000
57 Personality Disorders	0.091	0.001	0.086	0.002	0.092	0.001	0.093	0.001	0.087	0.001
58 Depression	0.036	0.000	0.036	0.000	0.036	0.000	0.037	0.000	0.037	0.000
59 Anxiety Disorders	0.043	0.000	0.043	0.000	0.043	0.000	0.043	0.000	0.043	0.000
60 Other Psychiatric Disorders	0.054	0.000	0.054	0.000	0.054	0.000	0.055	0.000	0.055	0.000
68 Paraplegia	-0.019	0.512	-0.022	0.441	-0.018	0.522	-0.018	0.523	-0.021	0.456
74 Seizure Disorders and Convulsions	0.046	0.000	0.042	0.000	0.046	0.000	0.046	0.000	0.043	0.000
76 Mononeuropathy/Oth Neuro Cond/Inj	0.046	0.000	0.047	0.000	0.046	0.000	0.047	0.000	0.048	0.000
80 Congestive Heart	0.153	0.000	0.152	0.000	0.153	0.000	0.152	0.000	0.151	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Failure										
81 Acute Myocardial Infarction	0.057	0.000	0.057	0.000	0.057	0.000	0.057	0.000	0.057	0.000
82 Unstable Angina/Oth ac Ischemic Heart	0.026	0.002	0.024	0.004	0.026	0.002	0.027	0.002	0.025	0.003
83 Angina Pectoris/Old Myocardial Infect	0.020	0.002	0.020	0.002	0.020	0.002	0.020	0.002	0.020	0.002
84 Coronary Athero/Oth Chron Ischemic Heart	0.070	0.000	0.070	0.000	0.071	0.000	0.070	0.000	0.070	0.000
85 Heart Infec/Inflam, Exc Rheumatic	0.041	0.000	0.041	0.000	0.041	0.000	0.042	0.000	0.042	0.000
89 Hypertensive Heart/Renal/Encephalopathy	0.053	0.000	0.053	0.000	0.053	0.000	0.052	0.000	0.052	0.000
90 Hypertensive Heart Disease	-0.054	0.000	-0.056	0.000	-0.053	0.000	-0.054	0.000	-0.056	0.000
92 Specified Heart Arrhythmias	0.127	0.000	0.129	0.000	0.127	0.000	0.128	0.000	0.130	0.000
94 Other and Unspecified Heart Disease	0.015	0.001	0.015	0.002	0.015	0.002	0.015	0.002	0.014	0.003
95 Cerebral Hemorrhage	0.062	0.000	0.062	0.000	0.063	0.000	0.064	0.000	0.064	0.000
104 Peripheral Vascular Disease with Complications	0.113	0.000	0.113	0.000	0.113	0.000	0.113	0.000	0.113	0.000
105 Peripheral Vascular Disease	0.058	0.000	0.057	0.000	0.058	0.000	0.058	0.000	0.058	0.000
106 Other Circulatory Disease	0.035	0.000	0.036	0.000	0.035	0.000	0.036	0.000	0.036	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
108 chron Obstructive Pulmonary Disease	0.145	0.000	0.144	0.000	0.145	0.000	0.142	0.000	0.141	0.000
110 Asthma	0.012	0.052	0.010	0.121	0.013	0.040	0.013	0.035	0.011	0.079
113 Viral/Unspec Pneumonia, Pleurisy	0.016	0.003	0.015	0.005	0.016	0.003	0.016	0.003	0.015	0.004
114 Pleural Effusion/Pneumothorax	0.086	0.000	0.087	0.000	0.086	0.000	0.087	0.000	0.087	0.000
115 Other Lung Disorders	0.006	0.186	0.006	0.185	0.006	0.178	0.006	0.185	0.006	0.181
127 Other Ear, Nose, Throat, and Mouth	-0.018	0.000	-0.018	0.000	-0.018	0.000	-0.017	0.000	-0.017	0.000
128 Kidney Transplant Status	0.097	0.000	0.100	0.000	0.097	0.000	0.099	0.000	0.102	0.000
129 End Stage Renal Disease (Medicare elig)	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
131 Renal Failure	0.128	0.000	0.127	0.000	0.128	0.000	0.127	0.000	0.127	0.000
133 Urinary Obstruction and Retention	0.071	0.000	0.072	0.000	0.072	0.000	0.072	0.000	0.073	0.000
135 Urinary Tract Infection	0.011	0.020	0.011	0.025	0.011	0.019	0.011	0.022	0.011	0.027
136 Other Urinary Tract Disorders	0.037	0.000	0.037	0.000	0.037	0.000	0.037	0.000	0.038	0.000
140 Male Genital Disorders	-0.013	0.049	-0.014	0.036	-0.012	0.057	-0.012	0.071	-0.012	0.056
148 Decubitus Ulcer of Skin	0.078	0.000	0.077	0.000	0.078	0.000	0.079	0.000	0.077	0.000
157 Vertebral Fract w/out Spinal Cord Injury	0.071	0.000	0.071	0.000	0.070	0.000	0.071	0.000	0.072	0.000
158 Hip	-0.022	0.088	-0.022	0.084	-0.022	0.084	-0.022	0.089	-0.022	0.083

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Fracture/Dislocation										
159 Maj Fract, Exc Skull/Vertebrae/Hip	0.004	0.778	0.004	0.738	0.004	0.773	0.005	0.736	0.005	0.701
162 Other Injuries	0.012	0.009	0.013	0.006	0.012	0.007	0.013	0.004	0.014	0.003
163 Poisonings and Allegic Reactions	0.020	0.000	0.020	0.000	0.020	0.000	0.020	0.000	0.021	0.000
164 Maj Comp of Medical Care/Trauma	0.064	0.000	0.064	0.000	0.064	0.000	0.064	0.000	0.065	0.000
165 Other Complications of Medical Care	0.058	0.000	0.058	0.000	0.058	0.000	0.058	0.000	0.058	0.000
166 Major Symptoms, Abnormalities	0.220	0.000	0.219	0.000	0.221	0.000	0.220	0.000	0.219	0.000
167 Minor Symptoms, Signs, Findings	0.042	0.000	0.042	0.000	0.043	0.000	0.043	0.000	0.043	0.000
174 Major Organ Transplant Status	0.091	0.000	0.094	0.000	0.091	0.000	0.094	0.000	0.096	0.000
176 Artif Opens for Feeding/Elimination	0.134	0.000	0.132	0.000	0.134	0.000	0.134	0.000	0.133	0.000
179 Post-Surgical States/Aftercare/Electiv e	0.026	0.000	0.029	0.000	0.026	0.000	0.027	0.000	0.029	0.000
181 Chemotherapy	0.179	0.000	0.181	0.000	0.179	0.000	0.180	0.000	0.181	0.000
182 Rehabilitation	-0.046	0.000	-0.044	0.000	-0.046	0.000	-0.046	0.000	-0.045	0.000
183 Screening/Observation/ Special Exams	-0.043	0.000	-0.042	0.000	-0.042	0.000	-0.041	0.000	-0.041	0.000
184 History of Disease	0.017	0.000	0.019	0.000	0.018	0.000	0.019	0.000	0.021	0.000

Table 11: Risk Adjustment Model - Diagnostic Related Groupings (DRGs)

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
3 Not Found	0.282	0.003	0.281	0.003	0.281	0.003	0.279	0.003	0.279	0.003
4 ECMO or trach w MV 96+ hrs or PDX exc face, mouth & neck w maj O.R.	0.376	0.000	0.373	0.000	0.375	0.000	0.375	0.000	0.372	0.000
25 Trach w MV 96+ hrs or PDX exc face, mouth & neck w/o maj O.R.	0.536	0.000	0.534	0.000	0.536	0.000	0.535	0.000	0.533	0.000
26 Simultaneous pancreas/kidney transplant	0.633	0.000	0.630	0.000	0.633	0.000	0.633	0.000	0.630	0.000
27 Craniotomy & endovascular intracranial procedures w MCC	0.422	0.000	0.421	0.000	0.423	0.000	0.421	0.000	0.421	0.000
35 Craniotomy & endovascular intracranial procedures w CC	-0.018	0.933	-0.020	0.924	-0.017	0.936	-0.021	0.921	-0.023	0.915
36 Craniotomy & endovascular intracranial procedures w/o CC/MCC	0.154	0.497	0.150	0.508	0.156	0.492	0.153	0.500	0.150	0.509
37 Carotid artery stent procedure w CC	0.086	0.348	0.086	0.347	0.086	0.348	0.085	0.351	0.085	0.351
38 Carotid artery stent procedure w/o CC/MCC	0.103	0.138	0.102	0.142	0.103	0.136	0.102	0.143	0.101	0.146
39 Extracranial procedures w MCC	0.008	0.907	0.007	0.915	0.009	0.900	0.006	0.929	0.006	0.932
41 Extracranial procedures w CC	0.254	0.000	0.252	0.000	0.254	0.000	0.253	0.000	0.252	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
56 Extracranial procedures w/o CC/MCC	0.282	0.000	0.280	0.000	0.283	0.000	0.283	0.000	0.282	0.000
57 Periph/cranial nerve & other nerv syst proc w MCC	0.280	0.000	0.278	0.000	0.281	0.000	0.281	0.000	0.279	0.000
64 Periph/cranial nerve & other nerv syst proc w CC or periph neurostim	0.464	0.000	0.461	0.000	0.465	0.000	0.462	0.000	0.460	0.000
65 Nervous system neoplasms w/o MCC	0.288	0.000	0.286	0.000	0.288	0.000	0.286	0.000	0.284	0.000
66 Degenerative nervous system disorders w MCC	0.173	0.000	0.172	0.000	0.174	0.000	0.172	0.000	0.170	0.000
68 Degenerative nervous system disorders w/o MCC	0.323	0.000	0.319	0.000	0.324	0.000	0.321	0.000	0.318	0.000
69 Multiple sclerosis & cerebellar ataxia w/o CC/MCC	0.182	0.000	0.179	0.000	0.182	0.000	0.180	0.000	0.178	0.000
70 Intracranial hemorrhage or cerebral infarction w MCC	0.587	0.000	0.584	0.000	0.587	0.000	0.585	0.000	0.583	0.000
71 Intracranial hemorrhage or cerebral infarction w CC	0.300	0.000	0.298	0.000	0.301	0.000	0.300	0.000	0.298	0.000
72 Intracranial hemorrhage or cerebral infarction w/o CC/MCC	0.345	0.002	0.344	0.002	0.346	0.002	0.344	0.002	0.343	0.002
73 Nonspecific CVA & precerebral occlusion w/o infarct w MCC	0.533	0.000	0.531	0.000	0.534	0.000	0.533	0.000	0.531	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
74 Nonspecific CVA & precerebral occlusion w/o infarct w/o MCC	0.409	0.000	0.406	0.000	0.410	0.000	0.409	0.000	0.406	0.000
78 Transient ischemia	0.316	0.003	0.315	0.003	0.317	0.002	0.315	0.003	0.314	0.003
81 Nonspecific cerebrovascular disorders w MCC	0.121	0.313	0.118	0.326	0.121	0.312	0.121	0.313	0.118	0.325
85 Nonspecific cerebrovascular disorders w CC	0.717	0.000	0.715	0.000	0.717	0.000	0.717	0.000	0.715	0.000
86 Nonspecific cerebrovascular disorders w/o CC/MCC	0.496	0.000	0.493	0.000	0.496	0.000	0.495	0.000	0.493	0.000
87 Cranial & peripheral nerve disorders w MCC	0.411	0.000	0.409	0.000	0.411	0.000	0.411	0.000	0.410	0.000
91 Cranial & peripheral nerve disorders w/o MCC	0.331	0.000	0.327	0.000	0.331	0.000	0.330	0.000	0.327	0.000
92 Viral meningitis w CC/MCC	0.281	0.000	0.278	0.000	0.282	0.000	0.281	0.000	0.279	0.000
93 Hypertensive encephalopathy w MCC	0.176	0.033	0.172	0.036	0.177	0.032	0.176	0.033	0.173	0.036
100 Hypertensive encephalopathy w CC	0.250	0.000	0.248	0.000	0.251	0.000	0.249	0.000	0.247	0.000
101 Hypertensive encephalopathy w/o CC/MCC	0.261	0.000	0.258	0.000	0.262	0.000	0.260	0.000	0.257	0.000
103 Nontraumatic stupor & coma w/o MCC	0.138	0.164	0.136	0.172	0.140	0.160	0.138	0.165	0.136	0.171
150 Traumatic stupor & coma, coma <1 hr w	0.265	0.129	0.263	0.133	0.266	0.128	0.267	0.127	0.264	0.131

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
MCC										
151 Traumatic stupor & coma, coma <1 hr w CC	0.269	0.019	0.266	0.021	0.270	0.019	0.270	0.019	0.267	0.020
158 Traumatic stupor & coma, coma <1 hr w/o CC/MCC	0.243	0.047	0.240	0.049	0.244	0.046	0.242	0.048	0.240	0.050
166 Other disorders of nervous system w MCC	0.421	0.000	0.420	0.000	0.421	0.000	0.420	0.000	0.420	0.000
167 Other disorders of nervous system w CC	0.383	0.000	0.382	0.000	0.384	0.000	0.383	0.000	0.381	0.000
176 Other disorders of nervous system w/o CC/MCC	0.245	0.000	0.243	0.000	0.245	0.000	0.243	0.000	0.241	0.000
177 Seizures w MCC	0.450	0.000	0.447	0.000	0.451	0.000	0.451	0.000	0.447	0.000
178 Seizures w/o MCC	0.440	0.000	0.436	0.000	0.440	0.000	0.440	0.000	0.436	0.000
179 Headaches w MCC	0.296	0.000	0.292	0.000	0.296	0.000	0.296	0.000	0.293	0.000
183 Headaches w/o MCC	0.268	0.011	0.265	0.012	0.268	0.011	0.270	0.010	0.267	0.011
184 Intraocular procedures w/o CC/MCC	0.195	0.013	0.192	0.015	0.195	0.013	0.196	0.013	0.194	0.014
186 Other disorders of the eye w MCC	0.698	0.000	0.695	0.000	0.698	0.000	0.696	0.000	0.694	0.000
187 Other disorders of the eye w/o MCC	0.811	0.000	0.809	0.000	0.811	0.000	0.810	0.000	0.809	0.000
188 Mouth procedures w CC/MCC	1.012	0.000	1.009	0.000	1.011	0.000	1.009	0.000	1.007	0.000
189 Dysequilibrium	0.561	0.000	0.558	0.000	0.562	0.000	0.560	0.000	0.558	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
190 Epistaxis w MCC	0.605	0.000	0.601	0.000	0.605	0.000	0.605	0.000	0.601	0.000
191 Epistaxis w/o MCC	0.611	0.000	0.607	0.000	0.612	0.000	0.611	0.000	0.607	0.000
192 Otitis media & URI w/o MCC	0.560	0.000	0.556	0.000	0.560	0.000	0.559	0.000	0.555	0.000
193 Other ear, nose, mouth & throat diagnoses w MCC	0.411	0.000	0.408	0.000	0.411	0.000	0.410	0.000	0.407	0.000
194 Other ear, nose, mouth & throat diagnoses w CC	0.336	0.000	0.332	0.000	0.335	0.000	0.334	0.000	0.331	0.000
195 Other ear, nose, mouth & throat diagnoses w/o CC/MCC	0.208	0.000	0.205	0.000	0.207	0.000	0.206	0.000	0.203	0.000
196 Dental & oral diseases w MCC	0.762	0.000	0.761	0.000	0.763	0.000	0.763	0.000	0.762	0.000
197 Dental & oral diseases w CC	0.535	0.000	0.534	0.000	0.535	0.000	0.537	0.000	0.536	0.000
198 Major chest procedures w MCC	0.660	0.000	0.660	0.000	0.661	0.000	0.661	0.000	0.660	0.000
199 Major chest procedures w CC	0.509	0.000	0.507	0.000	0.509	0.000	0.508	0.000	0.507	0.000
201 Other resp system O.R. procedures w MCC	0.338	0.039	0.334	0.041	0.338	0.039	0.337	0.039	0.333	0.042
202 Other resp system O.R. procedures w CC	0.311	0.000	0.306	0.000	0.311	0.000	0.311	0.000	0.307	0.000
203 Other resp system O.R. procedures w/o CC/MCC	0.239	0.000	0.234	0.000	0.239	0.000	0.237	0.000	0.234	0.000
204 Pulmonary embolism w MCC	0.404	0.000	0.400	0.000	0.405	0.000	0.404	0.000	0.400	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
205 Pulmonary embolism w/o MCC	0.415	0.000	0.413	0.000	0.416	0.000	0.416	0.000	0.414	0.000
206 Respiratory infections & inflammations w MCC	0.300	0.000	0.296	0.000	0.300	0.000	0.300	0.000	0.297	0.000
207 Respiratory infections & inflammations w CC	0.158	0.001	0.154	0.002	0.158	0.001	0.157	0.001	0.153	0.002
208 Respiratory infections & inflammations w/o CC/MCC	0.421	0.000	0.418	0.000	0.421	0.000	0.419	0.000	0.416	0.000
216 Major chest trauma w MCC	0.290	0.000	0.290	0.000	0.290	0.000	0.292	0.000	0.291	0.000
217 Major chest trauma w CC	0.307	0.000	0.307	0.000	0.306	0.000	0.309	0.000	0.309	0.000
218 Pleural effusion w MCC	0.342	0.010	0.342	0.010	0.342	0.010	0.345	0.009	0.345	0.009
219 Pleural effusion w CC	0.282	0.000	0.282	0.000	0.281	0.000	0.283	0.000	0.283	0.000
220 Pleural effusion w/o CC/MCC	0.228	0.000	0.229	0.000	0.228	0.000	0.230	0.000	0.230	0.000
221 Pulmonary edema & respiratory failure	0.351	0.000	0.352	0.000	0.351	0.000	0.352	0.000	0.352	0.000
223 Chronic obstructive pulmonary disease w MCC	0.358	0.003	0.356	0.003	0.359	0.003	0.360	0.003	0.358	0.003
224 Chronic obstructive pulmonary disease w CC	0.244	0.011	0.243	0.011	0.244	0.010	0.244	0.011	0.243	0.011
226 Chronic obstructive pulmonary disease w/o CC/MCC	0.311	0.000	0.309	0.000	0.312	0.000	0.311	0.000	0.309	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
227 Simple pneumonia & pleurisy w MCC	0.179	0.002	0.177	0.002	0.180	0.002	0.179	0.002	0.178	0.002
228 Simple pneumonia & pleurisy w CC	0.262	0.004	0.264	0.004	0.262	0.004	0.263	0.004	0.264	0.004
229 Simple pneumonia & pleurisy w/o CC/MCC	0.301	0.000	0.302	0.000	0.300	0.000	0.301	0.000	0.301	0.000
231 Interstitial lung disease w MCC	0.296	0.007	0.297	0.007	0.296	0.007	0.295	0.007	0.296	0.007
233 Interstitial lung disease w CC	0.120	0.001	0.120	0.000	0.120	0.001	0.119	0.001	0.119	0.001
234 Interstitial lung disease w/o CC/MCC	0.078	0.006	0.079	0.006	0.077	0.007	0.077	0.007	0.077	0.007
237 Pneumothorax w MCC	0.491	0.000	0.490	0.000	0.491	0.000	0.490	0.000	0.489	0.000
238 Pneumothorax w CC	0.383	0.000	0.382	0.000	0.383	0.000	0.383	0.000	0.382	0.000
240 Pneumothorax w/o CC/MCC	0.419	0.000	0.415	0.000	0.418	0.000	0.415	0.000	0.411	0.000
242 Bronchitis & asthma w CC/MCC	0.288	0.000	0.284	0.000	0.288	0.000	0.286	0.000	0.284	0.000
243 Bronchitis & asthma w/o CC/MCC	0.185	0.000	0.181	0.000	0.186	0.000	0.184	0.000	0.181	0.000
244 Respiratory signs & symptoms	0.053	0.285	0.050	0.319	0.054	0.279	0.052	0.296	0.049	0.324
246 Other respiratory system diagnoses w MCC	0.626	0.000	0.624	0.000	0.626	0.000	0.626	0.000	0.624	0.000
247 Other respiratory system diagnoses w/o MCC	0.533	0.000	0.530	0.000	0.534	0.000	0.532	0.000	0.530	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
248 Respiratory system diagnosis w ventilator support 96+ hours	0.663	0.000	0.661	0.000	0.663	0.000	0.661	0.000	0.660	0.000
249 Respiratory system diagnosis w ventilator support <96 hours	0.686	0.000	0.683	0.000	0.687	0.000	0.685	0.000	0.682	0.000
250 Cardiac valve & oth maj cardiothoracic proc w card cath w MCC	0.587	0.000	0.585	0.000	0.588	0.000	0.587	0.000	0.586	0.000
251 Cardiac valve & oth maj cardiothoracic proc w card cath w CC	0.505	0.000	0.503	0.000	0.507	0.000	0.507	0.000	0.505	0.000
252 Cardiac valve & oth maj cardiothoracic proc w card cath w/o CC/MCC	0.510	0.000	0.508	0.000	0.510	0.000	0.508	0.000	0.507	0.000
253 Cardiac valve & oth maj cardiothoracic proc w/o card cath w MCC	0.556	0.000	0.553	0.000	0.556	0.000	0.554	0.000	0.552	0.000
254 Cardiac valve & oth maj cardiothoracic proc w/o card cath w CC	0.605	0.000	0.603	0.000	0.605	0.000	0.603	0.000	0.602	0.000
264 Cardiac valve & oth maj cardiothoracic proc w/o card cath w/o CC/MCC	0.282	0.000	0.280	0.000	0.282	0.000	0.279	0.000	0.278	0.000
280 Cardiac defib implant w cardiac cath w AMI/HF/shock w MCC	0.664	0.000	0.661	0.000	0.664	0.000	0.662	0.000	0.660	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
281 Cardiac defib implant w cardiac cath w AMI/HF/shock w/o MCC	0.604	0.000	0.601	0.000	0.604	0.000	0.602	0.000	0.600	0.000
282 Cardiac defib implant w cardiac cath w/o AMI/HF/shock w MCC	0.543	0.000	0.540	0.000	0.543	0.000	0.541	0.000	0.538	0.000
286 Cardiac defib implant w cardiac cath w/o AMI/HF/shock w/o MCC	0.493	0.000	0.492	0.000	0.494	0.000	0.493	0.000	0.492	0.000
287 Cardiac defibrillator implant w/o cardiac cath w MCC	0.442	0.000	0.440	0.000	0.443	0.000	0.442	0.000	0.440	0.000
288 Cardiac defibrillator implant w/o cardiac cath w/o MCC	0.834	0.000	0.834	0.000	0.834	0.000	0.834	0.000	0.835	0.000
289 Other cardiothoracic procedures w MCC	0.633	0.000	0.633	0.000	0.634	0.000	0.634	0.000	0.633	0.000
291 Other cardiothoracic procedures w CC	0.533	0.000	0.530	0.000	0.533	0.000	0.532	0.000	0.529	0.000
292 Coronary bypass w PTCA w MCC	0.578	0.000	0.576	0.000	0.579	0.000	0.578	0.000	0.575	0.000
293 Coronary bypass w cardiac cath w MCC	0.503	0.000	0.500	0.000	0.503	0.000	0.501	0.000	0.499	0.000
299 Coronary bypass w cardiac cath w/o MCC	0.409	0.000	0.405	0.000	0.409	0.000	0.407	0.000	0.404	0.000
300 Coronary bypass w/o cardiac cath w MCC	0.445	0.000	0.441	0.000	0.446	0.000	0.443	0.000	0.440	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
301 Coronary bypass w/o cardiac cath w/o MCC	0.298	0.000	0.293	0.000	0.298	0.000	0.294	0.000	0.290	0.000
302 Major cardiovasc procedures w MCC or thoracic aortic aneurysm repair	0.502	0.000	0.496	0.000	0.502	0.000	0.500	0.000	0.495	0.000
303 Major cardiovasc procedures w/o MCC	0.444	0.000	0.436	0.000	0.444	0.000	0.441	0.000	0.434	0.000
304 Amputation for circ sys disorders exc upper limb & toe w MCC	0.395	0.000	0.391	0.000	0.396	0.000	0.391	0.000	0.388	0.000
305 Amputation for circ sys disorders exc upper limb & toe w CC	0.369	0.000	0.363	0.000	0.370	0.000	0.366	0.000	0.362	0.000
306 Permanent cardiac pacemaker implant w MCC	0.519	0.000	0.518	0.000	0.520	0.000	0.521	0.000	0.520	0.000
307 Permanent cardiac pacemaker implant w CC	0.641	0.000	0.639	0.000	0.642	0.000	0.640	0.000	0.639	0.000
308 Permanent cardiac pacemaker implant w/o CC/MCC	0.665	0.000	0.663	0.000	0.666	0.000	0.664	0.000	0.662	0.000
309 AICD generator procedures	0.583	0.000	0.579	0.000	0.583	0.000	0.581	0.000	0.578	0.000
310 Perc cardiovasc proc w drug-eluting stent w MCC or 4+ vessels/stents	0.522	0.000	0.518	0.000	0.522	0.000	0.520	0.000	0.516	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
311 Perc cardiovasc proc w drug-eluting stent w/o MCC	0.443	0.000	0.438	0.000	0.443	0.000	0.440	0.000	0.436	0.000
312 Perc cardiovasc proc w non-drug-eluting stent w MCC or 4+ ves/stents	0.219	0.000	0.215	0.000	0.220	0.000	0.218	0.000	0.215	0.000
313 Perc cardiovasc proc w non-drug-eluting stent w/o MCC	0.414	0.000	0.406	0.000	0.415	0.000	0.411	0.000	0.404	0.000
314 Perc cardiovasc proc w/o coronary artery stent w MCC	0.465	0.000	0.462	0.000	0.465	0.000	0.463	0.000	0.461	0.000
315 Perc cardiovasc proc w/o coronary artery stent w/o MCC	0.426	0.000	0.423	0.000	0.426	0.000	0.424	0.000	0.422	0.000
316 Other vascular procedures w MCC	0.293	0.004	0.288	0.004	0.293	0.004	0.290	0.004	0.287	0.004
327 Other vascular procedures w CC	0.500	0.000	0.499	0.000	0.500	0.000	0.499	0.000	0.498	0.000
328 Other vascular procedures w/o CC/MCC	0.433	0.000	0.432	0.000	0.433	0.000	0.433	0.000	0.432	0.000
329 Cardiac pacemaker device replacement w/o MCC	0.399	0.000	0.400	0.000	0.399	0.000	0.399	0.000	0.399	0.000
330 Other circulatory system O.R. procedures	0.404	0.000	0.404	0.000	0.403	0.000	0.403	0.000	0.404	0.000
331 Acute myocardial infarction, discharged alive w MCC	0.471	0.000	0.471	0.000	0.471	0.000	0.471	0.000	0.471	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
335 Acute myocardial infarction, discharged alive w CC	0.228	0.000	0.226	0.000	0.227	0.000	0.227	0.000	0.226	0.000
336 Acute myocardial infarction, discharged alive w/o CC/MCC	0.164	0.001	0.163	0.001	0.165	0.001	0.164	0.001	0.163	0.001
350 Circulatory disorders except AMI, w card cath w MCC	0.040	0.794	0.038	0.803	0.041	0.787	0.040	0.791	0.039	0.795
354 Circulatory disorders except AMI, w card cath w/o MCC	0.366	0.000	0.364	0.000	0.367	0.000	0.365	0.000	0.364	0.000
355 Acute & subacute endocarditis w MCC	-0.009	0.918	-0.013	0.886	-0.009	0.925	-0.008	0.927	-0.012	0.899
356 Acute & subacute endocarditis w CC	0.402	0.000	0.401	0.000	0.402	0.000	0.400	0.000	0.399	0.000
357 Heart failure & shock w MCC	0.525	0.000	0.524	0.000	0.525	0.000	0.525	0.000	0.524	0.000
371 Heart failure & shock w CC	0.719	0.000	0.718	0.000	0.719	0.000	0.719	0.000	0.718	0.000
372 Heart failure & shock w/o CC/MCC	0.688	0.000	0.687	0.000	0.689	0.000	0.689	0.000	0.687	0.000
373 Peripheral vascular disorders w MCC	0.663	0.000	0.660	0.000	0.663	0.000	0.662	0.000	0.660	0.000
377 Peripheral vascular disorders w CC	0.404	0.000	0.401	0.000	0.404	0.000	0.403	0.000	0.401	0.000
378 Peripheral vascular disorders w/o CC/MCC	0.344	0.000	0.342	0.000	0.345	0.000	0.343	0.000	0.341	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
379 Atherosclerosis w MCC	0.270	0.000	0.265	0.000	0.270	0.000	0.268	0.000	0.264	0.000
380 Atherosclerosis w/o MCC	0.443	0.000	0.442	0.000	0.443	0.000	0.443	0.000	0.442	0.000
383 Hypertension w MCC	0.523	0.003	0.521	0.003	0.523	0.003	0.520	0.003	0.518	0.004
384 Hypertension w/o MCC	0.246	0.027	0.244	0.028	0.247	0.026	0.243	0.029	0.241	0.030
386 Cardiac congenital & valvular disorders w MCC	0.626	0.000	0.623	0.000	0.626	0.000	0.626	0.000	0.623	0.000
387 Cardiac congenital & valvular disorders w/o MCC	0.172	0.416	0.168	0.426	0.173	0.414	0.169	0.423	0.167	0.431
388 Cardiac arrhythmia & conduction disorders w MCC	0.421	0.000	0.417	0.000	0.421	0.000	0.420	0.000	0.417	0.000
389 Cardiac arrhythmia & conduction disorders w CC	0.391	0.000	0.387	0.000	0.391	0.000	0.391	0.000	0.387	0.000
390 Cardiac arrhythmia & conduction disorders w/o CC/MCC	0.271	0.000	0.265	0.000	0.271	0.000	0.270	0.000	0.264	0.000
391 Angina pectoris	0.522	0.000	0.519	0.000	0.523	0.000	0.522	0.000	0.519	0.000
392 Syncope & collapse	0.511	0.000	0.507	0.000	0.511	0.000	0.510	0.000	0.506	0.000
393 Chest pain	0.339	0.000	0.336	0.000	0.339	0.000	0.339	0.000	0.336	0.000
394 Other circulatory system diagnoses w MCC	0.398	0.000	0.395	0.000	0.399	0.000	0.398	0.000	0.395	0.000
395 Other circulatory system diagnoses w CC	0.255	0.001	0.251	0.001	0.256	0.001	0.255	0.001	0.251	0.001

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
405 Other circulatory system diagnoses w/o CC/MCC	0.641	0.000	0.641	0.000	0.641	0.000	0.642	0.000	0.641	0.000
406 Stomach, esophageal & duodenal proc w MCC	0.757	0.000	0.757	0.000	0.757	0.000	0.757	0.000	0.757	0.000
417 Stomach, esophageal & duodenal proc w CC	0.093	0.063	0.090	0.074	0.093	0.063	0.091	0.071	0.088	0.080
418 Stomach, esophageal & duodenal proc w/o CC/MCC	0.199	0.000	0.195	0.000	0.199	0.000	0.196	0.000	0.193	0.000
419 Major small & large bowel procedures w MCC	0.033	0.698	0.028	0.742	0.033	0.693	0.031	0.713	0.027	0.750
432 Major small & large bowel procedures w CC	0.845	0.000	0.844	0.000	0.845	0.000	0.844	0.000	0.843	0.000
433 Major small & large bowel procedures w/o CC/MCC	0.964	0.000	0.962	0.000	0.965	0.000	0.964	0.000	0.962	0.000
438 Peritoneal adhesiolysis w MCC	0.531	0.000	0.528	0.000	0.531	0.000	0.529	0.000	0.526	0.000
439 Peritoneal adhesiolysis w CC	0.403	0.000	0.399	0.000	0.403	0.000	0.401	0.000	0.397	0.000
440 Minor small & large bowel procedures w MCC	0.430	0.000	0.425	0.000	0.430	0.000	0.426	0.000	0.421	0.000
441 Anal & stomal procedures w CC	0.775	0.000	0.773	0.000	0.775	0.000	0.774	0.000	0.773	0.000
442 Inguinal & femoral hernia procedures w MCC	0.821	0.000	0.818	0.000	0.822	0.000	0.821	0.000	0.817	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
443 Hernia procedures except inguinal & femoral w MCC	0.670	0.000	0.665	0.000	0.670	0.000	0.668	0.000	0.664	0.000
444 Hernia procedures except inguinal & femoral w CC	0.549	0.000	0.544	0.000	0.549	0.000	0.549	0.000	0.544	0.000
445 Hernia procedures except inguinal & femoral w/o CC/MCC	0.607	0.000	0.602	0.000	0.608	0.000	0.607	0.000	0.602	0.000
446 Other digestive system O.R. procedures w MCC	0.337	0.000	0.331	0.001	0.338	0.000	0.336	0.000	0.331	0.001
459 Other digestive system O.R. procedures w CC	0.173	0.048	0.174	0.046	0.172	0.048	0.171	0.049	0.173	0.048
469 Major esophageal disorders w MCC	0.171	0.000	0.172	0.000	0.171	0.000	0.170	0.000	0.171	0.000
480 Major esophageal disorders w CC	0.211	0.002	0.208	0.002	0.210	0.002	0.209	0.002	0.207	0.002
492 Major esophageal disorders w/o CC/MCC	0.360	0.000	0.360	0.000	0.359	0.000	0.358	0.000	0.359	0.000
496 Major gastrointestinal disorders & peritoneal infections w MCC	0.308	0.000	0.307	0.000	0.308	0.000	0.308	0.000	0.307	0.000
515 Major gastrointestinal disorders & peritoneal infections w CC	0.406	0.000	0.404	0.000	0.406	0.000	0.405	0.000	0.403	0.000
516 Major gastrointestinal disorders & peritoneal infections w/o CC/MCC	0.372	0.000	0.371	0.000	0.373	0.000	0.372	0.000	0.371	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
517 G.I. hemorrhage w MCC	0.190	0.024	0.189	0.025	0.191	0.023	0.190	0.024	0.189	0.025
540 G.I. hemorrhage w CC	0.365	0.000	0.360	0.000	0.366	0.000	0.364	0.000	0.360	0.000
543 G.I. hemorrhage w/o CC/MCC	0.507	0.000	0.503	0.000	0.507	0.000	0.507	0.000	0.504	0.000
544 Complicated peptic ulcer w MCC	0.555	0.000	0.551	0.000	0.555	0.000	0.554	0.000	0.551	0.000
545 Complicated peptic ulcer w/o CC/MCC	0.548	0.000	0.546	0.000	0.548	0.000	0.548	0.000	0.546	0.000
546 Uncomplicated peptic ulcer w MCC	0.630	0.000	0.626	0.000	0.631	0.000	0.631	0.000	0.627	0.000
547 Uncomplicated peptic ulcer w/o MCC	0.139	0.453	0.134	0.467	0.140	0.449	0.138	0.454	0.135	0.466
551 Inflammatory bowel disease w MCC	0.407	0.000	0.403	0.000	0.407	0.000	0.406	0.000	0.403	0.000
552 Inflammatory bowel disease w CC	0.340	0.000	0.337	0.000	0.341	0.000	0.340	0.000	0.338	0.000
553 Inflammatory bowel disease w/o CC/MCC	0.516	0.000	0.510	0.000	0.517	0.000	0.513	0.000	0.508	0.000
555 G.I. obstruction w MCC	0.463	0.000	0.458	0.000	0.463	0.000	0.461	0.000	0.456	0.000
556 G.I. obstruction w CC	0.289	0.000	0.286	0.000	0.290	0.000	0.288	0.000	0.285	0.000
557 G.I. obstruction w/o CC/MCC	0.357	0.001	0.353	0.001	0.357	0.001	0.356	0.001	0.352	0.001
558 Esophagitis, gastroent & misc digest disorders w MCC	0.178	0.002	0.175	0.002	0.178	0.002	0.177	0.002	0.174	0.002

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
559 Esophagitis, gastroent & misc digest disorders w/o MCC	0.751	0.000	0.749	0.000	0.752	0.000	0.751	0.000	0.749	0.000
562 Other digestive system diagnoses w MCC	0.240	0.015	0.238	0.016	0.241	0.015	0.239	0.015	0.237	0.016
563 Other digestive system diagnoses w CC	0.412	0.000	0.410	0.000	0.413	0.000	0.412	0.000	0.410	0.000
580 Other digestive system diagnoses w/o CC/MCC	0.218	0.000	0.216	0.000	0.218	0.000	0.216	0.000	0.214	0.000
593 Pancreas, liver & shunt procedures w MCC	0.363	0.000	0.359	0.000	0.364	0.000	0.362	0.000	0.358	0.000
594 Pancreas, liver & shunt procedures w CC	0.282	0.313	0.277	0.321	0.282	0.313	0.281	0.315	0.277	0.321
595 Biliary tract proc except only cholecyst w or w/o c.d.e. w MCC	0.569	0.001	0.565	0.002	0.569	0.001	0.570	0.001	0.566	0.001
602 Biliary tract proc except only cholecyst w or w/o c.d.e. w CC	0.445	0.000	0.442	0.000	0.445	0.000	0.444	0.000	0.442	0.000
603 Laparoscopic cholecystectomy w/o c.d.e. w MCC	0.336	0.000	0.333	0.000	0.337	0.000	0.336	0.000	0.333	0.000
605 Laparoscopic cholecystectomy w/o c.d.e. w CC	0.434	0.000	0.432	0.000	0.435	0.000	0.434	0.000	0.432	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
607 Laparoscopic cholecystectomy w/o c.d.e. w/o CC/MCC	0.513	0.000	0.508	0.000	0.514	0.000	0.513	0.000	0.508	0.000
617 Cirrhosis & alcoholic hepatitis w MCC	-0.161	0.004	-0.161	0.004	-0.162	0.004	-0.163	0.004	-0.162	0.004
621 Cirrhosis & alcoholic hepatitis w CC	-0.010	0.933	-0.010	0.929	-0.009	0.936	-0.011	0.922	-0.011	0.921
637 Disorders of pancreas except malignancy w MCC	0.421	0.000	0.417	0.000	0.421	0.000	0.420	0.000	0.416	0.000
638 Disorders of pancreas except malignancy w CC	0.298	0.000	0.293	0.000	0.299	0.000	0.297	0.000	0.292	0.000
639 Disorders of pancreas except malignancy w/o CC/MCC	0.182	0.002	0.176	0.003	0.182	0.002	0.179	0.002	0.174	0.003
640 Disorders of liver except malig,cirr,alc hepa w MCC	0.529	0.000	0.525	0.000	0.530	0.000	0.528	0.000	0.524	0.000
641 Disorders of liver except malig,cirr,alc hepa w CC	0.546	0.000	0.542	0.000	0.546	0.000	0.544	0.000	0.541	0.000
643 Disorders of liver except malig,cirr,alc hepa w/o CC/MCC	0.467	0.000	0.464	0.000	0.468	0.000	0.468	0.000	0.464	0.000
644 Disorders of the biliary tract w MCC	0.550	0.000	0.545	0.000	0.550	0.000	0.550	0.000	0.546	0.000
645 Disorders of the biliary tract w CC	0.214	0.033	0.209	0.037	0.215	0.032	0.214	0.033	0.210	0.036

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
652 Disorders of the biliary tract w/o CC/MCC	0.979	0.000	0.978	0.000	0.979	0.000	0.979	0.000	0.978	0.000
654 Spinal fusion except cervical w MCC	0.567	0.000	0.567	0.000	0.566	0.000	0.567	0.000	0.566	0.000
659 Major joint replacement or reattachment of lower extremity w MCC	0.583	0.000	0.581	0.000	0.582	0.000	0.582	0.000	0.580	0.000
660 Biopsies of musculoskeletal system & connective tissue w MCC	0.755	0.000	0.753	0.000	0.756	0.000	0.755	0.000	0.754	0.000
669 Biopsies of musculoskeletal system & connective tissue w CC	0.531	0.000	0.528	0.000	0.531	0.000	0.530	0.000	0.527	0.000
670 Biopsies of musculoskeletal system & connective tissue w/o CC/MCC	0.628	0.001	0.623	0.001	0.629	0.001	0.628	0.001	0.623	0.001
673 Hip & femur procedures except major joint w MCC	0.358	0.000	0.357	0.000	0.359	0.000	0.358	0.000	0.357	0.000
674 Hip & femur procedures except major joint w CC	0.573	0.000	0.569	0.000	0.573	0.000	0.571	0.000	0.568	0.000
682 Lower extrem & humer proc except hip,foot,femur w MCC	0.540	0.000	0.536	0.000	0.540	0.000	0.537	0.000	0.534	0.000
683 Local excision & removal int fix devices exc hip & femur w CC	0.518	0.000	0.514	0.000	0.518	0.000	0.516	0.000	0.512	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
684 Local excision & removal int fix devices exc hip & femur w/o CC/MCC	0.428	0.000	0.423	0.000	0.428	0.000	0.426	0.000	0.422	0.000
689 Major shoulder or elbow joint procedures w CC/MCC	0.505	0.000	0.502	0.000	0.505	0.000	0.504	0.000	0.501	0.000
690 Other musculoskelet sys & conn tiss O.R. proc w MCC	0.428	0.000	0.424	0.000	0.428	0.000	0.426	0.000	0.423	0.000
694 Other musculoskelet sys & conn tiss O.R. proc w CC	0.491	0.000	0.488	0.000	0.492	0.000	0.491	0.000	0.488	0.000
696 Other musculoskelet sys & conn tiss O.R. proc w/o CC/MCC	0.691	0.000	0.687	0.000	0.692	0.000	0.691	0.000	0.687	0.000
698 Fractures of hip & pelvis w/o MCC	0.443	0.000	0.440	0.000	0.443	0.000	0.443	0.000	0.440	0.000
699 Sprains, strains, & dislocations of hip, pelvis & thigh w/o CC/MCC	0.527	0.000	0.523	0.000	0.527	0.000	0.526	0.000	0.523	0.000
700 Osteomyelitis w MCC	0.440	0.000	0.437	0.000	0.440	0.000	0.437	0.000	0.434	0.000
714 Osteomyelitis w CC	0.369	0.056	0.361	0.061	0.370	0.055	0.369	0.056	0.362	0.060
726 Osteomyelitis w/o CC/MCC	0.710	0.000	0.706	0.000	0.710	0.000	0.709	0.000	0.705	0.000
760 Pathological fractures & musculoskelet & conn tiss malig w MCC	0.161	0.431	0.152	0.457	0.162	0.427	0.159	0.436	0.152	0.456

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
800 Pathological fractures & musculoskelet & conn tiss malig w CC	0.359	0.192	0.356	0.195	0.358	0.193	0.356	0.195	0.354	0.197
808 Pathological fractures & musculoskelet & conn tiss malig w/o CC/MCC	0.413	0.000	0.411	0.000	0.412	0.000	0.411	0.000	0.410	0.000
809 Connective tissue disorders w MCC	0.658	0.000	0.655	0.000	0.658	0.000	0.656	0.000	0.654	0.000
811 Connective tissue disorders w CC	0.513	0.000	0.511	0.000	0.513	0.000	0.511	0.000	0.509	0.000
812 Connective tissue disorders w/o CC/MCC	0.530	0.000	0.527	0.000	0.530	0.000	0.528	0.000	0.525	0.000
813 Medical back problems w MCC	0.660	0.000	0.656	0.000	0.660	0.000	0.657	0.000	0.654	0.000
814 Medical back problems w/o MCC	0.553	0.001	0.552	0.001	0.553	0.001	0.552	0.001	0.551	0.001
846 Bone diseases & arthropathies w MCC	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
847 Bone diseases & arthropathies w/o MCC	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
853 Signs & symptoms of musculoskeletal system & conn tissue w MCC	0.331	0.000	0.330	0.000	0.331	0.000	0.330	0.000	0.329	0.000
856 Signs & symptoms of musculoskeletal system & conn tissue w/o MCC	0.258	0.000	0.259	0.000	0.258	0.000	0.257	0.000	0.258	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
857 Tendonitis, myositis & bursitis w MCC	0.224	0.000	0.224	0.000	0.224	0.000	0.224	0.000	0.224	0.000
862 Tendonitis, myositis & bursitis w/o MCC	0.211	0.000	0.211	0.000	0.212	0.000	0.211	0.000	0.211	0.000
864 Aftercare, musculoskeletal system & connective tissue w MCC	0.246	0.000	0.244	0.000	0.246	0.000	0.247	0.000	0.245	0.000
866 Fx, sprn, strn & disl except femur, hip, pelvis & thigh w MCC	0.226	0.008	0.225	0.008	0.226	0.008	0.226	0.008	0.225	0.008
871 Fx, sprn, strn & disl except femur, hip, pelvis & thigh w/o MCC	0.400	0.000	0.397	0.000	0.400	0.000	0.399	0.000	0.397	0.000
872 Other musculoskeletal sys & connective tissue diagnoses w/o CC/MCC	0.333	0.000	0.330	0.000	0.333	0.000	0.332	0.000	0.329	0.000
880 Skin graft &/or debrid for skn ulcer or cellulitis w CC	0.291	0.196	0.290	0.198	0.291	0.197	0.290	0.198	0.289	0.200
884 Skin graft &/or debrid exc for skin ulcer or cellulitis w CC	0.293	0.000	0.291	0.000	0.294	0.000	0.292	0.000	0.291	0.000
897 Other skin, subcut tiss & breast proc w MCC	0.265	0.000	0.264	0.000	0.266	0.000	0.266	0.000	0.265	0.000
907 Other skin, subcut tiss & breast proc w CC	0.271	0.000	0.272	0.000	0.271	0.000	0.270	0.000	0.271	0.000
908 Skin ulcers w CC	0.375	0.000	0.374	0.000	0.375	0.000	0.374	0.000	0.373	0.000
916 Skin ulcers w/o	0.155	0.353	0.148	0.377	0.157	0.349	0.153	0.359	0.147	0.378

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
CC/MCC										
917 Major skin disorders w MCC	0.208	0.000	0.204	0.000	0.208	0.000	0.207	0.000	0.203	0.000
918 Major skin disorders w/o MCC	0.113	0.058	0.107	0.071	0.113	0.058	0.111	0.062	0.107	0.073
919 Cellulitis w MCC	0.505	0.000	0.504	0.000	0.505	0.000	0.505	0.000	0.504	0.000
920 Cellulitis w/o MCC	0.348	0.000	0.347	0.000	0.349	0.000	0.348	0.000	0.347	0.000
921 Trauma to the skin, subcut tiss & breast w/o MCC	0.183	0.077	0.181	0.080	0.182	0.078	0.181	0.081	0.179	0.083
947 Minor skin disorders w/o MCC	0.523	0.000	0.520	0.000	0.523	0.000	0.522	0.000	0.519	0.000
948 Amputat of lower limb for endocrine,nutrit,& metabol dis w CC	0.468	0.000	0.465	0.000	0.468	0.000	0.467	0.000	0.464	0.000
974 O.R. procedures for obesity w/o CC/MCC	0.341	0.000	0.332	0.000	0.343	0.000	0.340	0.000	0.333	0.000
975 Skin grafts & wound debrid for endoc, nutrit & metab dis w CC	0.629	0.000	0.619	0.000	0.631	0.000	0.626	0.000	0.619	0.000
977 Other endocrine, nutrit & metab O.R. proc w CC	0.590	0.000	0.582	0.001	0.592	0.000	0.587	0.000	0.580	0.001
981 Diabetes w MCC	0.471	0.000	0.469	0.000	0.471	0.000	0.470	0.000	0.469	0.000
982 Diabetes w CC	0.307	0.000	0.306	0.000	0.307	0.000	0.306	0.000	0.305	0.000
987 Diabetes w/o CC/MCC	0.461	0.000	0.460	0.000	0.462	0.000	0.459	0.000	0.458	0.000
988 Nutritional & misc metabolic disorders w MCC	0.377	0.000	0.374	0.000	0.376	0.000	0.374	0.000	0.372	0.000

Table 12: Risk Adjustment Model - Activities of Daily Living (ADL) Scores

Health Status Variable (Activities of Daily Living [ADL] from the Claim Authorization String)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
ADL Score 1	0.003	0.191	0.002	0.283	0.003	0.197	0.003	0.216	0.002	0.308
ADL Score 2	0.037	0.000	0.036	0.000	0.037	0.000	0.036	0.000	0.036	0.000
ADL Score 3	-0.002	0.543	-0.001	0.678	-0.002	0.553	-0.002	0.615	-0.001	0.742
ADL Score 4	0.001	0.560	0.001	0.746	0.001	0.573	0.001	0.581	0.001	0.764

Table 13: Risk Adjustment Model - Enrollment Status Variables

Enrollment Status Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Currently End Stage Renal Disease	0.248	0.000	0.245	0.000	0.248	0.000	0.246	0.000	0.244	0.000
Originally End Stage Renal Disease	0.042	0.019	0.036	0.042	0.042	0.019	0.038	0.033	0.033	0.063
Originally Disabled, Female	0.116	0.000	0.108	0.000	0.115	0.000	0.111	0.000	0.104	0.000
Originally Disabled, Male	0.095	0.000	0.092	0.000	0.094	0.000	0.089	0.000	0.087	0.000

Table 14: Risk Adjustment Model - Interaction Terms

Interaction Terms	Original Model	Original Model + Dual Eligible	Original Model + Rural Location	Original Model + SES Index	Original Model + All SDS Variables

	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Congestive Heart Failure * Chronic Obstructive Pulmonary Disease	-0.051	0.000	-0.050	0.000	-0.050	0.000	-0.050	0.000	-0.049	0.000
Chronic Obstructive Pulmonary Disease * Chronic Renal Failure	0.052	0.000	0.053	0.000	0.052	0.000	0.053	0.000	0.054	0.000
Sepsis * Chronic Renal Failure	-0.074	0.000	-0.073	0.000	-0.074	0.000	-0.074	0.000	-0.073	0.000
Currently Disabled * Pressure Ulcer	-0.092	0.000	-0.092	0.000	-0.093	0.000	-0.092	0.000	-0.091	0.000

* Each input variable has an associated marginal effect value that can be interpreted as the change in the population value of the measure if all patients in the population had the risk factor but had the observed distribution of all other risk factors. For example, the marginal effect for Congestive Heart Failure takes into account the change in the predicted risk of the outcome due to changes caused by the Congestive Heart Failure and Congestive Heart Failure*Chronic Obstructive Pulmonary Disease variables, if the value of Congestive Heart Failure were set to 1 for all patients. Therefore, marginal effects are not included for interaction terms.

Table 15: Risk Adjustment Model - SDS Factors

SDS Variables	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value

Dual Medicaid Status	-	-	0.063	0.000	-	-	-	-	0.059	0.000
Rural	-	-	-	-	0.016	0.001	-	-	0.006	0.213
Low SES Index Score (SES Index Score <= 50.1)	-	-	-	-	-	-	0.023	0.000	0.019	0.000
Moderate SES Index Score (50.1< SES Index Score <57.1)	-	-	-	-	-	-	0.003	0.375	0.004	0.147
Missing SES Index Score	-	-	-	-	-	-	0.015	0.001	0.014	0.002

Note: Reference group for SES Index Variable is High SES Index Score (SES Index >= 57.1)

NATIONAL QUALITY FORUM

[NQF] Admissions and Readmissions March 8 and May 13 SDS Webinar Developer Questions

1. Enter measure # and title.

Measure # 2503 Hospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries.
Measure # 2504 30-day Rehospitalizations per 1000 Medicare fee-for-service (FFS) Beneficiaries

2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

The measures are intended to track changes in hospitalization and rehospitalization incidences in a geographically defined population ('community') of fee-for-service (FFS) Medicare beneficiaries over time. Their purpose is to support multiple stakeholder coalitions aiming to improve localized care coordination, by gauging progress in reducing hospitalization occurrence. The measure should be adjusted for demographic elements that have two characteristics: are related to hospitalization and re-hospitalization risk; and could plausibly change over a relatively short period of time in a geographically restricted population. For the purposes of these measures, a short period of time refers to 5 years or less, corresponding to the length of funding for many improvement initiatives. We tested the usefulness and feasibility of adjusting the measures for age (2,4), gender (5,12) and race (1,2,4,5,6) based on published evidence associating these factors with hospitalization and re-hospitalization risk.

1) Population age distribution: The US population has an unusually large birth cohort currently entering the Medicare program through reaching age 65. Younger beneficiaries entering the program through age are often relatively healthy and have low hospitalization rates, and could conceivably enter the population of any given community rapidly enough to influence the rate of hospitalizations/1000 beneficiaries over a several year period.

2) Population gender distribution: As women live longer than men, the percent of the population that is female grows as the cohort ages (3,10,13). Research illustrates an increased incidence of chronic conditions, comorbidities, and functional impairment in women as they age (7), which increases their likelihood of hospitalization and readmission (2,6)

We are exploring census-based area deprivation indices (ADI) as a potential method for describing aggregate population sociodemographic characteristics related to health. Deprivation indices use multiple census variables such as housing status, educational attainment, average income, and access to transportation to identify census blocks of concentrated poverty in which residents experience high degrees of social and economic disadvantage. In early studies, residence within a deprived neighborhood correlates more strongly with admission and readmission risk than personal socioeconomic status markers such as dual eligibility status (11). Our early work supported this

association, demonstrating that residence within a very deprived neighborhood is a significant risk factor for readmissions (8) among FFS Medicare beneficiaries. The measure development team is assessing the ADI as a potential adjustment factor, but does not have access to this variable at the time of this submission. Until more is known about the rate at which neighborhood deprivation indicators change, we are not recommending the ADI as an adjustment factor. The admissions and readmissions measures in conjunction with the ADI should be used to learn how to best tailor support for community improvement efforts among communities that vary by population disadvantage; adjusting the measure for ADI of the population served could obscure the results of tests of change.

3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

We recommend that the measure be standardized or adjusted for population age distribution.

4. What were the statistical results of the analyses used to select risk factors?

Analysis of Medicare claims for change in hospitalization and rehospitalization rates between 2011 to 2014, shows the gender adjusted rates to be no different than crude rates, and rates calculated using adjustment for the age and gender categories to be no different than adjustment for the age category only. (Table 1).

Table 1: 2014 Admissions and Readmissions Adjusted based on the Age Category and Gender Category Distribution of 2011

Adjustment Categories	Admissions	Readmissions	Total FFS Beneficiaries (2014)	Crude admissions per 1000	Adjusted admissions per 1000	Crude readmissions per 1000	Adjusted readmissions per 1000
Age and Gender	9,951,545	1,745,854	37,242,120	267.212	272.608	46.8785	47.8792
Age	9,951,545	1,745,854	37,242,120	267.212	272.732	46.8785	47.9227
Gender	9,951,545	1,745,854	37,242,120	267.212	267.283	46.8785	46.8616

On average, communities showed a reduction in admission rates between 2011 and 2012 that was 3/1000 greater using the unadjusted rate as compared to the age adjusted rate. Several communities experienced unadjusted improvement rates more than 6/1000 better using the unadjusted rate.
For readmission, communities showed a reduction in rates on average between 2011 and 2012 that was 0.56/1000 greater using the unadjusted rate as compared to the age adjusted rate.

	Unadjusted improvement rates for **admissions**/1000 2011 – 2012, compared to age adjusted improvement rates	Unadjusted improvement rates for **readmissions**/1000, 2011-2012, compared to age adjusted improvement rates
Mean difference	3.00	0.56
Median difference	3.22	0.54
Standard deviation	1.58933	0.29930
P-value (for testing, mean=0)	<.0001	<.0001

We focused on the conceptual purpose of the measure, plus the aggregated experience of the QIO program working to reduce rates of hospitalization within hundreds of communities, to identify demographic variables that are both related to hospitalization risk, and might change within a community over a short period of time. The measures have been used as evaluation measures in the CMS's QIO program since 2009. Beginning in 2011, reports generated by local QIO project leaders engaged in facilitating community improvement campaigns began referencing the effects of large numbers of Medicare beneficiaries entering the local market as being influential in the effort required of community stakeholder partners in driving the work. Reports included descriptions of challenges in providing services to rapidly increasing numbers of Medicare beneficiaries generally, and the challenges introduced by the mobility of the healthiest new beneficiaries. Retirement often accompanies transition to Medicare eligibility. New retirees, often being a younger Medicare population, may affect the hospitalization profile of communities by inundating attractive retirement locations, and leaving less attractive retirement markets for the older Medicare population.

We did not test adjustment for characteristics of facilities or other aspects of the healthcare market, because it would weaken the usefulness of the measure. It is intended to track the results of changes in care patterns across multiple providers, to be used by stakeholder partners as a whole population perspective on the outcomes of care arrangements as currently operating in the community regardless of individual challenges of separate institutions. For that reason the measure is calculated across the total FFS population, not merely those with previous hospitalizations or other medical care events. Facility characteristics are also unlikely to change quickly enough to impact a large proportion of the community population's propensity to be hospitalized.

5. Describe the analyses and interpretation resulting in the decision to select SDS factors (e.g. prevalence of the factor across measured entities, empirical association with the outcome, contribution of unique variation in the outcome, assessment of between-unit effects and within-unit effects).

N/A; see answers above

6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach (describe the steps—do not just name a method; what statistical analysis was used).

We tested the effect of adjusting the measures for age group using data from 198 communities participating in improvement efforts through the QIO 10th Statement of Work. We directly adjusted the 2012 rates of admissions/1000 and readmissions/1000 to the 2011 age distribution in each community. We calculated improvement in each measure between 2011 and 2012 using the unadjusted 2012 rates and again using the adjusted rates. We compared the improvement rates of (re)hospitalization/1000 resulting from each method using a Student's t- test.

7. Discuss the risks for misuse of the specified performance measure. This discussion could include information on the known limitations of the performance measure that could impact its use in accountability programs.

The measure is not intended for comparing performance between communities, or between providers within a community. In our experience this has not been a relevant factor in locally managed improvement activities. This measure was not designed to be an accountability measure, and because of that has distinct advantages as a metric for tracking progress in quality improvement initiatives (8).

To be useful as an accountability measure, it could be displayed as a reduction in failure rate, and used to compare progress between communities. It would likely need to be adjusted by ADI or other metric reflective of community population disadvantage.

8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables. This information may include the stratification variables, definitions, specific data collection items/responses, code/value sets, and the risk-model covariates and coefficients for the clinically-adjusted version of the measure when appropriate.

N/A – the measures do not include clinical variables

9. Please enter the details of the final statistical risk model and variables here.

We do not have a statistical risk model. We recommend that the measure be stratified or adjusted by age category: Younger than 65, 65-69, 70-74, 75-79, 80-84, and 85 years and older.

10. Compare measure performance scores with and without SDS factors in the risk adjustment model. Include the method of testing conducted to compare performance scores with and without SDS factors in the risk adjustment model for the same entities, the statistical results from testing the differences in the performance scores with and without SDS factors in the risk adjustment model. (e.g., correlation, rank order) and provide an interpretation of your results in terms of the differences in performance scores with and without SDS factors in the risk adjustment model for the same entities.

Figure 1: Distribution of the difference in improvement (reduction) in admissions/1000 between 2011 and 2012 among 198 communities, unadjusted vs. age adjusted

Figure 1: Difference in Improvement in Admissions/1000

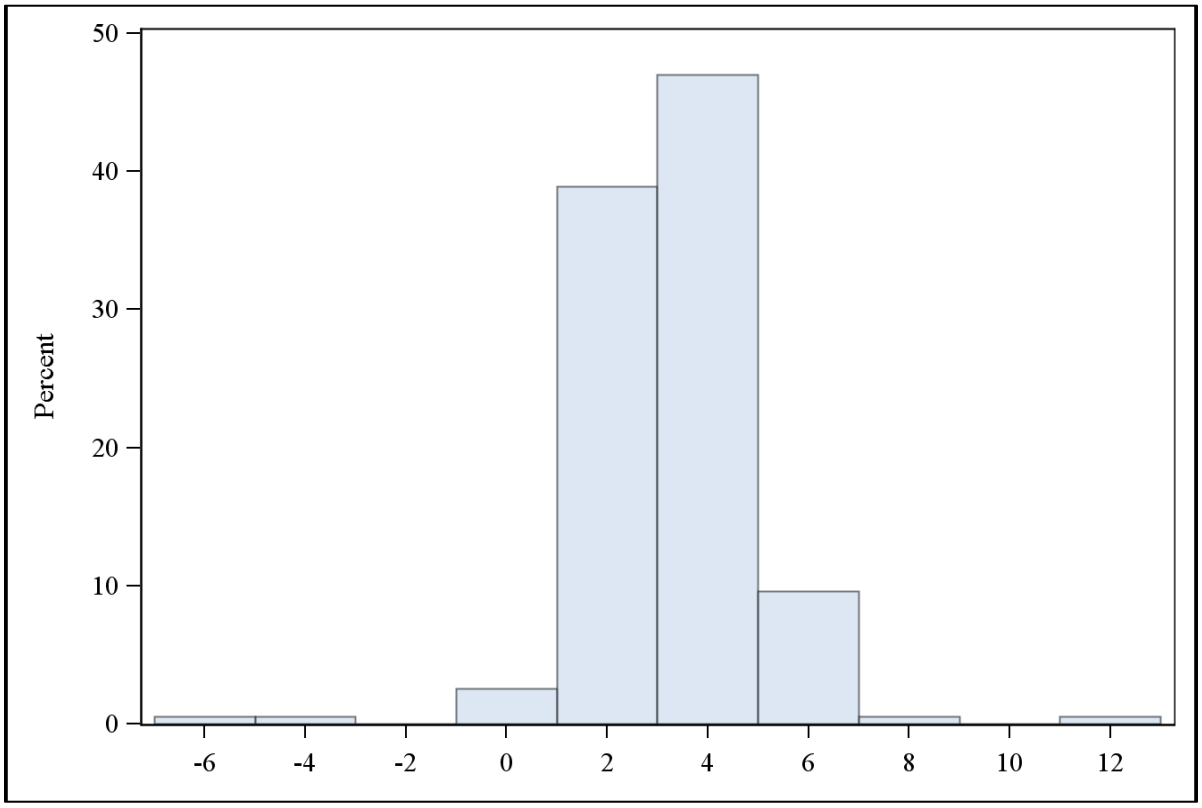
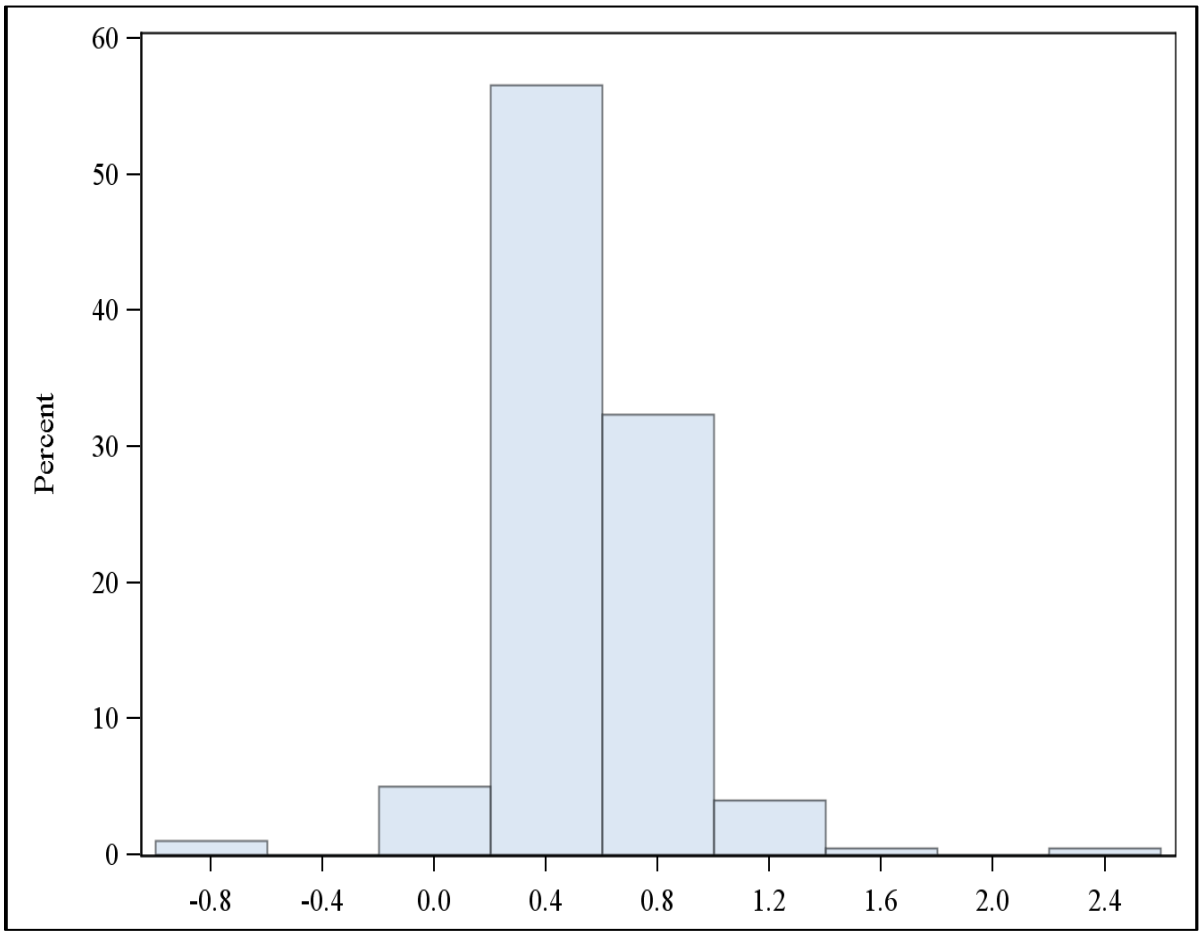


Figure 2: Distribution of the difference in improvement (reduction) in readmissions/1000 between 2011 and 2012 among 198 communities, unadjusted vs. age adjusted.

Figure 2: Difference in Improvement in Readmissions/1000



Interpretation: Communities using admissions/1000 and readmissions/1000 may overestimate improvement using the measures without adjustment for the age distribution of FFS beneficiaries in the community. This overestimation may be as large as 12 admissions/1000/year or 2.4 readmissions/1000/year in a community experiencing high rates of people entering the Medicare program through reaching age 65.

11. Appendix (includes literature review, reference list, etc.)

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TO: NQF Staff
FROM: Abt Associates
DATE: April 27, 2016
SUBJECT: **[NQF] Admissions and Readmissions NQF # 2505 SDS Developer Questionnaire**

1. Enter measure # and title.

NQF# 2505: Emergency Department (ED) Use without Hospital Readmission during the First 30 Days of Home Health

2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

The current model already includes the demographic characteristics of age and sex. Additionally, the prior care setting risk factors likely account for some of the impact that additional SDS factors have on acute care utilization. Finally, Medicare Enrollment Status indicators identify beneficiaries who are disabled and disability may act as both a clinical risk factor and a socio-demographic factor, due to correlation with income or employment.

Our team identified several additional socio-demographic factors that can be reliably and feasibly captured using existing data sources. These include:

- Medicaid Status – included in the CMS Enrollment Database (EDB)
- Rural Location – determined from beneficiary address, as captured in EDB
- SES Index[1] Score – determined from beneficiary address linked to American Community Survey (ACS) data. The index is a composite of seven ACS variables:
  - Percentage of people in the labor force who are unemployed
  - Percentage of persons below US poverty line
  - Median household income
  - Median value of owner-occupied homes
  - Percentage of persons aged ≥ 25 years with less than a 12th-grade education
  - Percentage of persons aged ≥ 25 years with at least 4 years of college
  - Percentage of households containing one or more person per room

[1] For more information on the construction of the SES Index please refer to the Agency for Healthcare Research and Quality's (AHRQ) publication Chapter 3: Creation of New Race-Ethnicity Codes and SES Indicators for Medicare Beneficiaries - Chapter 3. January 2008. Agency for Healthcare Research and Quality, Rockville, MD. http://archive.ahrq.gov/research/findings/final-reports/medicareindicators/medicareindicators3.html

3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

We do not recommend including SDS factors in the final risk adjustment model for NQF measure # 2505: Emergency Department (ED) Use without Hospital Readmission during the First 30 Days of Home Health.

4. What were the statistical results of the analyses used to select risk factors?

In this section we describe the approach used to select clinical risk factors and the results of that approach for the endorsement of the ED Use without Hospital Readmission measure. A single multinomial logit model was used to predict both the Rehospitalization During the First 30 Days of Home Health measure and the ED Use without Hospital Readmission During the First 30 Days of Home Health measure. Of the 1,669,802 qualifying home health stays beginning from July 1, 2010 to June 30, 2013, a random 80 percent sample without replacement was chosen to calibrate the multinomial logit model and to estimate marginal effects for model development purposes. The remaining 20 percent of the stays were used to cross-validate the model.

Risk factors included in the model include prior care setting, health status (measured using hierarchical condition categories (HCC), diagnostic related groupings (DRG), and activity of daily living scores (ADL), demographic information (measured using age-gender interactions), enrollment status (end stage renal disease (ESRD) and disability), and interactions between one set of the health status covariates. To determine which risk factors should be included in the risk adjustment model, a Wald test of joint restrictions was applied to each variable in each of 1,150 bootstrap samples created using simple random sampling, with replacement, of 80 percent of all home health stays. The Wald test determined the likelihood that the change in either or both outcomes associated with each covariate was statistically different from zero. The current risk adjustment model includes only covariates that were significant at a level of 0.05 for either outcome in at least 80 percent of bootstrap samples. This restriction reduces the number of variables included in the current model, thus streamlining the model and avoiding over-fitting.

To evaluate the impact of each risk factor, the marginal effects were calculated. The marginal effect represents the relative impact of each risk factor on the outcome. Each risk factor has an associated marginal effect value that can be interpreted as the change in the population value of the measure if all patients in the population had the risk factor but had the observed distribution of all other risk factors. Goodness of fit statistics were then calculated for the calibrated model and the 20 percent sample was used for cross-validation.

Once the significant risk factors were identified in the development stage, the model was then calibrated using 100 percent of home health stays. This model would be used to calculate the

predicted probabilities of the two outcomes for each home health stay for the home health quality reporting program.

In May 2014, the measure developer re-calibrated the model using three years of data (i.e., all home health stays beginning between July 1, 2010 and June 30, 2013) to reflect the three-year reporting period planned for the public reporting of the *Rehospitalization* and the *ED Use without Hospital Readmission* measures. The coefficients and marginal effects for each risk factor in the model calibrated using all home health stays beginning between July 1, 2010 and June 30, 2013 are available on CMS's Quality Measures webpage[2].

5. Describe the analyses and interpretation resulting in the decision to select SDS factors (e.g. prevalence of the factor across measured entities, empirical association with the outcome, contribution of unique variation in the outcome, assessment of between-unit effects and within-unit effects).

Acumen performed multiple analyses in accordance with NQF's guidance. Specifically:

- Prevalence of each SDS factor across home health agencies (HHA);
- Distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor to determine if there is variation in HHA performance across populations with low/high proportions of each SDS factor;
- Univariate associations between the SDS characteristics and the outcome;
- C-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to improvement in the model's ability to differentiate between outcomes; and
- HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment.

[2] To access the parameter estimates for the Rehospitalization measures, please refer to the *Home Health Rehospitalization Measures Technical Documentation and Risk Adjustment Model* link under Downloads: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html

Results:

Table 1 summarizes the prevalence of each SDS factor across HHAs. The median percentage of stays for beneficiaries with dual Medicaid eligibility is 17.7% (IQR: 8.4% to 40%). The median percentage of stays for beneficiaries who live rural locations is 2.4% (IQR: 0% to 30%). The median percentage of stays for beneficiaries with high and low SES Index Scores is 25.3% (IQR: 10.7% to 46.2%) and 6.9% (IQR: 0% to 24.1%), respectively.

Table 1: Proportion of SDS Factors across HHAs

Data Element	Medicaid	Rural	High SES Index Score (SES Index >= 57.1)	Low SES Index Score (SES Index Score <= 50.1)
Total # of HHAs	11,580			
Maximum	100%	100%	100.0%	100.0%
75th percentile	40%	30%	46.2%	24.1%
Mean	27.7%	23.2%	30.9%	15.3%
Median	17.7%	2.4%	25.3%	6.9%
25th percentile	8.4%	0%	10.7%	0.0%
Minimum	0%	0%	0.0%	0.0%

Figure 1 provides the distribution of risk adjusted rates for all HHAs by proportion of stays for beneficiaries with low/high SDS for each factor. Risk-adjusted performance rates tend to be lower among HHAs that treat a lower proportion of beneficiaries dually enrolled in Medicaid, a lower proportion of beneficiaries residing in rural locations, a higher proportion of beneficiaries who have a high SES Index score, and a lower proportion of beneficiaries who have a low SES Index score.

Figure 1: Distribution of Risk-Adjusted Rates, by Proportion of SDS Factor

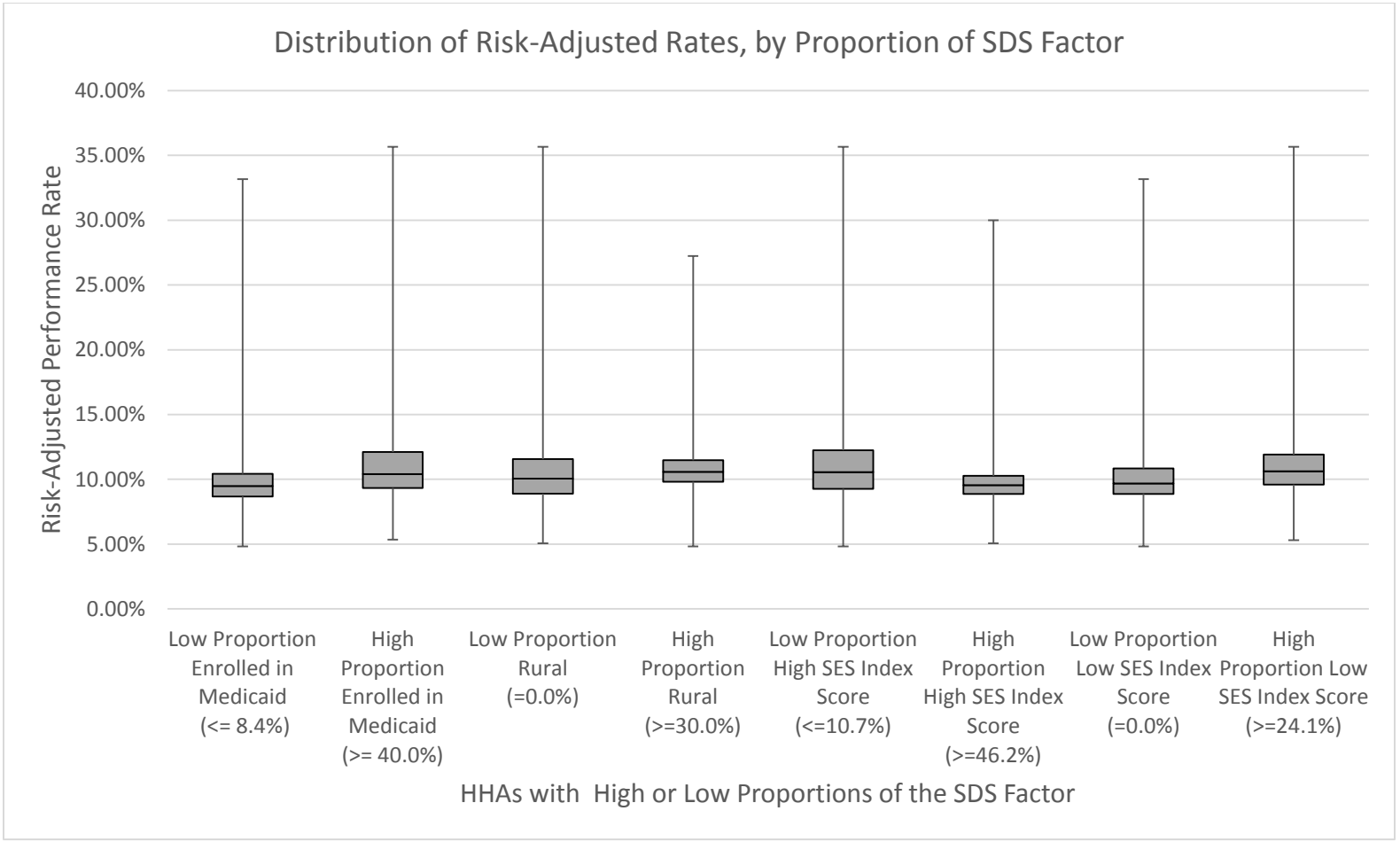


Table 2 displays the univariate association with the unadjusted performance rate. HHAs that provide care to dual-Medicaid beneficiaries, beneficiaries living in a rural location, or beneficiaries classified with low SES Index score have higher unadjusted performance rates (i.e., higher ED-Use without Readmission rates).

Table 2: Unadjusted Performance Rates, by SDS Factor

Factor	Observed Rate
Dual Medicaid Status	
Yes	13.02%
No	9.25%
Urban - Rural Status	
Urban	9.42%
Rural	11.28%
SES Index	
Low SES Index Score (SES Index Score <= 50.1)	11.26%
High SES Index Score (SES Index >= 57.1)	8.34%

Table 3 provides the c-statistic for the original model and the original model with each factor to assess whether the addition of SDS characteristics leads to improvement in the model's ability to differentiate between outcomes. The c-statistic scores are similar across all variations of the risk adjustment models. The parameter estimates for the multivariate risk adjustment models including the clinical covariates and the various SDS characteristics are provided in the appendix. The effect sizes for the dual-Medicaid and rural characteristics are moderate and the SES Index score has a small effect. The inclusion the of the SDS characteristics in the risk adjustment model has a negligible impact on the parameter estimates of the clinical characteristics.

Table 3: Comparison of Model Fit across Models

Model	C- Statistic
Original Model	0.6459
Original Model + Dual Medicaid Status	0.6464
Original Model + Rural Status	0.6469
Original Model + SES Index Score	0.6465
Original Model + All SDS Variables	0.6475

Tables 4 – 7 provide the HHA categorizations before and after the adjustment of each SDS factor to determine how many agencies are impacted by SDS adjustment.

Table 4: HHA Categorizations - Before and After Adjustment for Medicaid Status

Original Model	Original Model + Dual Medicaid Status							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	616	5.32%	21	0.18%	-	-	-	-
Same As Expected	19	0.16%	5939	51.29%	17	0.15%	-	-
Better than Expected	-	-	15	0.13%	499	4.31%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 72 (0.62%) HHAs shift categorizations by adjusting for Medicaid Status.

Table 5: HHA Categorizations - Before and After Adjustment for Rural Status

Original Model	Original Model + Rural Status							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	562	4.85%	75	0.65%	-	-	-	-
Same As Expected	51	0.44%	5863	50.63%	61	0.53%	-	-
Better than Expected	-	-	53	0.46%	461	3.98%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 240 (2.07%) HHAs shift categorizations by adjusting for Rural Status.

Table 6: HHA Categorizations - Before and After Adjustment for SES Index

Original Model	Original Model + SES Index							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	598	5.16%	23	0.20%	-	-	-	-
Same As Expected	39	0.34%	5922	51.14%	20	0.17%	-	-
Better than Expected	-	-	30	0.26%	494	4.27%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 112 (0.97%) HHAs shift categorizations by adjusting for the SDS Index.

Table 7: HHA Categorizations - Before and After Adjustment for All SDS Variables

Original Model	Original Model + All SDS Variables							
	Worse than Expected		Same as Expected		Better than Expected		Not Available (number of stays less than 20)	
	#	%	#	%	#	%	#	%
Worse than Expected	559	4.83%	49	0.42%	-	-	-	-
Same As Expected	78	0.67%	5865	50.65%	56	0.48%	-	-
Better than Expected	-	-	61	0.53%	458	3.96%	-	-
Not Available (number of Stays less than 20)	-	-	-	-	-	-	4454	38.46%

Of the 11,580 HHAs, 244 (2.11%) HHAs shift categorizations by adjusting for all SDS variables.

6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach (describe the steps—do not just name a method; what statistical analysis was used).

In this section we describe the methods that were implemented to validate the adequacy of the statistical model during initial measure development. The predictive power of the risk adjustment model was evaluated using two measures of predictive power on both the development sample and the validation sample. The two measures of predictive power are the c-statistic and the range of predicted probabilities. Evaluating the model's predictive power on the development sample shows how well the model predicts outcomes in the data on which it was developed, while evaluating the model using the validation sample shows how well the model predicts outcomes outside the data on which it was developed.

A version of the area under the receiver operating curve (AUC) statistic, also known as the c-statistic, was calculated for each individual logit and for the model overall. The c-statistic measures the ability of a risk adjustment model to differentiate between outcomes without resorting to an arbitrary cutoff point. This analysis averages pair-wise comparisons to extend the standard two-class case to the multi-class form.[3] A model that perfectly discriminates between outcomes would have a c-statistic of 1, while a model that has no predictive power would have a c-statistic of 0.5. To calculate c-statistics for binomial outcomes (i.e., acute care rehospitalization vs. no event and ED use without hospital readmission v. no event), the outlying event was omitted and a generalized logistic estimated on the remaining two outcomes using all the risk factors in the model. A generalized logistic model omitting one event leads to the same coefficients as the full multinomial model. The average of the c-statistics for all possible binomial logistic regressions produces the AUC for the full multinomial model.

The c-statistic for the rehospitalization development sample is 0.693, which is identical to the validation sample value of 0.693, showing that the model differentiates between outcomes as well on new data as it does on the development data. For ED use without hospital readmission, the c-statistic for the development sample is 0.643, which is similar to the validation sample value of 0.642. Finally, the total AUC for the model in the development sample is 0.660, which is comparable to the validation sample value of 0.645.[4] The table below presents these values.

[3] For more information on this extension of the c-statistic, please refer to: David J. Hand and Robert J. Till, "A Simple Generalisation of the Area Under the ROC Curve for Multiple Class Classification Problems." Ed. David W. Aha. *Machine Learning* 45 (2001): 171-186.

[4] The total area under the curve is an assessment of the overall model fit obtained by averaging the c-statistics for the individual logits, which in this case is the two c-statistics shown as well as the c-statistic between rehospitalization and ED use without hospital readmission, which is not shown. For more information on this statistic, refer to the footnote above.

AUC Statistics

AUC Statistic	Development Sample	Validation Sample
Rehospitalization During the First 30 Days of Home Health c-statistic	0.693	0.693
ED Use without Hospital Readmission During the First 30 Days of Home Health c-statistic	0.643	0.642
Total AUC	0.660	0.645

To further evaluate the predictive power of the model, the range of differences between the 90th and 10th percentile of predicted probabilities were calculated. In this case, a larger range of predicted values indicates that the model is better at discriminating between beneficiaries at high risk for ED use without hospital readmission than beneficiaries at low risk. In the development sample, the range of predicted probabilities for ED use without hospital readmission was 5.4 percent to 14.6 percent. In the validation sample, the range was 5.4 percent to 14.7 percent. The table below presents these ranges.

Range of Differences between 90th and 10th Percentile of Predicted Probabilities

Measure	Development Sample		Validation Sample	
	Minimum (%)	Maximum (%)	Minimum (%)	Maximum (%)
ED Use without Hospital Readmission During the First 30 Days of Home Health	5.4	14.6	5.4	14.7

Finally, the measure developer evaluated the extent to which differences in case-mix would lead to differences in observed rates of ED use without hospital readmission. The table below shows the distribution of expected agency rates of ED Use without rehospitalization, by agency size. The interquartile ranges, by agency size, range from 0.9 percent for large agencies with 1000+ stays to 1.6 percent for small agencies with 20-49 stays.

Impact of Risk Adjustment on ED Use without Hospital Readmission Rates, By Agency Size

Total Stays	# HHAs	Mean	St. Dev.	Min	10th	25th	50th	75th	90th	Max	Interquartile Range
20-49	1655	9.4%	1.3%	6.0%	8.0%	8.6%	9.3%	10.2%	11.2%	15.4%	1.6%
50-99	1486	9.3%	1.0%	6.3%	8.1%	8.6%	9.2%	9.9%	10.6%	13.8%	1.4%
100–199	1385	9.3%	1.0%	5.8%	8.2%	8.6%	9.2%	9.9%	10.6%	14.2%	1.3%
200 – 399	1244	9.2%	1.0%	6.1%	8.1%	8.5%	9.1%	9.8%	10.4%	13.0%	1.2%
400 – 999	1115	9.0%	0.8%	6.1%	8.1%	8.5%	9.0%	9.5%	10.0%	13.3%	1.0%
1000+	680	8.9%	0.7%	6.7%	8.1%	8.4%	8.8%	9.3%	9.7%	11.6%	0.9%

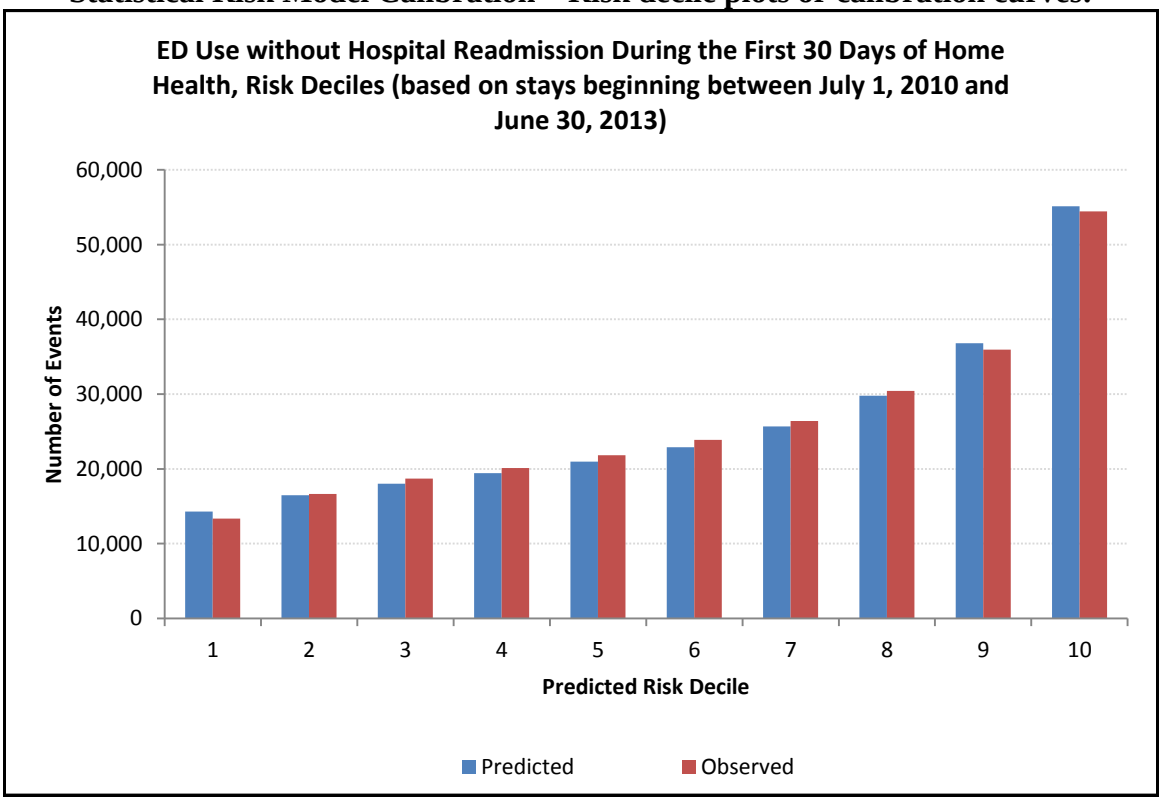
Over-fitting occurs when a model can describe the relationship between the covariates and the outcome in the development data set but cannot successfully predict the outcome on a new data set. To compute the over-fitting indices, the coefficients of the model were first estimated using the development sample. A logistic regression was then estimated on the validation sample with an intercept and the linear predictor for the probability of an event for a given home health stay in the validation sample. Values of the intercept far from 0 and values of the coefficient far from 1 provide evidence of over-fitting. Over-fitting indices were computed separately for the multinomial logit model and the hierarchical-multinomial logit model.

Over-fitting indices were computed and showed no indication that the model was over-fit. In our validation sample, the calibration statistic for ED use without hospital readmission produced an intercept of -0.011 and a coefficient of 0.998. With t-statistics of 0.456 and 0.180, these values are also not significantly different from 0 and 1 at the 95% confidence level. In other words, there is no evidence that the model is over-fitting the data for the outcome.

Over-Fitting Indices

Measure	Intercept		Coefficient	
	Value	**Statistically different from 0 at 95% confidence?**	**Value**	**Statistically different from 1 at 95% confidence?**
ED Use without Hospital Readmission During the First 30 Days of Home Health	-0.011	No	0.998	No

Statistical Risk Model Calibration – Risk decile plots or calibration curves:



7. Discuss the risks for misuse of the specified performance measure. This discussion could include information on the known limitations of the performance measure that could impact its use in accountability programs.

The measure developers have not identified any risks for misuse throughout the measure development process.

8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables. This information may include the stratification variables, definitions, specific data collection items/responses, code/value sets, and the risk-model covariates and coefficients for the clinically-adjusted version of the measure when appropriate.

N/A

9. Please enter the details of the final statistical risk model and variables here.

The final risk adjustment model[5] for NQF 2505 relies on five categories of risk factors:

(1) Prior Care Setting including: acute care received in 30 days prior to HH, acute care received in 6 months prior to HH, and length of index hospitalization

(2) Age and sex interactions

(3) Health Status as measures by: Hierarchical Condition Categories (HCCs) based on past 6 months of Medicare claims, Diagnosis-Related Grouping (DRGs) on index hospitalization, and activities of daily living indicators, as captured on HH claims

(4) Medicare Enrollment Status, which identifies beneficiaries who are eligible for Medicare due to End-Stage Renal Disease (ESRD) or who were originally eligible due to disability

(5) Additional interactions between HHCs and Medicare Enrollment Status

10. Compare measure performance scores with and without SDS factors in the risk adjustment model. Include the method of testing conducted to compare performance scores with and without SDS factors in the risk adjustment model for the same entities, the statistical results from testing the differences in the performance scores with and without SDS factors in the risk adjustment model. (e.g., correlation, rank order) and provide an interpretation of your results in terms of the differences in performance scores with and without SDS factors in the risk adjustment model for the same entities.

As previously mentioned in question 5, Tables 4 – 7 provide the HHA categorizations before and after the adjustment of each SDS factor. Adjusting for each SDS factor and all SDS factors had a minimal effect on HHA performance.

[5] To access the parameter estimates for the Rehospitalization measures, please refer to the *Home Health Rehospitalization Measures Technical Documentation and Risk Adjustment Model* link under Downloads: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html

11. Appendix (includes literature review, reference list, etc.)

Tables 8 - 15 provide risk adjustment model results.

Table 8: Risk Adjustment Model - Prior Care Settings

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Intercept	-3.015	0.000	-3.018	0.000	-3.058	0.000	-3.012	0.000	-3.053	0.000
Skilled Nursing Facility In 30 Days Before Home Health Stay	0.029	0.053	0.032	0.033	0.028	0.058	0.029	0.054	0.031	0.038
Multiple Inpatient Admissions in the Past 30 Days From Home Health Stay	0.130	0.000	0.132	0.000	0.123	0.000	0.127	0.000	0.124	0.000
Emergency Room Visit, Single, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.430	0.000	0.428	0.000	0.419	0.000	0.424	0.000	0.414	0.000
Emergency Room Visit, Multiple, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.940	0.000	0.933	0.000	0.920	0.000	0.929	0.000	0.909	0.000

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Inpatient Admission, Surgical Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	-0.086	0.000	-0.083	0.000	-0.088	0.000	-0.087	0.000	-0.085	0.000
Inpatient Admission, Medicine Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.046	0.000	0.045	0.000	0.047	0.000	0.045	0.000	0.045	0.000
Inpatient Admission, Cardiovascular Disease Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.122	0.000	0.122	0.000	0.123	0.000	0.121	0.000	0.121	0.000
Inpatient Admission, Chronic Renal Failure Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.082	0.000	0.080	0.000	0.081	0.000	0.080	0.000	0.078	0.000

Prior Care Setting Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Inpatient Admission, Neurology Cohort, for Care Received in the Six Months Prior to Home Health, Not Including the Past 30 Days From Home Health Stay	0.050	0.007	0.051	0.006	0.052	0.005	0.049	0.008	0.052	0.005
Length of Index Hospital Stay, One to Two Weeks (July 1, 2010 to June 30, 2013)	0.014	0.014	0.014	0.016	0.014	0.012	0.013	0.026	0.013	0.020
Length of Index Hospital Stay, Greater than Two Weeks	0.048	0.000	0.047	0.000	0.047	0.000	0.045	0.000	0.045	0.000

Table 9: Risk Adjustment Model - Demographics

Demographics Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
0-34 Years, Female	0.621	0.000	0.564	0.000	0.631	0.000	0.610	0.000	0.567	0.000
0-34 Years, Male	0.440	0.000	0.378	0.000	0.451	0.000	0.431	0.000	0.383	0.000
35-44, Female	0.531	0.000	0.488	0.000	0.537	0.000	0.519	0.000	0.486	0.000
35-44, Male	0.354	0.000	0.308	0.000	0.361	0.000	0.345	0.000	0.310	0.000
45-54, Female	0.314	0.000	0.279	0.000	0.319	0.000	0.304	0.000	0.278	0.000

Demographics Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
45-54, Male	0.320	0.000	0.287	0.000	0.326	0.000	0.313	0.000	0.289	0.000
55-59, Female	0.166	0.000	0.142	0.000	0.169	0.000	0.156	0.000	0.139	0.000
55-59, Male	0.168	0.000	0.147	0.000	0.173	0.000	0.163	0.000	0.149	0.000
60-64, Female	0.077	0.000	0.064	0.000	0.079	0.000	0.071	0.000	0.062	0.001
60-64, Male	0.095	0.000	0.084	0.000	0.097	0.000	0.091	0.000	0.084	0.000
65-69, Female	-0.012	0.360	-0.016	0.199	-0.012	0.362	-0.015	0.242	-0.019	0.146
70-74, Female	-0.013	0.303	-0.015	0.227	-0.014	0.273	-0.015	0.230	-0.017	0.168
70-74, Male	0.004	0.741	0.007	0.547	0.001	0.919	0.005	0.693	0.005	0.657
75-79, Female	0.012	0.351	0.010	0.421	0.011	0.388	0.010	0.435	0.008	0.521
75-79, Male	0.028	0.025	0.033	0.008	0.024	0.055	0.028	0.023	0.030	0.017
80-84, Female	0.022	0.087	0.022	0.087	0.022	0.076	0.023	0.074	0.023	0.070
80-84, Male	0.017	0.177	0.025	0.055	0.015	0.242	0.021	0.109	0.025	0.055
85-89, Female	0.021	0.114	0.022	0.091	0.024	0.066	0.025	0.055	0.028	0.032
85-89, Male	0.050	0.000	0.059	0.000	0.050	0.000	0.056	0.000	0.063	0.000
90-94, Female	0.039	0.011	0.041	0.007	0.044	0.004	0.047	0.002	0.051	0.001
90-94, Male	0.038	0.037	0.048	0.009	0.041	0.026	0.048	0.009	0.057	0.002
95+, Female	0.019	0.423	0.019	0.424	0.025	0.293	0.027	0.242	0.030	0.204
95+, Male	0.079	0.020	0.088	0.009	0.083	0.014	0.090	0.008	0.099	0.003

Table 10: Risk Adjustment Model - Hierarchical Condition Categories (HCCs)

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
2 Septicemia/Shock	-0.023	0.051	-0.026	0.027	-0.023	0.053	-0.023	0.049	-0.026	0.029
5 Opportunistic Infections	0.043	0.047	0.046	0.033	0.044	0.039	0.044	0.039	0.048	0.024
6 Other Infectious Diseases	0.008	0.103	0.006	0.249	0.012	0.015	0.012	0.017	0.012	0.017
7 Metastatic Cancer and Acute Leukemia	0.124	0.000	0.126	0.000	0.127	0.000	0.127	0.000	0.130	0.000
8 Lung/Upper Digestive/Oth Sev Cancer	0.064	0.000	0.065	0.000	0.067	0.000	0.067	0.000	0.070	0.000
9 Lymphatic/Head/Neck/Brain/Maj Cancer	0.003	0.798	0.005	0.719	0.006	0.675	0.007	0.617	0.009	0.505
10 Breast/Prostate/Colorectal/Oth Cancer	-0.033	0.000	-0.032	0.000	-0.031	0.000	-0.031	0.000	-0.029	0.000
14 Ben Neoplasms of Skin, Breast, Eye	-0.013	0.074	-0.008	0.281	-0.010	0.199	-0.005	0.534	0.001	0.888
15 Diabetes with Renal Manifestation	0.019	0.021	0.011	0.183	0.024	0.004	0.015	0.075	0.012	0.139
16 Diabs w/ Neurol/Periph Circ Manifest	0.063	0.000	0.057	0.000	0.063	0.000	0.056	0.000	0.052	0.000
18 Diab w/ Ophthalmologic Manifestation	0.025	0.148	0.016	0.353	0.025	0.141	0.019	0.276	0.012	0.470
19 Diabetes w/ No/Unspecified comp	0.014	0.013	0.009	0.113	0.013	0.022	0.008	0.137	0.004	0.447
21 Protein-Calorie Malnutrition	0.051	0.000	0.050	0.000	0.050	0.000	0.048	0.000	0.047	0.000
22 Oth Significant Endocrine/Metabolic	-0.005	0.525	-0.004	0.635	-0.002	0.791	-0.002	0.747	0.000	0.957
23 Fluid/Electrolyte/Acid-Base Balance	0.005	0.331	0.006	0.276	0.005	0.340	0.005	0.324	0.005	0.280
25 End-Stage Liver Disease	0.089	0.000	0.088	0.000	0.088	0.000	0.088	0.000	0.086	0.000
26 Cirrhosis of Liver	0.056	0.004	0.053	0.007	0.058	0.003	0.055	0.005	0.054	0.006

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
29 Other Hepatitis and Liver Disease	0.025	0.003	0.022	0.008	0.029	0.001	0.026	0.002	0.027	0.002
31 Intestinal Obstruction/Perforation	0.015	0.150	0.015	0.145	0.014	0.183	0.015	0.152	0.014	0.174
32 Pancreatic Disease	0.040	0.001	0.040	0.001	0.041	0.000	0.043	0.000	0.044	0.000
33 Inflammatory Bowel Disease	0.023	0.174	0.027	0.106	0.027	0.116	0.030	0.081	0.035	0.040
34 Peptic Ulcer/Hemorrhage/Oth Spec GI	0.006	0.394	0.006	0.406	0.007	0.357	0.006	0.402	0.006	0.377
36 Other Gastrointestinal Disorders	0.082	0.000	0.081	0.000	0.081	0.000	0.081	0.000	0.079	0.000
38 Rheum Arthritis/Inflam Conn Tissue	0.008	0.277	0.011	0.138	0.010	0.202	0.010	0.191	0.013	0.075
39 Disorders of Vertebrae/Spinal Discs	0.048	0.000	0.050	0.000	0.049	0.000	0.050	0.000	0.053	0.000
40 Osteoarthritis of Hip or Knee	-0.050	0.000	-0.049	0.000	-0.049	0.000	-0.048	0.000	-0.047	0.000
43 Oth Musculoskeletal/connect Tissue	0.020	0.001	0.018	0.004	0.021	0.001	0.020	0.002	0.019	0.003
44 Severe Hematological Disorders	-0.005	0.796	-0.004	0.825	-0.002	0.920	-0.002	0.909	0.000	0.987
46 Coagulation defs/Oth Spec Hematologic	-0.010	0.128	-0.009	0.178	-0.007	0.280	-0.008	0.226	-0.005	0.446
47 Iron Defic, Oth/Unspec Anemias/Blood	-0.014	0.005	-0.015	0.003	-0.011	0.026	-0.013	0.006	-0.012	0.014
49 Dementia/Cerebral Degeneration	0.061	0.000	0.057	0.000	0.065	0.000	0.062	0.000	0.062	0.000
53 Drug/Alcohol Abuse, W/out Dependence	0.058	0.000	0.053	0.000	0.056	0.000	0.052	0.000	0.048	0.000
55 Major Depressive, Bipolar, Paranoid	0.089	0.000	0.086	0.000	0.096	0.000	0.094	0.000	0.096	0.000
56 Reactive and Unspecified Psychosis	0.067	0.000	0.068	0.000	0.064	0.000	0.066	0.000	0.065	0.000
57 Personality Disorders	0.219	0.000	0.208	0.000	0.221	0.000	0.222	0.000	0.213	0.000
58 Depression	0.053	0.000	0.054	0.000	0.053	0.000	0.056	0.000	0.055	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
59 Anxiety Disorders	0.101	0.000	0.101	0.000	0.101	0.000	0.102	0.000	0.102	0.000
60 Other Psychiatric Disorders	0.095	0.000	0.095	0.000	0.095	0.000	0.096	0.000	0.096	0.000
68 Paraplegia	-0.088	0.006	-0.095	0.003	-0.084	0.009	-0.087	0.007	-0.090	0.005
74 Seizure Disorders and Convulsions	0.062	0.000	0.055	0.000	0.065	0.000	0.062	0.000	0.057	0.000
76 Mononeuropathy/Oth Neuro Cond/Inj	0.063	0.000	0.065	0.000	0.063	0.000	0.064	0.000	0.066	0.000
80 Congestive Heart Failure	0.026	0.000	0.024	0.001	0.024	0.000	0.023	0.001	0.020	0.003
81 Acute Myocardial Infarction	0.048	0.000	0.048	0.000	0.046	0.000	0.048	0.000	0.046	0.000
82 Unstable Angina/Oth ac Ischemic Heart	0.050	0.000	0.048	0.000	0.053	0.000	0.052	0.000	0.052	0.000
83 Angina Pectoris/Old Myocardial Infect	0.027	0.000	0.026	0.000	0.028	0.000	0.027	0.000	0.027	0.000
84 Coronary Athero/Oth Chron Ischemic Heart	0.043	0.000	0.043	0.000	0.044	0.000	0.042	0.000	0.042	0.000
85 Heart Infec/Inflam, Exc Rheumatic	-0.008	0.535	-0.008	0.559	-0.007	0.633	-0.006	0.647	-0.005	0.726
89 Hypertensive Heart/Renal/Encephalopathy	-0.012	0.080	-0.013	0.080	-0.013	0.063	-0.014	0.046	-0.014	0.043
90 Hypertensive Heart Disease	-0.062	0.000	-0.066	0.000	-0.055	0.000	-0.062	0.000	-0.059	0.000
92 Specified Heart Arrhythmias	0.042	0.000	0.046	0.000	0.044	0.000	0.046	0.000	0.049	0.000
94 Other and Unspecified Heart Disease	0.000	0.941	0.000	0.979	-0.001	0.855	-0.001	0.831	-0.002	0.656
95 Cerebral Hemorrhage	-0.004	0.828	-0.004	0.846	0.000	0.993	0.000	0.979	0.002	0.895
104 Peripheral Vascular Disease with Complications	0.066	0.000	0.066	0.000	0.069	0.000	0.067	0.000	0.069	0.000
105 Peripheral Vascular Disease	0.014	0.008	0.013	0.013	0.017	0.001	0.015	0.004	0.017	0.002
106 Other Circulatory Disease	0.004	0.464	0.005	0.340	0.004	0.419	0.005	0.280	0.006	0.211
108 chron Obstructive Pulmonary Disease	0.044	0.000	0.041	0.000	0.038	0.000	0.037	0.000	0.030	0.000
110 Asthma	0.047	0.000	0.042	0.000	0.054	0.000	0.049	0.000	0.049	0.000
113 Viral/Unspec Pneumonia, Pleurisy	-0.025	0.000	-0.026	0.000	-0.025	0.000	-0.025	0.000	-0.026	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
114 Pleural Effusion/Pneumothorax	-0.012	0.075	-0.010	0.142	-0.012	0.080	-0.009	0.153	-0.008	0.227
115 Other Lung Disorders	0.008	0.126	0.008	0.130	0.009	0.086	0.008	0.136	0.008	0.099
127 Other Ear, Nose, Throat, and Mouth	0.054	0.000	0.054	0.000	0.054	0.000	0.055	0.000	0.054	0.000
128 Kidney Transplant Status	-0.173	0.000	-0.168	0.000	-0.172	0.000	-0.168	0.000	-0.164	0.000
129 End Stage Renal Disease (Medicare elig)	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
131 Renal Failure	0.033	0.000	0.033	0.000	0.033	0.000	0.031	0.000	0.031	0.000
133 Urinary Obstruction and Retention	0.128	0.000	0.129	0.000	0.130	0.000	0.131	0.000	0.132	0.000
135 Urinary Tract Infection	0.028	0.000	0.027	0.000	0.028	0.000	0.027	0.000	0.027	0.000
136 Other Urinary Tract Disorders	-0.001	0.908	0.000	0.941	0.001	0.931	-0.001	0.910	0.001	0.926
140 Male Genital Disorders	0.037	0.000	0.036	0.000	0.041	0.000	0.040	0.000	0.041	0.000
148 Decubitus Ulcer of Skin	-0.006	0.680	-0.010	0.496	-0.005	0.719	-0.005	0.712	-0.009	0.557
157 Vertebral Fract w/out Spinal Cord Injury	0.045	0.000	0.047	0.000	0.044	0.000	0.046	0.000	0.047	0.000
158 Hip Fracture/Dislocation	-0.100	0.000	-0.100	0.000	-0.102	0.000	-0.100	0.000	-0.102	0.000
159 Maj Fract, Exc Skull/Vertebrae/Hip	-0.133	0.000	-0.131	0.000	-0.132	0.000	-0.131	0.000	-0.130	0.000
162 Other Injuries	0.019	0.000	0.020	0.000	0.022	0.000	0.022	0.000	0.024	0.000
163 Poisonings and Allegic Reactions	0.012	0.069	0.013	0.049	0.013	0.040	0.013	0.043	0.015	0.021
164 Maj Comp of Medical Care/Trauma	0.040	0.000	0.041	0.000	0.041	0.000	0.041	0.000	0.042	0.000
165 Other Complications of Medical Care	0.027	0.000	0.027	0.000	0.028	0.000	0.028	0.000	0.028	0.000
166 Major Symptoms, Abnormalities	0.103	0.000	0.100	0.000	0.108	0.000	0.103	0.000	0.104	0.000
167 Minor Symptoms, Signs, Findings	0.062	0.000	0.062	0.000	0.065	0.000	0.065	0.000	0.067	0.000
174 Major Organ Transplant	-0.125	0.000	-0.119	0.000	-0.123	0.000	-0.117	0.000	-0.113	0.000

Health Status Variable (2008 Hierarchical Condition Categories, 6-month look-back)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Status										
176 Artif Opens for Feeding/Elimination	0.059	0.000	0.056	0.000	0.060	0.000	0.061	0.000	0.058	0.000
179 Post-Surgical States/Aftercare/Elective	0.017	0.010	0.023	0.001	0.015	0.029	0.019	0.005	0.021	0.001
181 Chemotherapy	0.029	0.085	0.032	0.055	0.028	0.099	0.030	0.079	0.031	0.061
182 Rehabilitation	0.012	0.216	0.014	0.144	0.005	0.569	0.011	0.229	0.008	0.396
183 Screening/Observation/Special Exams	-0.037	0.000	-0.036	0.000	-0.034	0.000	-0.034	0.000	-0.031	0.000
184 History of Disease	0.014	0.006	0.018	0.001	0.018	0.000	0.017	0.001	0.023	0.000

Table 11: Risk Adjustment Model - Diagnostic Related Groupings (DRGs)

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
3 Not Found	0.722	0.000	0.722	0.000	0.719	0.000	0.717	0.000	0.716	0.000
4 ECMO or trach w MV 96+ hrs or PDX exc face, mouth & neck w maj O.R.	0.866	0.000	0.862	0.000	0.863	0.000	0.864	0.000	0.858	0.000
25 Trach w MV 96+ hrs or PDX exc face, mouth & neck w/o maj O.R.	0.117	0.105	0.113	0.119	0.119	0.102	0.116	0.109	0.113	0.118

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
26 Simultaneous pancreas/kidney transplant	0.252	0.001	0.245	0.002	0.251	0.001	0.251	0.001	0.244	0.002
27 Craniotomy & endovascular intracranial procedures w MCC	0.143	0.074	0.141	0.079	0.146	0.069	0.142	0.078	0.143	0.076
35 Craniotomy & endovascular intracranial procedures w CC	0.350	0.053	0.344	0.057	0.354	0.050	0.344	0.057	0.343	0.058
36 Craniotomy & endovascular intracranial procedures w/o CC/MCC	-0.077	0.735	-0.084	0.709	-0.065	0.774	-0.078	0.730	-0.076	0.738
37 Carotid artery stent procedure w CC	0.163	0.083	0.163	0.083	0.162	0.084	0.162	0.085	0.161	0.085
38 Carotid artery stent procedure w/o CC/MCC	0.119	0.071	0.117	0.076	0.122	0.066	0.117	0.077	0.118	0.075
39 Extracranial procedures w MCC	0.125	0.033	0.124	0.035	0.129	0.028	0.121	0.039	0.124	0.034
41 Extracranial procedures w CC	0.039	0.596	0.036	0.626	0.041	0.583	0.037	0.613	0.036	0.625
56 Extracranial procedures w/o CC/MCC	0.099	0.208	0.094	0.233	0.106	0.178	0.101	0.202	0.101	0.200
57 Periph/cranial nerve & other nerv syst proc w MCC	0.077	0.069	0.072	0.088	0.086	0.042	0.078	0.065	0.081	0.056

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
64 Periph/cranial nerve & other nerv syst proc w CC or periph neurostim	0.248	0.000	0.241	0.000	0.247	0.000	0.242	0.000	0.237	0.000
65 Nervous system neoplasms w/o MCC	0.172	0.000	0.167	0.000	0.171	0.000	0.166	0.000	0.162	0.000
66 Degenerative nervous system disorders w MCC	0.156	0.000	0.152	0.000	0.156	0.000	0.151	0.000	0.149	0.000
68 Degenerative nervous system disorders w/o MCC	0.109	0.230	0.101	0.268	0.114	0.212	0.105	0.246	0.102	0.260
69 Multiple sclerosis & cerebellar ataxia w/o CC/MCC	0.170	0.000	0.164	0.000	0.174	0.000	0.166	0.000	0.165	0.000
70 Intracranial hemorrhage or cerebral infarction w MCC	0.118	0.086	0.113	0.102	0.124	0.073	0.115	0.095	0.115	0.094
71 Intracranial hemorrhage or cerebral infarction w CC	0.108	0.052	0.103	0.063	0.113	0.043	0.107	0.054	0.107	0.055
72 Intracranial hemorrhage or cerebral infarction w/o CC/MCC	-0.016	0.888	-0.019	0.865	-0.010	0.931	-0.019	0.865	-0.016	0.886
73 Nonspecific CVA & precerebral occlusion w/o	-0.023	0.806	-0.027	0.770	-0.017	0.853	-0.024	0.796	-0.023	0.805

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
infarct w MCC										
74 Nonspecific CVA & precerebral occlusion w/o infarct w/o MCC	0.128	0.005	0.121	0.007	0.136	0.003	0.126	0.005	0.127	0.005
78 Transient ischemia	0.245	0.015	0.242	0.016	0.253	0.012	0.242	0.016	0.247	0.014
81 Nonspecific cerebrovascular disorders w MCC	-0.072	0.548	-0.080	0.509	-0.072	0.552	-0.073	0.546	-0.079	0.514
85 Nonspecific cerebrovascular disorders w CC	0.336	0.000	0.331	0.000	0.335	0.000	0.335	0.000	0.329	0.000
86 Nonspecific cerebrovascular disorders w/o CC/MCC	0.160	0.002	0.154	0.003	0.164	0.002	0.158	0.003	0.156	0.003
87 Cranial & peripheral nerve disorders w MCC	0.088	0.138	0.084	0.157	0.092	0.121	0.088	0.137	0.087	0.140
91 Cranial & peripheral nerve disorders w/o MCC	-0.003	0.961	-0.010	0.884	0.000	0.995	-0.005	0.944	-0.008	0.905
92 Viral meningitis w CC/MCC	0.034	0.477	0.027	0.570	0.040	0.406	0.034	0.470	0.033	0.493
93 Hypertensive encephalopathy w MCC	0.046	0.535	0.039	0.601	0.053	0.471	0.046	0.532	0.046	0.539

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
100 Hypertensive encephalopathy w CC	0.077	0.109	0.071	0.138	0.082	0.088	0.075	0.120	0.074	0.122
101 Hypertensive encephalopathy w/o CC/MCC	0.064	0.089	0.056	0.135	0.071	0.058	0.062	0.102	0.061	0.102
103 Nontraumatic stupor & coma w/o MCC	0.199	0.013	0.195	0.015	0.210	0.009	0.200	0.013	0.205	0.011
150 Traumatic stupor & coma, coma <1 hr w MCC	-0.135	0.548	-0.141	0.530	-0.132	0.559	-0.132	0.557	-0.136	0.547
151 Traumatic stupor & coma, coma <1 hr w CC	0.206	0.075	0.200	0.085	0.215	0.063	0.208	0.073	0.208	0.073
158 Traumatic stupor & coma, coma <1 hr w/o CC/MCC	0.087	0.494	0.083	0.518	0.097	0.447	0.086	0.503	0.090	0.481
166 Other disorders of nervous system w MCC	0.135	0.014	0.134	0.015	0.137	0.013	0.134	0.014	0.135	0.014
167 Other disorders of nervous system w CC	0.194	0.001	0.189	0.002	0.196	0.001	0.192	0.001	0.191	0.002
176 Other disorders of nervous system w/o CC/MCC	0.416	0.000	0.410	0.000	0.414	0.000	0.412	0.000	0.406	0.000
177 Seizures w MCC	0.017	0.604	0.009	0.790	0.019	0.547	0.018	0.571	0.012	0.704

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
178 Seizures w/o MCC	0.071	0.034	0.063	0.063	0.073	0.030	0.073	0.031	0.065	0.053
179 Headaches w MCC	0.203	0.002	0.195	0.002	0.202	0.002	0.204	0.001	0.196	0.002
183 Headaches w/o MCC	-0.145	0.242	-0.149	0.226	-0.145	0.239	-0.142	0.250	-0.148	0.231
184 Intraocular procedures w/o CC/MCC	-0.036	0.659	-0.042	0.604	-0.032	0.695	-0.033	0.686	-0.036	0.655
186 Other disorders of the eye w MCC	0.233	0.001	0.227	0.001	0.230	0.001	0.228	0.001	0.222	0.002
187 Other disorders of the eye w/o MCC	0.275	0.000	0.271	0.000	0.279	0.000	0.274	0.000	0.274	0.000
188 Mouth procedures w CC/MCC	0.327	0.028	0.320	0.032	0.324	0.030	0.321	0.031	0.315	0.035
189 Dysequilibrium	-0.046	0.041	-0.052	0.020	-0.043	0.052	-0.048	0.032	-0.052	0.021
190 Epistaxis w MCC	0.033	0.083	0.024	0.197	0.037	0.047	0.032	0.092	0.028	0.137
191 Epistaxis w/o MCC	0.034	0.093	0.025	0.217	0.040	0.046	0.033	0.101	0.030	0.136
192 Otitis media & URI w/o MCC	0.019	0.477	0.011	0.692	0.019	0.470	0.016	0.540	0.009	0.724
193 Other ear, nose, mouth & throat diagnoses w MCC	0.010	0.603	0.004	0.841	0.011	0.587	0.008	0.696	0.003	0.889
194 Other ear, nose, mouth & throat diagnoses w CC	-0.041	0.027	-0.049	0.009	-0.045	0.016	-0.044	0.017	-0.054	0.004

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
195 Other ear, nose, mouth & throat diagnoses w/o CC/MCC	-0.022	0.456	-0.028	0.325	-0.030	0.301	-0.027	0.351	-0.039	0.177
196 Dental & oral diseases w MCC	-0.025	0.773	-0.027	0.753	-0.017	0.841	-0.022	0.795	-0.019	0.826
197 Dental & oral diseases w CC	0.044	0.661	0.042	0.676	0.048	0.631	0.047	0.637	0.048	0.633
198 Major chest procedures w MCC	-0.149	0.417	-0.150	0.414	-0.149	0.417	-0.149	0.419	-0.149	0.418
199 Major chest procedures w CC	0.232	0.014	0.228	0.016	0.231	0.015	0.231	0.015	0.227	0.017
201 Other resp system O.R. procedures w MCC	0.194	0.249	0.187	0.266	0.191	0.255	0.192	0.253	0.184	0.273
202 Other resp system O.R. procedures w CC	0.027	0.445	0.017	0.629	0.033	0.353	0.027	0.444	0.023	0.524
203 Other resp system O.R. procedures w/o CC/MCC	0.029	0.616	0.019	0.735	0.033	0.565	0.025	0.657	0.021	0.712
204 Pulmonary embolism w MCC	0.085	0.204	0.076	0.254	0.090	0.177	0.083	0.215	0.080	0.234
205 Pulmonary embolism w/o MCC	-0.114	0.191	-0.118	0.174	-0.108	0.216	-0.113	0.193	-0.112	0.196
206 Respiratory infections & inflammations w MCC	0.064	0.288	0.056	0.350	0.067	0.270	0.065	0.279	0.060	0.323

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
207 Respiratory infections & inflammations w CC	-0.166	0.011	-0.174	0.008	-0.167	0.011	-0.169	0.010	-0.176	0.007
208 Respiratory infections & inflammations w/o CC/MCC	-0.069	0.041	-0.076	0.025	-0.071	0.035	-0.073	0.030	-0.081	0.017
216 Major chest trauma w MCC	0.117	0.016	0.116	0.017	0.115	0.017	0.120	0.013	0.118	0.015
217 Major chest trauma w CC	0.263	0.000	0.264	0.000	0.260	0.000	0.268	0.000	0.264	0.000
218 Pleural effusion w MCC	0.409	0.002	0.408	0.002	0.405	0.002	0.413	0.001	0.409	0.002
219 Pleural effusion w CC	0.197	0.000	0.198	0.000	0.195	0.000	0.200	0.000	0.199	0.000
220 Pleural effusion w/o CC/MCC	0.195	0.000	0.196	0.000	0.192	0.000	0.199	0.000	0.196	0.000
221 Pulmonary edema & respiratory failure	0.256	0.000	0.257	0.000	0.254	0.000	0.258	0.000	0.256	0.000
223 Chronic obstructive pulmonary disease w MCC	-0.128	0.431	-0.132	0.418	-0.117	0.472	-0.124	0.447	-0.119	0.465
224 Chronic obstructive pulmonary disease w CC	0.160	0.152	0.158	0.159	0.160	0.153	0.159	0.155	0.157	0.161
226 Chronic obstructive pulmonary disease w/o CC/MCC	0.030	0.723	0.025	0.768	0.036	0.672	0.029	0.734	0.029	0.730

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
227 Simple pneumonia & pleurisy w MCC	0.008	0.908	0.004	0.953	0.018	0.794	0.009	0.899	0.013	0.847
228 Simple pneumonia & pleurisy w CC	0.055	0.635	0.059	0.608	0.049	0.673	0.056	0.626	0.054	0.637
229 Simple pneumonia & pleurisy w/o CC/MCC	0.382	0.000	0.384	0.000	0.378	0.000	0.381	0.000	0.381	0.000
231 Interstitial lung disease w MCC	0.434	0.000	0.437	0.000	0.432	0.000	0.431	0.000	0.433	0.000
233 Interstitial lung disease w CC	0.232	0.000	0.233	0.000	0.229	0.000	0.229	0.000	0.229	0.000
234 Interstitial lung disease w/o CC/MCC	0.243	0.000	0.245	0.000	0.236	0.000	0.240	0.000	0.237	0.000
237 Pneumothorax w MCC	0.225	0.000	0.224	0.000	0.224	0.000	0.222	0.000	0.220	0.000
238 Pneumothorax w CC	0.108	0.002	0.105	0.003	0.108	0.002	0.107	0.003	0.105	0.003
240 Pneumothorax w/o CC/MCC	-0.054	0.629	-0.062	0.578	-0.062	0.579	-0.064	0.566	-0.076	0.498
242 Bronchitis & asthma w CC/MCC	0.171	0.000	0.164	0.000	0.173	0.000	0.169	0.000	0.164	0.000
243 Bronchitis & asthma w/o CC/MCC	0.168	0.000	0.160	0.000	0.174	0.000	0.166	0.000	0.164	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
244 Respiratory signs & symptoms	0.252	0.000	0.244	0.000	0.256	0.000	0.249	0.000	0.246	0.000
246 Other respiratory system diagnoses w MCC	0.213	0.000	0.209	0.000	0.215	0.000	0.212	0.000	0.210	0.000
247 Other respiratory system diagnoses w/o MCC	0.333	0.000	0.326	0.000	0.338	0.000	0.332	0.000	0.330	0.000
248 Respiratory system diagnosis w ventilator support 96+ hours	0.206	0.001	0.202	0.001	0.205	0.001	0.204	0.001	0.199	0.002
249 Respiratory system diagnosis w ventilator support <96 hours	0.401	0.000	0.394	0.000	0.403	0.000	0.398	0.000	0.394	0.000
250 Cardiac valve & oth maj cardiothoracic proc w card cath w MCC	0.113	0.090	0.109	0.101	0.119	0.075	0.114	0.088	0.115	0.086
251 Cardiac valve & oth maj cardiothoracic proc w card cath w CC	0.079	0.193	0.074	0.223	0.088	0.147	0.081	0.181	0.083	0.170
252 Cardiac valve & oth maj cardiothoracic proc w card cath w/o CC/MCC	0.137	0.000	0.133	0.000	0.138	0.000	0.133	0.000	0.131	0.001

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
253 Cardiac valve & oth maj cardiothoracic proc w/o card cath w MCC	0.104	0.001	0.100	0.001	0.105	0.001	0.101	0.001	0.098	0.002
254 Cardiac valve & oth maj cardiothoracic proc w/o card cath w CC	0.109	0.024	0.104	0.031	0.110	0.022	0.105	0.030	0.103	0.033
264 Cardiac valve & oth maj cardiothoracic proc w/o card cath w/o CC/MCC	0.003	0.944	0.000	0.996	0.004	0.927	-0.002	0.971	-0.003	0.954
280 Cardiac defib implant w cardiac cath w AMI/HF/shock w MCC	0.124	0.000	0.118	0.000	0.124	0.000	0.122	0.000	0.117	0.000
281 Cardiac defib implant w cardiac cath w AMI/HF/shock w/o MCC	0.223	0.000	0.217	0.000	0.224	0.000	0.221	0.000	0.215	0.000
282 Cardiac defib implant w cardiac cath w/o AMI/HF/shock w MCC	0.216	0.000	0.209	0.000	0.216	0.000	0.210	0.000	0.205	0.000
286 Cardiac defib implant w cardiac cath w/o AMI/HF/shock w/o MCC	0.125	0.001	0.122	0.001	0.131	0.001	0.125	0.001	0.127	0.001

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
287 Cardiac defibrillator implant w/o cardiac cath w MCC	0.083	0.007	0.078	0.011	0.090	0.003	0.082	0.008	0.083	0.007
288 Cardiac defibrillator implant w/o cardiac cath w/o MCC	0.520	0.000	0.520	0.000	0.518	0.000	0.520	0.000	0.520	0.000
289 Other cardiothoracic procedures w MCC	0.192	0.226	0.187	0.237	0.191	0.227	0.192	0.224	0.188	0.236
291 Other cardiothoracic procedures w CC	0.013	0.464	0.006	0.729	0.016	0.340	0.010	0.563	0.008	0.659
292 Coronary bypass w PTCA w MCC	0.061	0.000	0.055	0.000	0.065	0.000	0.059	0.000	0.058	0.000
293 Coronary bypass w cardiac cath w MCC	0.103	0.000	0.097	0.000	0.104	0.000	0.099	0.000	0.095	0.000
299 Coronary bypass w cardiac cath w/o MCC	0.243	0.000	0.236	0.000	0.247	0.000	0.239	0.000	0.237	0.000
300 Coronary bypass w/o cardiac cath w MCC	0.228	0.000	0.219	0.000	0.231	0.000	0.222	0.000	0.218	0.000
301 Coronary bypass w/o cardiac cath w/o MCC	0.426	0.000	0.417	0.000	0.427	0.000	0.418	0.000	0.412	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
302 Major cardiovasc procedures w MCC or thoracic aortic aneurysm repair	0.267	0.017	0.255	0.023	0.264	0.019	0.261	0.020	0.249	0.027
303 Major cardiovasc procedures w/o MCC	0.217	0.001	0.202	0.002	0.221	0.001	0.211	0.001	0.200	0.002
304 Amputation for circ sys disorders exc upper limb & toe w MCC	0.270	0.007	0.262	0.009	0.279	0.005	0.259	0.010	0.262	0.009
305 Amputation for circ sys disorders exc upper limb & toe w CC	0.366	0.000	0.355	0.000	0.374	0.000	0.360	0.000	0.358	0.000
306 Permanent cardiac pacemaker implant w MCC	-0.011	0.933	-0.014	0.921	-0.007	0.957	-0.007	0.958	-0.007	0.959
307 Permanent cardiac pacemaker implant w CC	-0.039	0.742	-0.043	0.711	-0.032	0.784	-0.040	0.735	-0.038	0.743
308 Permanent cardiac pacemaker implant w/o CC/MCC	0.181	0.000	0.176	0.000	0.184	0.000	0.178	0.000	0.176	0.000
309 AICD generator	0.287	0.000	0.279	0.000	0.289	0.000	0.283	0.000	0.278	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
procedures										
310 Perc cardiovasc proc w drug-eluting stent w MCC or 4+ vessels/stents	0.323	0.000	0.315	0.000	0.326	0.000	0.319	0.000	0.314	0.000
311 Perc cardiovasc proc w drug-eluting stent w/o MCC	0.375	0.000	0.363	0.001	0.378	0.000	0.369	0.000	0.362	0.001
312 Perc cardiovasc proc w non-drug-eluting stent w MCC or 4+ ves/stents	0.021	0.354	0.013	0.571	0.029	0.207	0.019	0.412	0.018	0.427
313 Perc cardiovasc proc w non-drug-eluting stent w/o MCC	0.245	0.000	0.229	0.000	0.254	0.000	0.238	0.000	0.233	0.000
314 Perc cardiovasc proc w/o coronary artery stent w MCC	0.090	0.018	0.084	0.028	0.091	0.017	0.087	0.024	0.083	0.031
315 Perc cardiovasc proc w/o coronary artery stent w/o MCC	0.075	0.118	0.069	0.151	0.077	0.106	0.072	0.133	0.069	0.150
316 Other vascular procedures w MCC	0.030	0.784	0.019	0.859	0.031	0.772	0.024	0.824	0.017	0.875

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
327 Other vascular procedures w CC	0.195	0.004	0.193	0.004	0.198	0.003	0.194	0.004	0.195	0.004
328 Other vascular procedures w/o CC/MCC	0.224	0.016	0.222	0.017	0.223	0.016	0.225	0.016	0.223	0.017
329 Cardiac pacemaker device replacement w/o MCC	0.146	0.000	0.146	0.000	0.144	0.000	0.146	0.000	0.144	0.000
330 Other circulatory system O.R. procedures	0.070	0.019	0.070	0.018	0.068	0.023	0.070	0.019	0.069	0.022
331 Acute myocardial infarction, discharged alive w MCC	0.185	0.001	0.186	0.001	0.184	0.001	0.186	0.000	0.186	0.001
335 Acute myocardial infarction, discharged alive w CC	0.118	0.082	0.114	0.092	0.117	0.085	0.117	0.084	0.113	0.095
336 Acute myocardial infarction, discharged alive w/o CC/MCC	-0.009	0.859	-0.014	0.791	-0.008	0.887	-0.009	0.858	-0.012	0.816
350 Circulatory disorders except AMI, w card cath w MCC	0.110	0.496	0.107	0.511	0.120	0.462	0.110	0.496	0.114	0.481

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
354 Circulatory disorders except AMI, w card cath w/o MCC	0.052	0.421	0.048	0.464	0.056	0.387	0.051	0.431	0.050	0.438
355 Acute & subacute endocarditis w MCC	-0.095	0.250	-0.103	0.216	-0.088	0.286	-0.093	0.262	-0.095	0.254
356 Acute & subacute endocarditis w CC	0.310	0.000	0.307	0.000	0.310	0.000	0.306	0.000	0.304	0.000
357 Heart failure & shock w MCC	0.288	0.001	0.286	0.001	0.290	0.001	0.289	0.001	0.288	0.001
371 Heart failure & shock w CC	0.060	0.338	0.058	0.352	0.062	0.323	0.060	0.334	0.060	0.337
372 Heart failure & shock w/o CC/MCC	0.124	0.004	0.120	0.005	0.126	0.004	0.124	0.004	0.122	0.005
373 Peripheral vascular disorders w MCC	0.131	0.114	0.126	0.129	0.134	0.106	0.130	0.116	0.128	0.124
377 Peripheral vascular disorders w CC	-0.033	0.367	-0.039	0.282	-0.031	0.393	-0.035	0.341	-0.039	0.288
378 Peripheral vascular disorders w/o CC/MCC	-0.036	0.145	-0.042	0.087	-0.033	0.174	-0.038	0.119	-0.041	0.091
379 Atherosclerosis w MCC	-0.050	0.417	-0.060	0.330	-0.050	0.411	-0.055	0.369	-0.063	0.301
380 Atherosclerosis w/o MCC	-0.108	0.478	-0.111	0.464	-0.105	0.490	-0.107	0.481	-0.108	0.478
383 Hypertension	0.327	0.111	0.321	0.117	0.332	0.106	0.320	0.118	0.321	0.117

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
w MCC										
384 Hypertension w/o MCC	0.183	0.100	0.178	0.108	0.188	0.091	0.174	0.116	0.177	0.110
386 Cardiac congenital & valvular disorders w MCC	-0.073	0.491	-0.078	0.460	-0.070	0.507	-0.074	0.485	-0.077	0.469
387 Cardiac congenital & valvular disorders w/o MCC	0.143	0.494	0.133	0.525	0.149	0.477	0.137	0.512	0.135	0.520
388 Cardiac arrhythmia & conduction disorders w MCC	-0.041	0.514	-0.050	0.428	-0.039	0.536	-0.043	0.500	-0.049	0.438
389 Cardiac arrhythmia & conduction disorders w CC	-0.024	0.569	-0.033	0.429	-0.019	0.642	-0.024	0.558	-0.029	0.482
390 Cardiac arrhythmia & conduction disorders w/o CC/MCC	-0.037	0.580	-0.050	0.451	-0.032	0.631	-0.039	0.555	-0.047	0.479
391 Angina pectoris	0.177	0.000	0.170	0.000	0.182	0.000	0.177	0.000	0.174	0.000
392 Syncope & collapse	0.152	0.000	0.144	0.000	0.157	0.000	0.150	0.000	0.147	0.000
393 Chest pain	0.063	0.245	0.056	0.302	0.067	0.220	0.063	0.249	0.059	0.278
394 Other circulatory system diagnoses w MCC	0.098	0.012	0.090	0.021	0.103	0.008	0.098	0.012	0.095	0.015

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
395 Other circulatory system diagnoses w CC	-0.056	0.504	-0.065	0.439	-0.048	0.572	-0.055	0.512	-0.057	0.501
405 Other circulatory system diagnoses w/o CC/MCC	0.368	0.003	0.366	0.003	0.363	0.003	0.370	0.003	0.364	0.003
406 Stomach, esophageal & duodenal proc w MCC	0.298	0.020	0.297	0.020	0.299	0.020	0.297	0.020	0.298	0.020
417 Stomach, esophageal & duodenal proc w CC	-0.053	0.350	-0.060	0.290	-0.051	0.364	-0.058	0.306	-0.062	0.273
418 Stomach, esophageal & duodenal proc w/o CC/MCC	-0.025	0.621	-0.033	0.508	-0.023	0.645	-0.029	0.557	-0.035	0.488
419 Major small & large bowel procedures w MCC	-0.018	0.816	-0.028	0.711	-0.014	0.857	-0.022	0.779	-0.027	0.725
432 Major small & large bowel procedures w CC	0.312	0.000	0.310	0.000	0.314	0.000	0.309	0.000	0.309	0.000
433 Major small & large bowel procedures w/o CC/MCC	0.258	0.009	0.253	0.011	0.266	0.007	0.259	0.009	0.260	0.009
438 Peritoneal adhesiolysis w MCC	0.157	0.021	0.151	0.026	0.157	0.021	0.153	0.025	0.148	0.030

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
439 Peritoneal adhesiolysis w CC	0.067	0.247	0.057	0.319	0.066	0.248	0.062	0.283	0.054	0.347
440 Minor small & large bowel procedures w MCC	-0.021	0.836	-0.032	0.748	-0.026	0.799	-0.030	0.766	-0.042	0.676
441 Anal & stomal procedures w CC	0.184	0.004	0.181	0.004	0.185	0.004	0.183	0.004	0.181	0.004
442 Inguinal & femoral hernia procedures w MCC	0.155	0.007	0.148	0.010	0.157	0.006	0.153	0.008	0.148	0.010
443 Hernia procedures except inguinal & femoral w MCC	0.010	0.939	0.001	0.997	0.005	0.968	0.005	0.969	-0.007	0.960
444 Hernia procedures except inguinal & femoral w CC	0.288	0.000	0.278	0.000	0.291	0.000	0.287	0.000	0.280	0.000
445 Hernia procedures except inguinal & femoral w/o CC/MCC	0.213	0.000	0.202	0.000	0.218	0.000	0.212	0.000	0.206	0.000
446 Other digestive system O.R. procedures w MCC	0.184	0.052	0.172	0.070	0.188	0.047	0.182	0.055	0.174	0.066
459 Other digestive system O.R. procedures w CC	0.163	0.050	0.166	0.046	0.160	0.055	0.160	0.054	0.161	0.053

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
469 Major esophageal disorders w MCC	0.184	0.000	0.184	0.000	0.180	0.000	0.182	0.000	0.179	0.000
480 Major esophageal disorders w CC	0.093	0.224	0.087	0.256	0.086	0.264	0.090	0.238	0.079	0.303
492 Major esophageal disorders w/o CC/MCC	-0.012	0.905	-0.011	0.915	-0.017	0.869	-0.015	0.885	-0.016	0.870
496 Major gastrointestinal disorders & peritoneal infections w MCC	0.195	0.005	0.191	0.006	0.196	0.005	0.193	0.005	0.191	0.006
515 Major gastrointestinal disorders & peritoneal infections w CC	0.211	0.055	0.207	0.059	0.215	0.050	0.210	0.056	0.210	0.056
516 Major gastrointestinal disorders & peritoneal infections w/o CC/MCC	0.256	0.000	0.253	0.000	0.261	0.000	0.256	0.000	0.258	0.000
517 G.I. hemorrhage w MCC	0.182	0.012	0.179	0.013	0.188	0.009	0.180	0.012	0.184	0.011
540 G.I. hemorrhage w CC	0.178	0.038	0.168	0.049	0.183	0.033	0.176	0.040	0.171	0.045
543 G.I. hemorrhage w/o CC/MCC	0.045	0.565	0.038	0.627	0.051	0.517	0.046	0.556	0.044	0.575

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
544 Complicated peptic ulcer w MCC	0.221	0.046	0.213	0.054	0.225	0.042	0.218	0.049	0.215	0.053
545 Complicated peptic ulcer w/o CC/MCC	-0.067	0.604	-0.071	0.578	-0.065	0.615	-0.068	0.596	-0.071	0.583
546 Uncomplicated peptic ulcer w MCC	-0.085	0.405	-0.093	0.362	-0.078	0.444	-0.085	0.404	-0.087	0.395
547 Uncomplicated peptic ulcer w/o MCC	-0.016	0.929	-0.023	0.896	-0.005	0.978	-0.016	0.925	-0.014	0.937
551 Inflammatory bowel disease w MCC	0.043	0.529	0.036	0.595	0.046	0.496	0.041	0.546	0.038	0.573
552 Inflammatory bowel disease w CC	0.054	0.051	0.048	0.085	0.060	0.031	0.054	0.054	0.053	0.058
553 Inflammatory bowel disease w/o CC/MCC	-0.055	0.712	-0.067	0.654	-0.045	0.767	-0.064	0.672	-0.063	0.675
555 G.I. obstruction w MCC	0.020	0.877	0.010	0.941	0.020	0.879	0.017	0.900	0.007	0.958
556 G.I. obstruction w CC	0.007	0.902	-0.001	0.985	0.009	0.869	0.004	0.938	-0.001	0.992
557 G.I. obstruction w/o CC/MCC	0.192	0.078	0.184	0.092	0.188	0.086	0.189	0.082	0.178	0.104
558 Esophagitis, gastroent & misc digest disorders w MCC	0.066	0.223	0.060	0.267	0.067	0.221	0.064	0.240	0.059	0.277

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
559 Esophagitis, gastroent & misc digest disorders w/o MCC	0.389	0.021	0.383	0.022	0.392	0.020	0.388	0.021	0.385	0.022
562 Other digestive system diagnoses w MCC	0.095	0.385	0.090	0.410	0.099	0.365	0.092	0.400	0.092	0.400
563 Other digestive system diagnoses w CC	0.025	0.606	0.020	0.685	0.029	0.552	0.025	0.617	0.023	0.639
580 Other digestive system diagnoses w/o CC/MCC	-0.040	0.508	-0.043	0.474	-0.038	0.529	-0.043	0.471	-0.044	0.467
593 Pancreas, liver & shunt procedures w MCC	-0.177	0.074	-0.185	0.062	-0.174	0.078	-0.180	0.070	-0.184	0.064
594 Pancreas, liver & shunt procedures w CC	0.294	0.253	0.286	0.267	0.290	0.260	0.293	0.255	0.281	0.275
595 Biliary tract proc except only cholecyst w or w/o c.d.e. w MCC	0.129	0.566	0.119	0.595	0.136	0.544	0.132	0.554	0.128	0.567
602 Biliary tract proc except only cholecyst w or w/o c.d.e. w CC	-0.014	0.732	-0.019	0.626	-0.011	0.789	-0.015	0.710	-0.017	0.661
603 Laparoscopic cholecystectomy w/o c.d.e. w MCC	-0.041	0.022	-0.048	0.008	-0.037	0.041	-0.043	0.017	-0.045	0.012

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
605 Laparoscopic cholecystectomy w/o c.d.e. w CC	0.031	0.546	0.026	0.615	0.036	0.488	0.032	0.534	0.031	0.551
607 Laparoscopic cholecystectomy w/o c.d.e. w/o CC/MCC	-0.113	0.271	-0.125	0.224	-0.103	0.314	-0.114	0.266	-0.117	0.255
617 Cirrhosis & alcoholic hepatitis w MCC	-0.106	0.047	-0.106	0.049	-0.110	0.040	-0.110	0.040	-0.112	0.038
621 Cirrhosis & alcoholic hepatitis w CC	0.053	0.540	0.051	0.555	0.058	0.506	0.050	0.563	0.053	0.541
637 Disorders of pancreas except malignancy w MCC	0.055	0.243	0.047	0.315	0.060	0.201	0.052	0.266	0.050	0.285
638 Disorders of pancreas except malignancy w CC	0.140	0.000	0.129	0.000	0.145	0.000	0.136	0.000	0.132	0.000
639 Disorders of pancreas except malignancy w/o CC/MCC	0.044	0.426	0.031	0.581	0.047	0.395	0.039	0.486	0.030	0.588
640 Disorders of liver except malig,cirr,alc hepa w MCC	0.111	0.001	0.101	0.002	0.114	0.001	0.108	0.001	0.103	0.002
641 Disorders of liver except malig,cirr,alc hepa w CC	0.147	0.000	0.139	0.000	0.147	0.000	0.143	0.000	0.136	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
643 Disorders of liver except malig,cirr,alc hepa w/o CC/MCC	0.060	0.438	0.052	0.499	0.064	0.407	0.059	0.442	0.056	0.471
644 Disorders of the biliary tract w MCC	0.169	0.004	0.160	0.006	0.175	0.003	0.170	0.004	0.165	0.005
645 Disorders of the biliary tract w CC	0.373	0.000	0.363	0.000	0.380	0.000	0.373	0.000	0.368	0.000
652 Disorders of the biliary tract w/o CC/MCC	0.320	0.000	0.317	0.000	0.321	0.000	0.318	0.000	0.317	0.000
654 Spinal fusion except cervical w MCC	0.245	0.049	0.245	0.049	0.239	0.054	0.244	0.050	0.240	0.054
659 Major joint replacement or reattachment of lower extremity w MCC	0.145	0.117	0.141	0.127	0.142	0.126	0.144	0.122	0.138	0.138
660 Biopsies of musculoskeletal system & connective tissue w MCC	0.374	0.000	0.369	0.000	0.378	0.000	0.375	0.000	0.374	0.000
669 Biopsies of musculoskeletal system & connective tissue w CC	0.289	0.000	0.282	0.001	0.292	0.000	0.286	0.000	0.284	0.001

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
670 Biopsies of musculoskeletal system & connective tissue w/o CC/MCC	0.120	0.580	0.108	0.617	0.120	0.580	0.118	0.585	0.108	0.619
673 Hip & femur procedures except major joint w MCC	0.180	0.015	0.177	0.017	0.180	0.015	0.179	0.015	0.177	0.017
674 Hip & femur procedures except major joint w CC	0.367	0.000	0.360	0.000	0.367	0.000	0.364	0.000	0.357	0.000
682 Lower extrem & humer proc except hip,foot,femur w MCC	0.133	0.000	0.126	0.000	0.134	0.000	0.127	0.000	0.123	0.000
683 Local excision & removal int fix devices exc hip & femur w CC	0.186	0.000	0.177	0.000	0.188	0.000	0.181	0.000	0.175	0.000
684 Local excision & removal int fix devices exc hip & femur w/o CC/MCC	0.210	0.000	0.200	0.000	0.210	0.000	0.204	0.000	0.196	0.000
689 Major shoulder or elbow joint procedures w CC/MCC	0.132	0.000	0.125	0.000	0.135	0.000	0.130	0.000	0.127	0.000
690 Other musculoskelet sys & conn tiss O.R.	0.168	0.000	0.159	0.000	0.170	0.000	0.164	0.000	0.159	0.000

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
proc w MCC										
694 Other musculoskelet sys & conn tiss O.R. proc w CC	0.229	0.005	0.222	0.007	0.234	0.004	0.229	0.005	0.226	0.006
696 Other musculoskelet sys & conn tiss O.R. proc w/o CC/MCC	0.388	0.000	0.378	0.000	0.394	0.000	0.387	0.000	0.384	0.000
698 Fractures of hip & pelvis w/o MCC	0.114	0.017	0.106	0.025	0.117	0.013	0.114	0.017	0.110	0.021
699 Sprains, strains, & dislocations of hip, pelvis & thigh w/o CC/MCC	0.244	0.000	0.237	0.000	0.249	0.000	0.242	0.000	0.239	0.000
700 Osteomyelitis w MCC	0.384	0.000	0.378	0.000	0.385	0.000	0.378	0.000	0.374	0.000
714 Osteomyelitis w CC	0.436	0.005	0.420	0.007	0.447	0.004	0.437	0.005	0.431	0.006
726 Osteomyelitis w/o CC/MCC	0.981	0.000	0.972	0.000	0.988	0.000	0.978	0.000	0.977	0.000
760 Pathological fractures & musculoskelet & conn tiss malig w MCC	0.110	0.583	0.095	0.636	0.119	0.553	0.106	0.599	0.100	0.617

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
800 Pathological fractures & musculoskelet & conn tiss malig w CC	0.218	0.478	0.212	0.491	0.205	0.504	0.211	0.493	0.196	0.524
808 Pathological fractures & musculoskelet & conn tiss malig w/o CC/MCC	-0.090	0.339	-0.093	0.323	-0.094	0.319	-0.093	0.325	-0.099	0.297
809 Connective tissue disorders w MCC	0.145	0.024	0.139	0.031	0.142	0.027	0.140	0.030	0.133	0.038
811 Connective tissue disorders w CC	0.125	0.012	0.119	0.017	0.126	0.012	0.120	0.016	0.116	0.020
812 Connective tissue disorders w/o CC/MCC	0.025	0.471	0.018	0.615	0.026	0.463	0.020	0.572	0.015	0.677
813 Medical back problems w MCC	0.254	0.005	0.246	0.007	0.252	0.005	0.247	0.006	0.240	0.008
814 Medical back problems w/o MCC	0.219	0.274	0.218	0.276	0.212	0.288	0.215	0.281	0.209	0.295
846 Bone diseases & arthropathies w MCC	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
847 Bone diseases & arthropathies w/o MCC	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
853 Signs & symptoms of musculoskeletal system & conn	0.107	0.001	0.104	0.001	0.104	0.001	0.103	0.001	0.100	0.001

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
tissue w MCC										
856 Signs & symptoms of musculoskeletal system & conn tissue w/o MCC	0.127	0.062	0.130	0.058	0.126	0.064	0.126	0.066	0.128	0.062
857 Tendonitis, myositis & bursitis w MCC	0.008	0.881	0.007	0.882	0.008	0.872	0.008	0.878	0.008	0.873
862 Tendonitis, myositis & bursitis w/o MCC	-0.101	0.097	-0.102	0.094	-0.099	0.103	-0.101	0.098	-0.100	0.100
864 Aftercare, musculoskeletal system & connective tissue w MCC	-0.101	0.186	-0.105	0.169	-0.099	0.196	-0.098	0.200	-0.101	0.188
866 Fx, sprn, strn & disl except femur, hip, pelvis & thigh w MCC	-0.161	0.105	-0.164	0.099	-0.158	0.111	-0.160	0.107	-0.160	0.106
871 Fx, sprn, strn & disl except femur, hip, pelvis & thigh w/o MCC	0.054	0.001	0.047	0.003	0.054	0.001	0.052	0.001	0.046	0.004
872 Other musculoskeletal sys & connective tissue diagnoses w/o CC/MCC	0.060	0.006	0.054	0.013	0.061	0.005	0.058	0.008	0.053	0.014

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
880 Skin graft &/or debrid for skn ulcer or cellulitis w CC	-0.160	0.526	-0.162	0.520	-0.161	0.522	-0.164	0.516	-0.166	0.510
884 Skin graft &/or debrid exc for skin ulcer or cellulitis w CC	0.031	0.604	0.027	0.648	0.039	0.510	0.028	0.642	0.032	0.589
897 Other skin, subcut tiss & breast proc w MCC	0.042	0.518	0.041	0.533	0.050	0.445	0.044	0.495	0.049	0.453
907 Other skin, subcut tiss & breast proc w CC	0.131	0.032	0.133	0.030	0.126	0.039	0.129	0.035	0.126	0.039
908 Skin ulcers w CC	0.106	0.059	0.105	0.062	0.106	0.059	0.103	0.067	0.102	0.069
916 Skin ulcers w/o CC/MCC	0.228	0.129	0.214	0.155	0.240	0.110	0.224	0.136	0.222	0.141
917 Major skin disorders w MCC	-0.076	0.129	-0.085	0.090	-0.072	0.147	-0.079	0.116	-0.083	0.096
918 Major skin disorders w/o MCC	-0.005	0.933	-0.015	0.787	-0.002	0.967	-0.008	0.892	-0.015	0.795
919 Cellulitis w MCC	-0.052	0.476	-0.055	0.454	-0.052	0.478	-0.053	0.469	-0.055	0.452
920 Cellulitis w/o MCC	-0.072	0.241	-0.075	0.220	-0.070	0.251	-0.071	0.244	-0.073	0.231
921 Trauma to the skin, subcut tiss & breast w/o MCC	-0.058	0.583	-0.061	0.566	-0.059	0.574	-0.063	0.552	-0.065	0.539
947 Minor skin disorders w/o MCC	0.187	0.006	0.181	0.008	0.190	0.005	0.186	0.006	0.183	0.007

Health Status Variable (Diagnostic-Related Groupings)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
948 Amputat of lower limb for endocrine,nutrit,& metabol dis w CC	0.054	0.120	0.046	0.179	0.054	0.116	0.050	0.144	0.045	0.192
974 O.R. procedures for obesity w/o CC/MCC	-0.279	0.027	-0.295	0.020	-0.262	0.038	-0.282	0.025	-0.281	0.026
975 Skin grafts & wound debrid for endoc, nutrit & metab dis w CC	-0.034	0.839	-0.052	0.752	-0.016	0.921	-0.040	0.808	-0.041	0.801
977 Other endocrine, nutrit & metab O.R. proc w CC	-0.055	0.790	-0.071	0.732	-0.045	0.829	-0.064	0.757	-0.068	0.744
981 Diabetes w MCC	0.068	0.167	0.065	0.187	0.070	0.157	0.066	0.182	0.065	0.188
982 Diabetes w CC	0.030	0.560	0.028	0.581	0.031	0.540	0.027	0.591	0.028	0.585
987 Diabetes w/o CC/MCC	0.092	0.273	0.088	0.295	0.094	0.262	0.088	0.296	0.087	0.299
988 Nutritional & misc metabolic disorders w MCC	-0.010	0.896	-0.015	0.838	-0.009	0.899	-0.015	0.844	-0.018	0.806

Table 12: Risk Adjustment Model - Activities of Daily Living (ADL) Scores

Health Status Variable (Activities of Daily Living [ADL] from the Claim Authorization String)	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
ADL Score 1	0.00152	0.5299	0.000	0.857	0.001	0.605	0.001	0.627	0.000	0.991
ADL Score 2	0.0159	0.0000	0.015	0.000	0.016	0.000	0.015	0.000	0.015	0.000
ADL Score 3	-0.00083	0.8307	0.001	0.867	-0.001	0.895	0.000	0.998	0.001	0.716
ADL Score 4	-0.00563	0.0214	-0.007	0.005	-0.006	0.015	-0.006	0.018	-0.007	0.004

Table 13: Risk Adjustment Model - Enrollment Status Variables

Enrollment Status Variable	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Currently End Stage Renal Disease	0.255	0.000	0.249	0.000	0.256	0.000	0.248	0.000	0.246	0.000
Originally End Stage Renal Disease	-0.061	0.006	-0.072	0.001	-0.061	0.007	-0.071	0.001	-0.078	0.000
Originally Disabled, Female	0.148	0.000	0.132	0.000	0.143	0.000	0.136	0.000	0.119	0.000
Originally Disabled, Male	0.120	0.000	0.115	0.000	0.113	0.000	0.107	0.000	0.100	0.000

Table 14: Risk Adjustment Model - Interaction Terms

Interaction Terms	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Congestive Heart Failure * Chronic Obstructive Pulmonary Disease	-0.024	0.012	-0.023	0.015	-0.024	0.014	-0.022	0.020	-0.022	0.023
Chronic Obstructive Pulmonary Disease * Chronic Renal Failure	-0.027	0.001	-0.025	0.003	-0.026	0.002	-0.025	0.003	-0.023	0.006
Sepsis * Chronic Renal Failure	-0.036	0.009	-0.036	0.010	-0.037	0.007	-0.036	0.009	-0.036	0.008
Currently Disabled * Pressure Ulcer	-0.120	0.000	-0.119	0.000	-0.123	0.000	-0.118	0.000	-0.120	0.000

* Each input variable has an associated marginal effect value that can be interpreted as the change in the population value of the measure if all patients in the population had the risk factor but had the observed distribution of all other risk factors. For example, the marginal effect for Congestive Heart Failure takes into account the change in the predicted risk of the outcome due to changes caused by the Congestive Heart Failure and Congestive Heart Failure*Chronic Obstructive Pulmonary Disease variables, if the value of Congestive Heart Failure were set to 1 for all patients. Therefore, marginal effects are not included for interaction terms.

Table 15: Risk Adjustment Model - SDS Factors

SDS Variables	Original Model		Original Model + Dual Eligible		Original Model + Rural Location		Original Model + SES Index		Original Model + All SDS Variables	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Dual Medicaid Status	-	-	0.128	0.000	-	-	-	-	0.122	0.000
Rural	-	-	-	-	0.122	0.000	-	-	0.105	0.000
Low SES Index Score (SES Index Score <= 50.1)	-	-	-	-	-	-	0.060	0.000	0.045	0.000
Moderate SES Index Score (50.1< SES Index Score <57.1)	-	-	-	-	-	-	-0.007	0.034	-0.001	0.695
Missing SES Index Score	-	-	-	-	-	-	0.038	0.000	0.020	0.000

Note: Reference group for SES Index Variable is High SES Index Score (SES Index >= 57.1)

NATIONAL QUALITY FORUM

Admissions & Readmissions SDS Trial Period Questions: Standardized Readmissions Ratio for dialysis facilities

Produced by the University of Michigan Kidney Epidemiology and Cost Center
April 27, 2016

1. Enter measure # and title

#2496 - Standardized Readmission Ratio (SRR) for dialysis facilities

2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

We selected the following patient- and area-level factors to assess the association with readmissions.

- Patient level (Data obtained from Medicare claims and administrative data)
  - Employment status 6 months prior to ESRD onset
  - Race
  - Ethnicity
  - Medicare coverage at index hospital discharge
- ZIP code level Area Deprivation Index (ADI) derived from Census data (Source: Singh, GK. Area deprivation and widening inequalities in US mortality, 1969–1998. Am J Public Health. 2003;93(7):1137–1143)

The relationship between hospital utilization and readmissions and SDS/SES factors is well documented in studies in the hospital setting (Herrin et al 2015; Jiang et al 2010; Kind et al 2014). We describe the conceptual relationship between the selected patient- and area-level SDS/SES factors and readmissions.

There is increasing interest in exploring the relation of hospital readmissions for dialysis patients to patient-level SDS/SES characteristics such as income, education, insurance status, race, and employment status. However, many existing studies of this set of relationships were conducted in other health care settings, such as nursing homes and hospitals. Among the few studies on readmissions in the dialysis facility setting, patient-level SDS factors either are not included in the analyses or they are included as basic controls without a description of the conceptual pathway between these factors and readmissions. For example, the focus of the analysis by Erikson et al (2014) is to examine frequency of physician visits, subsequent to a

discharge, and the impact on preventing readmissions. While the analysis included race and sex in the descriptive statistics and models, these were considered as basic patient level controls. It may not be appropriate to extrapolate about the empirical relationship between these SDS patient-level factors and readmissions on the basis of this study alone.

Studies have also demonstrated that dually eligible (Medicare and Medicaid) Medicare beneficiaries experience higher readmission compared to the overall FFS population (Jiang et al, 2010; Moon and Shin 2006; Kind et al 2014). Dual eligibles typically have greater comorbidity burden and face access to care barriers which, in turn, drive higher hospital utilization (Jiang et al 2010; Moon and Shin 2006; Wright, Potter, and Trivedi 2015).

Insurance status, and specifically dual eligibility, has not been studied extensively within the dialysis population as it relates to hospital utilization and specifically readmissions. We assume that Medicare coverage type will be independently associated with readmissions. Dual eligibility is a proxy for lower income status, whereby patients that are dually eligible are expected to have higher readmission utilization as demonstrated in the literature on the general Medicare population. We assume that patients with this coverage type may be more likely to experience higher readmissions due to less access to comprehensive primary care. This may be particularly true for dialysis patients that have higher comorbidity burden and therefore are doubly disadvantaged by their chronic health status and more limited access to care compared with patients that have Medicare primary or Medicare secondary coverage, the latter type including private insurance.

Area-level factors, typically operating as proxies of patient level factors, have also been found to influence readmission (Herrin et al., 2015; Kind et al, 2014; Philbin et al 2001) as well as other outcomes. Work by Philbin et al. (2001) found substantially higher risk of readmission for persons residing in low-income ZIP codes. These results held after controlling for comorbidities, location of care, and a fairly full set of SDS/SES characteristics, including age, sex, race and insurance type, as measured at the ZIP code level. All SDS/SES characteristics in the model were also associated with odds of readmission. Within the dialysis population, one recent study found area-level SES factors are associated with poor outcomes (Almachraki et al 2016).

In our analyses we use the publicly available Area Deprivation Index (ADI) developed by Singh and colleagues at the University of Wisconsin. The ADI reflects a full set of SES characteristics, including measures of income, education, and employment status, measured at the ZIP code level. Singh (2003) has applied the index in a variety of contexts, including analysis of county-level mortality rates. Singh found area differences in mortality associated with low SDS. Over the period studied, mortality differences widened because of slower mortality reductions in more deprived areas. More recently, the ADI has been applied to the calculation of risk-adjusted rates of hospital readmission (Kind et al 2014).

Area and patient-level factors are also related, suggesting the complexity of delineating each and its effect on health outcomes. For example, health care outcomes and utilization are

associated with area-level income and residential segregation, particularly so for racial minorities (Williams 2006; Williams and Collins 2001). This suggests the interplay of patient-level demographic factors (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).

Given these observed linkages we tested five 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 analyses.

3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

Hospital readmissions may reflect aspects of the quality of care received by patients. Repeat admissions indicate patients are not receiving the level of inpatient or follow-up care needed to manage their conditions. In the dialysis care realm, hospital readmissions can reflect problems in the care provided by both the dialysis facility and the hospital that provides care at the index hospitalization. Readmissions suggest there are problems in the coordination of care between the discharging hospital and the dialysis facility, especially during the transition from inpatient hospitalization to outpatient dialysis care. The SRR is intended to reflect the quality of care provided by the dialysis facility, an important aspect of which is coordination between the discharging hospital and the dialysis facility.

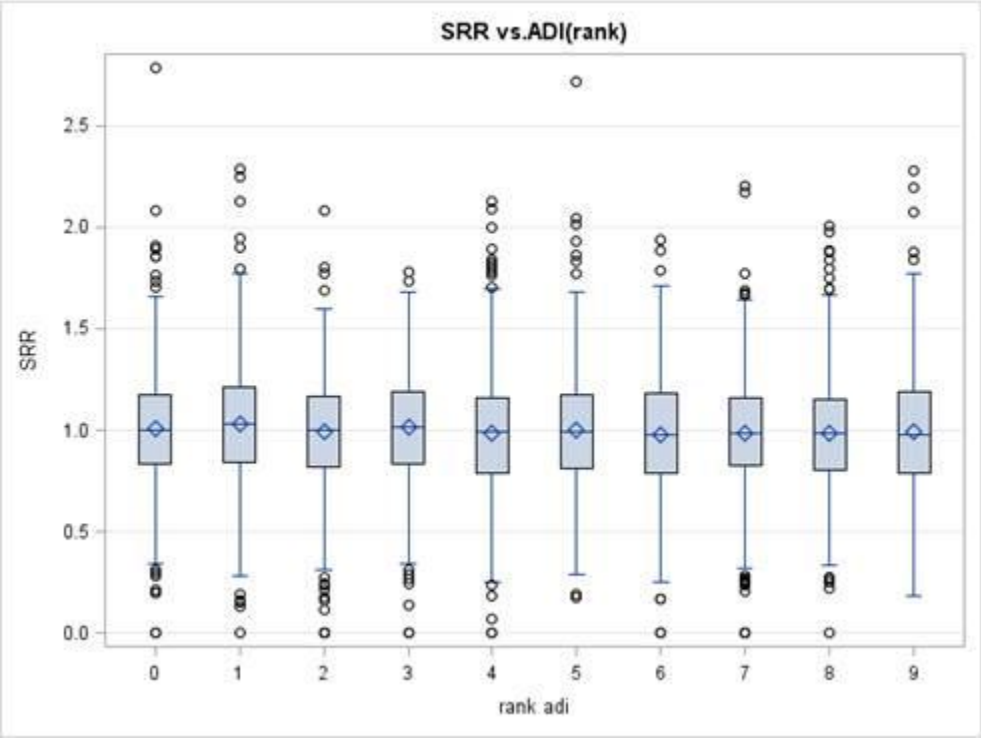
Recognizing certain risk factors predispose these patients to higher hospitalization usage, the SRR includes adjustments for discharging hospital and for patient characteristics, including comorbidities (in the prior year), considered outside the control of dialysis facility care. These adjustments allow for a more valid assessment of facility performance, thereby protecting the facility from an unfair performance measurement resulting from circumstances beyond its control. These adjustments are also made to ensure that patients with health conditions more likely to result in readmissions do not face barriers to care that could result in facilities avoiding treating patients that could adversely impact their SRR score.

In addition to the current risk adjustors in the SRR, we evaluated the addition of adjustment for patient- and area-level socioeconomic factors (Medicare coverage, employment status at ESRD incidence, and the ADI) and demographics (patient-level race and ethnicity). These factors are assumed to be outside the control of the facility, but, as described earlier, they have been found to be associated with readmission. Adjustment for these SDS/SES factors, to the extent that they predict readmission, could protect the facility from worse facility outcomes on SRR, as

well as protect patient access to care. In analyses described further below, we find a generally fairly weak set of associations between SRR and variables reflecting SES, race, and ethnicity. Adjusting for these variables does not result in changes in the classification of many facilities as better than or worse than expected on SRR.

In addition to the lack of strong empirical differences after SDS/SES adjustment, we posit that a principal problem with adjusting for SES and patient race and ethnicity is that patients in minority or disadvantaged subgroups may have higher comorbidity burden and poorer health; however, adjusting for these characteristics essentially sets different expectations for outcomes for these patient subgroups, and in turn sets different standards of care that exacerbate disparities in outcomes. Rather than accepting poorer outcomes, the imperative should be to ensure that facilities have the resources needed to care for these more complex and sicker patient populations. Simply allowing poor outcomes may appear fair to providers, but it does not result in any clear benefit to improving or sufficiently addressing patient care for this population. Therefore, adjustment for SES and demographics has the potential benefits of preserving patient access and increasing measurement fairness to facilities. But it also has the potential cost of reinforcing and maybe increasing disparities in access to high quality care. To assess this tradeoff further, we analyzed facility SRRs by SES, as measured by the Area Deprivation Index.

Figure 1. Facility SRR, by decile of median facility ADI



We find that there are many facilities serving disadvantaged populations that are able to achieve SRR levels in the range of that achieved by facilities serving patients with higher SES. Therefore, we conclude that adjustment for SES and race and ethnicity may not be justified as a means of assuring patient access to high quality care.

In summary, the weak empirical basis for adjusting for SES, race, and ethnicity, combined with the risks of seeming to condone a lower standard of care for patients in disadvantaged groups defined by race, ethnicity, or SES leads us to recommend against adjusting for SES, race, or ethnicity in the calculation of the SRR.

4. What were the statistical results of the analyses used to select risk factors?

We based the list of covariates considered for inclusion in the endorsed version of the measure on CMS's Hospital-Wide All-Cause Readmission Rate (HWR; NQF #1789) and CMS's Standardized Hospitalization Ratio (SHR; NQF #1463), all of which were statistically verified by the measure developer (Horwitz et al 2011). The HWR and SHR adjusted for patient comorbidities measured at different points in time (prevalent and at ESRD incidence, respectively). Based on TEP input, we chose as a starting point the HWR comorbidity adjustments which are defined using claims data and can capture current comorbidities.

The risk adjustment is based on a two-stage logistic model. Adjustment is made for patient age, sex, diabetes, duration of ESRD, BMI at ESRD incidence, prior-year comorbidities, length of hospital stay and presence of a high-risk diagnosis at discharge. In the first stage of this model, both dialysis facilities and hospitals are represented as random effects, and regression adjustments are made for the set of patient-level characteristics listed above. From this first stage, we obtain the estimated standard deviation of the random effects of hospitals.

The second stage of the model is a mixed-effects model, in which facilities are fixed effects and hospitals are modeled as random effects, with the standard deviation specified as equal to its estimate from the first stage. The expected number of readmissions for each facility is estimated as the summation of the probabilities of readmission for the discharges of all patients in this facility, assuming the national average or norm for facility effect. This model accounts for a given facility's case mix using the same set of patient-level characteristics as those in the first stage (He et al 2014).

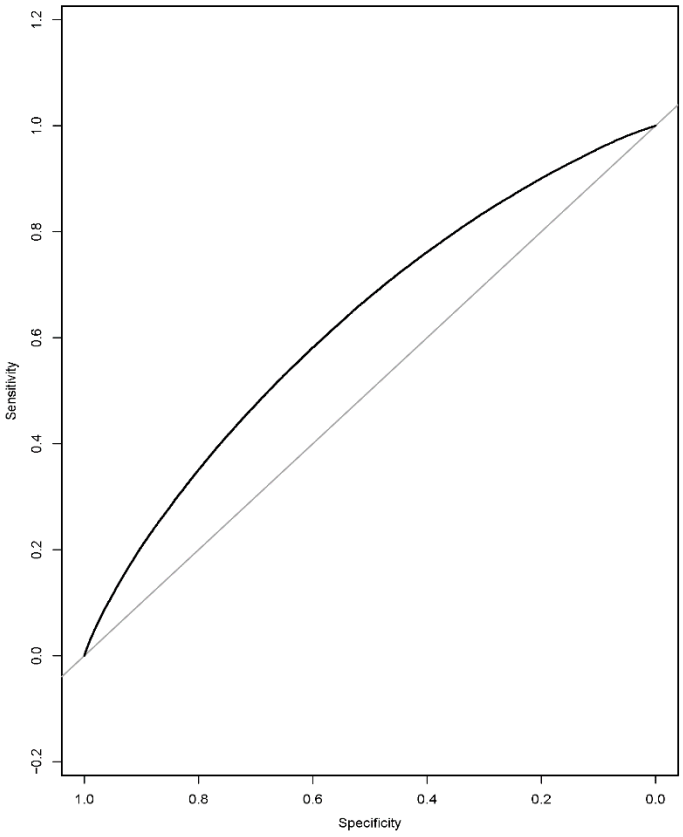
As described above, all risk factors included in the model have face validity, and all but four—age 60-75 years, being underweight, being respirator-dependent or experiencing a hip fracture/dislocation at some point in the year leading up to hospitalization—are also significantly predictive of readmission in the original SRR model (Table 1). As the ROC curve demonstrates, the model's accuracy is fair (Figure 2; c-statistic = 0.6265).

Table 1. Effects from original SRR: 2014

Risk Factor	Beta	*p*
Age (y)		
<25	0.2721	<.0001
25–45	0.2403	<.0001
45–60 (ref)	.	.
60–75	-0.0033	0.4386
>75	0.0564	<.0001
BMI		
Underweight	-0.0178	0.2699
Normal Weight (ref)	.	.
Overweight	-0.0382	<.0001
Obese	-0.1098	<.0001
Cause of ESRD: Diabetes	0.0193	0.0427
Comorbidity (past year)		
Severe infection	0.0974	<.0001
Other infectious disease & pneumonias	0.1739	<.0001
Metastatic cancer/acute leukemia	0.2839	<.0001
Severe cancer	0.1873	<.0001
Other major cancers	0.0935	<.0001
End-Stage Liver Disease	0.3017	<.0001
Other hematological disorders	0.1939	<.0001
Drug and alcohol disorders	0.3023	<.0001
Psychiatric comorbidity	0.2404	<.0001
Hemiplegia/paraplegia/paralysis	0.0693	<.0001
Functional disability	0.0299	0.0243
Seizure disorders and convulsions	0.1560	<.0001
COPD	0.2228	<.0001
Fibrosis of lung or other chronic lung d	0.0675	<.0001
Ulcers	0.1757	<.0001
Septicemia/shock	0.0857	<.0001
Cardiorespiratory failure/shock	0.2226	<.0001
Pancreatic disease	0.2262	<.0001
Rheumatoid arthritis and inflammatory co	0.0757	<.0001
Respirator dependence/tracheostomy statu	-0.0687	0.0657
Major organ transplants - excl kidney	0.0663	0.0335
Coagulation defects and other specified	0.1629	<.0001
Hip fracture/dislocation	0.0181	0.7228
Length of Index Hospitalization (days)		
<2	.	
2-4	0.0460	<.0001
4-7	0.1134	<.0001
>7	0.2394	<.0001
Presence of high-risk diagnosis at index discharge	0.4071	<.0001
Sex: Female	0.0444	<.0001
Time on ESRD (y)		
<1 (ref)	.	
1–2	0.0780	<.0001
2–3	0.0861	<.0001
3–6	0.0722	<.0001
>6	0.0433	0.0001

***Note*.** Discharge diagnoses that were relatively rare but led to a 30-day unplanned readmission in at least 40% of cases.

Figure 2. ROC Curve for Original SRR Model (c-statistic = 0.6265)



5. Describe the analyses and interpretation resulting in the decision to select SDS factors (e.g. prevalence of the factor across measured entities, empirical association with the outcome, contribution of unique variation in the outcome, assessment of between-unit effects and within-unit effects).

Using hierarchical binary logistic regression we fit three additional models for readmissions to 2014 hospitalization data (Medicare claims), including covariates from the original SRR model and adding several SES indicators as well as patients' race/ethnicity. Table 2 shows effects from these selected additional covariates in the three models.

Table 2. SES and race/ethnicity effects from three additional sensitivity models: 2014

Risk Factor	Area-level factor		Patient-level factors		All factors	
	Beta	*p*	Beta	*p*	Beta	*p*
ADI*	0.0003	0.3058	.	.	0.0003	0.9387
Employment 6 months prior to ESRD						
Employed (ref)	.	.	.	.	.	.
Unemployed	.	.	-0.0587	<.0001	-0.0596	<.0001
Unknown	.	.	-0.0052	0.7153	-0.006	0.6973
Medicare coverage at index discharge						
Medicare primary (ref)	.	.	.	.	.	.
Medicare secondary	.	.	0.0011	0.4213	0.0006	0.4375
Dually eligible for Medicare & Medicaid	.	.	0.0307	0.0002	0.0303	0.0002
Non-Medicare/unknown	.	.	-0.0599	0.1828	-0.0608	0.1763
Race						
White (ref)	.	.	.	.	.	.
Black	.	.	-0.0034	0.0006	-0.005	0.0007
Asian/Pacific Islander	.	.	-0.0825	0.0001	-0.0832	0.0001
Native American	.	.	-0.0726	0.0004	-0.0737	0.0004
Other/unknown	.	.	0.0942	0.1572	0.0935	0.1615
Ethnicity						
Non-Hispanic (ref)	.	.	.	.	.	.
Hispanic	.	.	-0.0644	0.0014	-0.0659	0.0012
Unknown	.	.	-0.0399	0.443	-0.0402	0.4323

***** Area Deprivation Index. Source: Singh, GK. Area deprivation and widening inequalities in US mortality, 1969–1998. Am J Public Health. 2003;93(7):1137–1143. We linked the ADI to each patient's ZIP code of residence as of the index discharge.

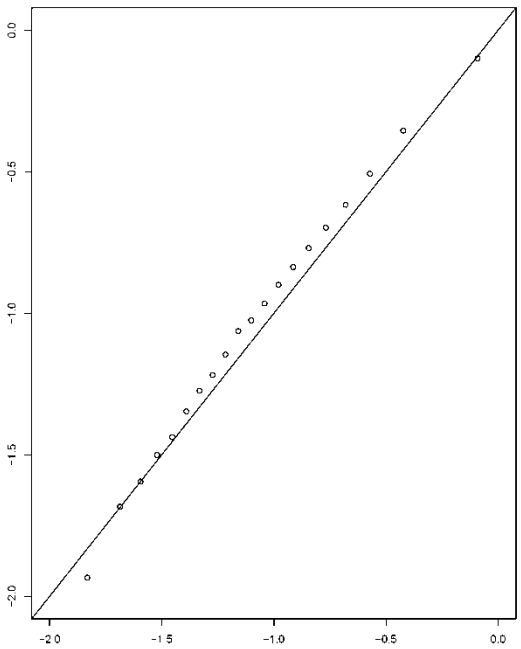
As shown in the table, several patient-level factors are significantly predictive of readmissions (being unemployed, being dually eligible for Medicare and Medicaid, race and Hispanic ethnicity). Perhaps unsurprisingly, the ZIP-code level ADI is not predictive of readmissions, given its less direct relationship with patients' economic status. As discussed in Question 10, after adding these covariates, the SRRs remain highly correlated with the original SRR model (correlation coefficient >0.99 for all models), and outlier facilities are flagged at a nearly identical rate between the original and sensitivity models (kappa statistic > 0.96 for all models).

6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach (describe the steps—do not just name a method; what statistical analysis was used).

The model's fit is demonstrated in Figure 3, which compares the observed rates of readmission with the model-based predictions. We categorize all index discharges into 20 groups based on their model-based predicted values and compute the observed readmission proportion for each

group. We then apply the logit transformation to each group's observed readmission proportion and plot it against the same group's average linear prediction; see the dots for all 20 groups in the plot. The 45-degree line represents a perfect match between the observed values and the model-based predictions. In general, the closer the observed values are to this line the better the model fit. As the figure shows, the observed values are spaced fairly equally and lie very close to the 45-degree line, indicating a good fit.

Figure 3. The observed proportion (logit) of readmissions versus the model-based estimated probabilities (logit) of readmission: 2014.



7. Discuss the risks for misuse of the specified performance measure. This discussion could include information on the known limitations of the performance measure that could impact its use in accountability programs.

The potentials for two unintended consequences have been previously raised during the NQF endorsement process: (1) delay in or foregoing of necessary readmission to the hospital for patients with time-sensitive conditions; and (2) the selection of relatively healthy patients for care by the dialysis facility. We discuss each in turn.

The concern that a readmission measure might result in delay in or foregoing of necessary and timely readmission goes to the heart of any readmission measure, whether for dialysis patients or for patients in other care settings. Hence, the decision to measure and make public the readmission rate of patients receiving care from a particular provider must consider the benefits and risks of the measure. It is CMS's view that the benefits far outweigh the risks across a range of care settings and for dialysis facilities in particular. Patients and potential patients benefit from learning whether the care they will get from a particular provider is of such quality as to reduce the likelihood of early hospital readmission. Facilities benefit from learning how their performance compares to facilities with similar patients. Measurement is necessary to enable identification of opportunities for improvement. Patients very clearly benefit if facilities succeed in identifying processes and structures that reduce inappropriate readmissions. The health care system in general benefits from the reduction in cost associated with elimination of unnecessary readmissions. Against these benefits must be weighed the risks of measuring and making public facility-specific readmission rates. CMS does not think a risk of delay in or foregoing of readmissions is very high. The nephrologist-dialysis facility team managing patient care and authorizing hospitalization is unlikely to be influenced by the effect of a fairly minor incentive associated with the SRR. Physicians and other health professionals face a powerful array of factors that affect the decision to admit a patient to the hospital. The strongest of these is the ethical imperative to do what is in the best interest of the patient, clinically and otherwise. In particular, it is difficult to envision a decision by the care team in a facility to postpone what it considers a necessary readmission out of concern for a facility's score on the SRR. In addition, providers face legal sanctions for failure to hospitalize the patient as needed. Finally, the facility faces a set of quality outcomes measures. Postponing or eliminating necessary readmissions could result in poor performance on other measures, including the standardized mortality ratio. Taken together, these factors are likely to overwhelm any thought of delaying or eliminating necessary hospital readmission.

The concern about patient selection relates to ensuring access to care for sicker patients. CMS considers ensuring patient access to dialysis care to be particularly important, and we continue to seek ways to ensure that access is unabated. This is part of the reason we proposed to adopt the SRR measure, which incorporates a risk adjustment methodology that levels the playing field for facilities with different case-mixes and counters the incentive for cherry-picking patients. Given the adjustment for patient health in the SRR, we think it would be difficult for a facility to identify patients of given health conditions (which are adjusted for in the measure) that are more or less likely to experience a hospital readmission.

In addition to the risk of selection of healthier patients by facilities, negative selection of less socially disadvantaged patients may occur. The exclusion of sociodemographic adjustment could increase the likelihood that patients in socially disadvantaged positions might face barriers to access to care. Fulfillment of this widely accepted principle of equality in access to healthcare may result in financial disadvantage for providers caring for such patients. If risk adjustment for sociodemographic factors is included in this measure, dialysis providers that care for these patients are less likely to be at a financial and reporting disadvantage. However, this protection of provider interests comes with a very real risk: Sociodemographic risk adjustment effectively results in quality measures that allow unequal access to care, by effectively holding providers to different (more relaxed) standards for expected patient outcomes. In the absence of definitive evidence demonstrating that sociodemographic risk adjustment does not result in differential access to care, we believe that the most appropriate decision should be to exclude risk adjustment for sociodemographic factors from the ESRD SRR. Our primary goal should be to implement quality measures that result in the highest quality of patient care and equitable access for all patients to that care.

Recognizing the concern of providers that treat a disproportionately higher percentage of disadvantaged patients that have more complex needs and are in poorer health, we have the capacity to monitor for some types of unintended consequences. For example, we currently assess rates of mortality at the facility level in the Dialysis Facility Compare program. This is an approach similar to that used on Hospital Compare, which publicly reports both mortality and readmissions rates for hospitals. In general, we note that mortality and readmission rates are positively correlated between dialysis facilities and in other settings, suggesting that reducing readmissions does not create increased risk to patients through ‘‘cherry picking’’. In addition, to date, we have not identified evidence that dialysis providers avoid doing business in areas of sociodemographic disadvantage. In fact, a recent study suggests the opposite among larger providers (Almachraki et al 2016). Moreover, we are committed to monitoring for this and other potential unintended consequence of the continued use of the SRR without sociodemographic adjustment.

In conclusion, we think the potential value to patients and other consumers of measuring and reporting the risk of readmission to the hospital within 30 days clearly outweighs the potential for adverse consequences as described above. We note that similar hospital readmission measures have been implemented in other post-acute care settings for quality reporting and value-based purchasing, including long-term care hospitals, inpatient rehabilitation facilities, and nursing homes. The value proposition for dialysis patients is likely to be similar to that for patients in these other facilities. As is the case for measures applied in other care settings, we

intend to monitor whether the implementation of this measure leads to unintended consequences.

8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables. This information may include the stratification variables, definitions, specific data collection items/responses, code/value sets, and the risk-model covariates and coefficients for the clinically-adjusted version of the measure when appropriate.

N/A

9. Please enter the details of the final statistical risk model and variables here.

To estimate the probability of 30-day unplanned readmission, we use a two-stage model, the first of which is a double random-effects logistic regression model. In this stage of the model, both dialysis facilities and hospitals are represented as random effects, and regression adjustments are made for a set of patient-level characteristics. From this model, we obtain the estimated standard deviation of the random effects of hospitals (Diggle et al 2002).

The second stage of the model is a mixed-effects logistic regression model, in which dialysis facilities are modeled as fixed effects and hospitals are modeled as random effects, with the standard deviation specified as equal to its estimates from the first model. The expected number of readmissions for each facility is estimated as the summation of the probabilities of readmission of all patients in this facility and assuming the national norm (i.e., the median) for facility effect. This model accounts for a given facility's case mix using the same set of patient-level characteristics as those in the first model.

The equations used in the measure calculation are as follows:

To estimate the probability of 30-day unplanned readmission, we use a two-stage approach. The main model, which produces the estimates used to calculate SRR, takes the form:

$$\log \frac{p_{ijk}}{1-p_{ijk}} = \gamma_i + \alpha_j + \beta^T Z_{ijk}\,, \qquad (1)$$

where p_{ijk} represents the probability of an unplanned readmission for the k^{th} discharge among patients from the i^{th} facility who are discharged from j^{th} hospital, and Z_{ijk} represents the set of patient-level characteristics. Here, $\gamma_i$is the fixed effect for facility and α_j is the random effect for hospital j. It is assumed that the α_js arise as independent normal variables (i.e., $\alpha_j \sim N(0, \sigma^2)$).

We then use the estimates from this model to calculate each facility's SRR:

$$SRR_i = \frac{O_i}{E_i} = \frac{O_i}{\sum_{j \in H(i)} \sum_{k=1}^{n_{ij}} \tilde{p}_{ijk}}, \qquad (2)$$

where, for the *i*th facility, O_i is the number of observed unplanned readmissions, E_i is the expected number of unplanned readmissions for discharges, $H(i)$ is the collection of indices of hospitals from which patients are discharged, and $\tilde{p}_{ijk}$ is the predicted probability of unplanned readmission under the national norm for each discharge. Specifically, $\tilde{p}_{ijk}$ takes the form

$$\tilde{p}_{ijk} = \frac{\exp(\widehat{\gamma_M} + \widehat{\alpha_j} + \hat{\beta}^T Z_{ijk})}{1 + \exp(\widehat{\gamma_M} + \widehat{\alpha_j} + \hat{\beta}^T Z_{ijk})}, \qquad (3)$$

which estimates the probability that a discharge from hospital *j* of an individual in facility *i* with characteristics Z_{ijk} would result in an unplanned readmission if the facility effect corresponded to the median of national facility effects, denoted by $\widehat{\gamma_M}$. Here, $\widehat{\alpha_j}$ and $\hat{\beta}$ are estimates from model (1). The sum of these probabilities is the expected number of unplanned readmissions E_i at facility *i*; e.g., the number of readmissions that would have been expected in facility i had they progressed to the readmissions at the same rate as the national population of dialysis patients.

Patient-Level Risk Adjustors

As mentioned previously, the model accounts for a set of patient-level characteristics:

- Sex
- Age
- Years on ESRD
- Diabetes as cause of ESRD
- BMI at incidence of ESRD
- Length (days) of index hospitalization
- Past-year comorbidities: We identify all unique ICD-9 diagnosis codes from each patient's prior year of Medicare claims. We group these diagnosis codes by diagnosis category using the Condition Categories (CCs) included in the CMS Hierachical Condition Categories (HCC) grouper. The CCs used in calculation of the SRR are:
    - CCs 177, 178: Amputation status
    - CC 108: COPD
    - CC 79: Cardiorespiratory failure/shock
    - CC 46: Coagulation defects & other specified hematological disorders
    - CCs 51, 52: Drug and alcohol disorders
    - CCs 25, 26: End-Stage Liver Disease
    - CC 109: Fibrosis of lung or other chronic lung disorders

  - CCs 67–69, 100, 101: Hemiplegia, paraplegia, paralysis
  - CC 158: Hip fracture/dislocation
  - CC 174: Major organ transplants (excl. kidney)
  - CC 7: Metastatic cancer/acute leukemia
  - CC 44: Other hematological disorders
  - CCs 6, 111–113: Other infectious disease & pneumonias
  - CCs 10–12: Other major cancers
  - CC 32: Pancreatic disease
  - CCs 54–56, 58, 60: Psychiatric comorbidity
  - CC 77: Respirator dependence/tracheostomy status
  - CC 38: Rheumatoid arthritis & inflammatory connective tissue disease
  - CC 74: Seizure disorders & convulsions
  - CC 2: Septicemia/shock
  - CCs 8,9: Severe cancer
  - CCs 1, 3–5: Severe infection
  - CCs 148, 149: Ulcers
- Discharged with high-risk condition: We define a *high-risk* diagnosis as any diagnosis area that was rare in our population but had a 30-day readmission rate of at least 40%. We did not include high-risk diagnosis groups related to cancer or mental health. We group these conditions using the Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications Software (CCS). The CCS areas identified as high-risk are:
  - CCS 5: HIV infection
  - CCS 6: Hepatitis
  - CCS 56: Cystic fibrosis
  - CCS 57: Immunity disorders
  - CCS 61: Sickle cell anemia
  - CCS 190: Fetal distress and abnormal forces of labor
  - CCS 151: Other liver diseases
  - CCS 182: Hemorrhage during pregnancy; abruptio placenta; placenta previa
  - CCS 186: Diabetes or abnormal glucose tolerance complicating pregnancy; childbirth; or the puerperium
  - CCS 210: Systemic lupus erythematosus and connective tissue disorders
  - CCS 243: Poisoning by nonmedicinal substances

10. Compare measure performance scores with and without SDS factors in the risk adjustment model. Include the method of testing conducted to compare performance scores with and without SDS factors in the risk adjustment model for the same entities, the statistical results from testing the differences in the performance scores with and without SDS factors in the risk adjustment model. (e.g., correlation, rank order) and provide an interpretation of your results in terms of the differences in performance scores with and without SDS factors in the risk adjustment model for the same entities.

We compared the effects of three different models with the original SRR model, finding that results from all three models were highly correlated:

- Sensitivity model 1 (original covariates + ADI): 0.99995 (p<0.0001); median difference -0.001
- Sensitivity model 2 (original covariates + patient race, ethnicity, employment status and Medicare coverage): 0.99895 (p<0.0001); median difference -0.001
- Sensitivity model 3 (original covariates + ADI + four patient-level factors): 0.99884 (p<0.0001); median difference -0.001

We also examined how the different modeling approaches changed how facilities were flagged in terms of their readmission performance. As shown in Tables 3a-c below, the flagging rate changed very minimally between the original SRR measure and each sensitivity model (weighted kappa $\geq$ 0.96 for all three models).

Table 3a. Facility performance on 2014 SRR, with and without adjusting for ADI (weighted kappa = 0.99)

	With ADI			
Original SRR	Better than Expected	As Expected	Worse than Expected	**Total**
Better than Expected	113	2	0	**115 (1.9%)**
As Expected	3	5811	5	**5819 (95.5%)**
Worse than Expected	0	7	150	**157 (2.6%)**
Total	**116 (1.9%)**	**5820 (95.6%)**	**155 (2.5%)**	—

Table 3b. Facility performance on 2014 SRR, with and without adjusting for selected patient-level SDS/SES factors* (weighted kappa = 0.96)

	With patient factors			
Original SRR	Better than Expected	As Expected	Worse than Expected	**Total**
Better than Expected	111	4	0	**115 (1.9%)**
As Expected	8	5794	17	**5819 (95.5%)**
Worse than Expected	0	18	139	**157 (2.6%)**
Total	**119 (2.0%)**	**5816 (95.49%)**	**156 (2.6%)**	—

*Medicare coverage at index discharge, employment status 6 months prior to ESRD onset, race and ethnicity.

Table 3c. Facility performance on 2014 SRR, with and without adjusting for all selected SES/SDS factors* (weighted kappa = 0.96)

	With all factors			
Original SRR	Better than Expected	As Expected	Worse than Expected	**Total**
Better than Expected	108	7	0	**115 (1.9%)**
As Expected	7	5798	14	**5819 (95.5%)**
Worse than Expected	0	20	137	**157 (2.6%)**
Total	**115 (1.9%)**	**5825 (95.6%)**	**151 (2.5%)**	—

*Patient factors are Medicare coverage at index discharge, employment status 6 months prior to ESRD onset, race and ethnicity.

These results show that facility profiling changes very little with the addition of these selected patient- or area-level SDS/SES factors. This empirical finding demonstrating very minimal differences, coupled with the risk of reducing patients' access to high quality care (see discussion in the response to Question 3), supports our recommendation to not adjust SRR for the selected SDS/SES factors.

11. Appendix (includes literature review, reference list, etc.)

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RTI INTERNATIONAL | Memorandum

To: NQF Standing Committee

From: RTI International

Date: May 2, 2016

Subject: Developer Response for NQF SDS Trial Period – IRF Readmission Measure NQF #2502

1. Enter measure # and title

Measure # 2502 All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs)

*2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

When considering risk-adjustment for sociodemographic variables, we (RTI International measure development contractors for CMS) considered the available literature across three post-acute care (PAC) settings for which we developed readmissions measures and are conducting analysis for NQF's SES trial period: Skilled Nursing Facilities (SNFs) for NQF #2510, Inpatient Rehabilitation Facilities (IRFs) for NQF #2502, and Long-Term Care Hospitals (LTCHs) for NQF #2512. CMS seeks to harmonize PAC measures as much as possible. Thus, our response to this question summarizes the relevant literature across PAC.

The potential relationship between SDS risk factors and the outcome of readmissions from institutional post-acute settings, including SNFs, IRFs and LTCHs, is plausible. The literature exploring this relationship is most developed and evidenced for SNFs. In addition to demonstrations of poorer performance on quality of care indicators and higher rates of readmission by race (Howard et al., 2002; Mor et al., 2004; Grabowski 2004; Silverstein et al., 2008; Jencks, Williams, and Coleman 2009), racial and socio-demographic disparities in the quality of nursing facilities have also been demonstrated. This evidence also suggests that these disparities arise from vulnerable populations being admitted disproportionately into poorer quality homes, not differential quality of care by race within the same facility (Mor et al., 2004; Cai, Mukamel, Temkin-Greener 2010). Mor et al. (2004), suggested that lack of resources to dedicate to quality improvement may contribute to systematically poorer quality of care among facilities serving minority and low SES residents.

The evidence in IRFs is mixed. Some studies have found neither sex nor race to be a significant indicator of acute rehospitalization from inpatient rehabilitation (Ottenbacher et al., 2012; Dossa, Glickman, & Berlowitz, 2011). Others have found ethnicity (Ottenbacher et al., 2001) to be indicative of post-IRF

readmissions for stroke patients. Older age has also been found to be a significant predictor of readmission for patients with hip fracture after discharge from IRF (Ottenbacher et al., 2003) The IRF literature does not explore the links between disparities in outcomes and facility quality or poorer quality of care. For LTCHs, the topic has not been specifically explored.

Evidence from the literature review suggests that socioeconomic status is a potential patient-level risk factor for readmissions. Patient-level sociodemographic variables available in the Medicare claims data include the following: age, sex, race, and dual eligibility indicators. The dual eligibility indicator is a categorical variable in the Master Beneficiary Summary File that indicates what category of dual eligibility the patient is classified as, based on varying levels of income and assistance received. The Original Reason for Entitlement variable, which captures the original reason the beneficiary qualified for Medicare benefits (e.g., age, disability or ESRD) is also available, and this variable allows us to adjust for beneficiaries that originally qualified for Medicare on the basis of disability.

The NQF-endorsed all-cause readmission measures (NQF #2510, 2502, 2512) for SNFs, IRFs, and LTCHs have always used age-sex group variables in risk adjustment. The LTCH and IRF models also utilize the Original Reason for Entitlement variable as a risk adjuster; however, for the SNFRM, we use a version of this variable coded as "Disabled as original reason for Medicare coverage" in the risk adjustment model.

We conducted analyses at the time of submission for NQF endorsement using race and dual status. Results of these analyses suggested possible differences in readmission rate based on these factors, suggesting that they may capture an underlying relationship and are potential candidates for inclusion in the SDS risk-adjustment testing for these measures. However, the strength of this empirical evidence varied by measure and SDS risk adjuster. In some cases, the SDS variables were predictive in the risk-adjustment model, but there appeared to be minimal impacts at the facility level. We further investigated this topic by expanding upon these analyses and conducted several additional analyses as part of the trial period.

Recently published literature has focused on the potential relationship between hospital readmissions and community or neighborhood-level socioeconomic characteristics that can serve as a proxy for individual-level factors. A small number of studies (Herrin et al, 2014; Kind et al, 2014; McHugh and Ma, 2013) have shown a relationship between county-level measures of low SDS (based on factors such as income, employment rate, education level, rate of home ownership and literacy) and increased rates of hospital readmission.

This conceptual rationale—that neighborhood or community characteristics including general access to resources within the community influence the likelihood of readmission—was used by the RTI team to identify potential county-level SDS factors for inclusion in the analysis. Because the Medicare County Code specifies county of residence and may be a more reliable geographic identifier for Medicare

beneficiaries than ZIP code over time, RTI focused on county-level measures of SDS for testing. The literature suggests a range of variables as possible measures of SES. Guided largely by the Singh Area Deprivation Index (ADI), which uses 17 U.S. census items to describe socioeconomic context and was used by Kind et al. (2014) and Barnett et al. (2015) to assess readmissions, RTI developed a set of poverty, education, housing, and employment items. Additionally, RTI included measures of access to care within counties, as done by Herrin et al. (2015) who used per Medicare beneficiary counts of general practitioners, specialists, and cardiologists, as well as ratios of general practitioners to specialists. RTI used the Area Health Resources Files to access several county characteristics, including those census items in the ADI, similar to work done by Sheingold et al. (2016).

In addition to the testing for beneficiary-level factors (e.g., dual eligibility and race/ethnicity), RTI tested a broad set of community characteristics for the SNF, IRF, and LTCH readmission measures' risk models, including the following: median household income, percent of residents with qualification for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment, non-English speakers, and levels of educational attainment. RTI also tested measures of provider supply and access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care, specialist, and physical therapist providers per capita.

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3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

Based on the results of our comprehensive SDS testing for this measure, our recommendation as measure developers is to make no changes to the specifications of NQF measure #2502 All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities at this time.

The results of our testing of both patient-level and county-level SDS factors were inconsistent. Specifically, we found that:

- Adjustment for SDS variables and combinations of SDS variables yielded generally inconsistent results; for example, several SDS variables were associated with lower odds of readmission when included in the model and others were not significant.
- We found that, overall, IRFs' performance on the measure with and without SDS adjustment was highly correlated, and that adjusting for these SDS factors and combinations of these factors did not have a substantial impact at the facility level.

Though we found that patient-level information on dual eligibility was significantly associated with lower odds of readmission, the results for the county-level risk adjusters were inconsistent. We found that

adjusting for SDS and dual eligibility had a small impact on facilities' performance on the measure and there was no remarkable change in the model's performance (i.e. *c*-statistic) with the addition of SDS risk factors. Given the inconsistency and limited impact of SDS risk adjustment on IRF's performance, particularly for SDS factors we tested where there is a plausible conceptual rationale as indicated in the literature, we believe that further study is warranted.

After considering the impact of the SDS factors selected, we also tested the impact of adjusting for race/ethnicity in our final models. Adjusting for race/ethnicity did not have a strong impact on the model results and measures of facility performance in these settings after adjusting for additional SDS factors, and as a result, we do not recommend adjusting for race/ethnicity. This is in line with the recommendation from the NQF that race/ethnicity not be used as a proxy for SDS, as the effects of race/ethnicity may be confounded by SDS and relevant factors such as income or education (which we tested at the county-level) and are more appropriate measures to consider when evaluating disparities in healthcare quality (NQF, 2015).

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*4. What were the statistical results of the analyses used to select risk factors?

This measure was developed to harmonize with the Hospital-Wide All-Cause Unplanned Readmission (HWR) measure (NQF #1789), and, as such, we used the same risk adjustment and statistical approach. We developed a hierarchical logistic regression model to predict the probability of an unplanned readmission. The risk adjusters are predictor variables. The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into IRFs. The statistical model estimates both the average predictive effect of the patient characteristics across all IRFs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. The facility effects are assumed to be randomly distributed around the average (according to a normal distribution). When computing the facility effect, hierarchical modeling accounts for the known predictors of readmissions, on average, such as patient characteristics, the observed facility rate, and the number of IRF stays included for the measure. The estimated facility effect is determined mostly by the facility's own data if the number of patient discharges is relatively large (as the estimate would be relatively precise), but is adjusted toward the average if the number of patient discharges is small (as that would yield an estimate of lower precision).

The estimated equation is used twice in the measure. The sum of the probabilities of readmission of all patients in the facility measure, including both the effects of patient characteristics and the IRF, is the "predicted number" of readmissions after adjusting for case mix. The same equation is used without the IRF effect to compute the "expected number" of readmissions for the same patients at the average IRF. The ratio of the predicted-to-expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This standardized risk ratio

(SRR) is then multiplied by the mean readmission rate for all IRF stays to get the risk-standardized readmission rate (RSRR) for each facility. This measure is calculated on 2 consecutive calendar years of fee-for-service claims data.

To test the impact of SDS variables for this measure, we began with risk-adjustment models based on clinical risk factors. The clinical risk factors used in the model were selected during the initial testing and measure development. Candidate risk factors were entered into a hierarchical logistic regression. RTI considered both statistical significance and predictive relationship with the dependent variable (all-cause readmission) in selecting clinical risk factors. This resulted in a final risk-adjustment model that included 204 variables. Risk factors for the model used to test the impact of SDS variables included:

- Age/sex categories
- Principal diagnosis on short-term bill (as in the HWR measure, grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model; the procedures are grouped using the CCS for ICD-9 procedures developed by AHRQ
- Receiving dialysis in prior short-term stay, defined by presence of revenue code
- Case-mix groups (from the IRF PPS)
- Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before facility admission (these are clustered using the CMS Hierarchical Condition Categories [HCC] groups)
- Original reason for entitlement being disability
- Prior Acute ICU/CCU Days
- Length of stay in the prior short-term hospital stay
- Count of stays in Prior Acute Care

Appendix Table A1 shows the final variables in the original model with their associated odds ratios and 95% confidence intervals. For the SDS testing, we used more recent data from calendar years 2012 and 2013.

*5. Describe the analyses and interpretation resulting in the decision to select SDS factors.

Methods:

In order to test SDS factors for this measure, we performed a number of analyses based on NQF guidance. These included assessing variation in prevalence of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk-adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. All testing was done in parallel for the SNF, IRF and LTCH readmission measures (NQF #2510, 2502, 2512) using the same SDS factors and methodology.

Variables related to SDS were identified via a search of available datasets. We examined the availability of SDS data at the patient-level and at the county-level both were based on the beneficiaries' residence and not the location of the provider.

Patient-Level. At the patient level, we examined Medicare/Medicaid dual status indicators and racial/ethnic identifiers. Indicators of dual status were abstracted from a special intermediary file from Medicare's Part D data[1] at the beneficiary level. The advantage of the Part D intermediary file is that it contains more detailed categories of dual eligibility status which is valuable because this variable is intended to capture low income status. In the previous analyses we conducted at the time of NQF submission we used a less detailed proxy for dual eligibility which was the state buy-in code from the Denominator file. The values we used for this Part D variable are listed below.

- 01 = Qualified Medicare Beneficiary (QMB) only
- 02 = QMB and full Medicaid coverage, including prescription drugs
- 03 = Specified Low-Income Medicare Beneficiary (SLMB) only
- 04 = SLMB and full Medicaid coverage including prescription drugs
- 05 = Qualified Disabled Working Individual (QDWI)
- 06 = Qualifying individuals (QI)
- 08 = Other dual eligible (not QMB, SLMB, QWDI, or QI) with full Medicaid coverage, including prescription drugs
- 09 = Other dual eligible, but without Medicaid coverage

[1] Note: Part D claims data are produced for all beneficiaries, regardless of whether they have Medicare Part D coverage

We conducted analyses using the 9 values above individually and also categorized these to create binary indicators as follows:

- **Any Dual Eligibility:** Indicates the presence of any of the above indicators. This variable captures any level of dual eligibility and is the most inclusive.
- **Full Dual Status:** Qualified Medicare Beneficiary (QMB) and full Medicaid coverage, Specified Low-Income Medicare Beneficiary (SLMB) Program and full Medicaid coverage, and other dual eligible with full Medicaid coverage. This variable indicates if a beneficiary has met certain low-income guidelines and receives full Medicaid benefits along with additional Medicare cost-sharing assistance.
- **Non-Medicaid Dual Status:** QMB only, SLMB only, Qualified Disabled Working Individuals (QWDI), Qualified Individual (QI), or other dual eligible *without* Medicaid coverage. These individuals qualify for dual eligibility based on either meeting low-income requirements or disability, but do not qualify for full Medicaid coverage.

Note: In merging the Part D intermediary data onto our analytic file we were unable to match approximately 2 percent of our sample.

The full dual indicator variable seemed to most accurately capture variation in SDS across beneficiaries. While each of the measures of dual eligibility were tested in this trial period, results for the models adjusting for full dual are the focus of our discussion.

County-Level. The county-level data we examined came from publicly available federal data sources including the American Community Survey, the Area Health Resources File (AHRF), and the U.S. Census. The measures we tested included all of the variables shown in ***Table 1*** from 2013. One benefit of testing the variables from the AHRF was that it provided some measures of health supply in beneficiaries' county of residence, which may be a contributor to disparities in quality of care, such as whether the county was a full or partial Health Professional Shortage Area (HPSA). We merged county-level data from 2013; when 2013 data were unavailable, we used the most recently available estimates. Variables were merged to the files using FIPS codes.

Table 1: County-Level SDS Factors Tested for PAC Hospital Readmission Measures (NQF #2510, 2502, and 2512)

Data Source	Variables
American Community Survey[2]	▪ Median household income ▪ Percent of individuals <138% of poverty level ▪ Percent of individuals 138-200% of poverty level ▪ Percent of people <200% of poverty level ▪ Percent of people <400% of poverty level ▪ Percent of county residents on SNAP benefits ▪ Median home value ▪ Percent of residents in county above 18 not English-speaking ▪ Percent of residents below age 18 who are disabled ▪ Percent of residents 18-64 who are disabled ▪ Percent of residents 65+ who are disabled ▪ Percent of residents with less than a High School diploma ▪ Percent of residents with more than a High School diploma ▪ Percent of residents with 4 or more years of college ▪ Percent Aged 16 and Above who are Employed ▪ Unemployment Rate for those Aged 16 and Above
Area Health Resources File[3]	▪ # of Primary care physicians per capita ▪ # of specialists (medical and surgical) per capita ▪ # of physical therapists/capita (last measured in 2009) ▪ Primary Care Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA) ▪ Mental Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA)

Source: RTI developed list of county-level variables used for SDS risk adjustment testing, 2016.
Note: 0.1% of beneficiaries did not successfully merge to the county-level variables based on the FIPS codes.

We conducted a series of analyses to determine both the relationship between SDS variables and our outcome of all-cause readmissions as well as the impact that including SDS variables has on facilities' risk-standardized readmission rates (RSRR). This involved the steps detailed below. (Note: each step was performed with and without the addition of the patient-level race/ethnicity using the RTI Race variable[4] which is also available in the Part D intermediary file described previously.)

1. We first summarized provider-level variation of selected SDS factors among IRF patients in our sample using data from 2013.
2. We then evaluated the impact on coefficients, distribution of RSRRs, and model fit after including the 9 patient-level dual status variables, as well as each individual dual status

2 Data available at: https://www.census.gov/acs/www/data/data-tables-and-tools/index.php

3 Data available from: http://ahrf.hrsa.gov/download.htm

4 Eicheldinger C, Bonito A. More Accurate Racial and Ethnic Codes for Medicare Administrative Data. Health Care Financing review 29(3): 27-42, 2008.

category indicator, as risk adjusters in both the original logistic and hierarchical models. In each of these and the following analyses, the logistic models were primarily used to evaluate the coefficients and odds ratios for each risk adjuster. The hierarchical models were used to then estimate the facility-level RSRRs.

3. Next, all county-level SDS variables and the full-dual indicator variable were added as risk-adjusters at once to the full logistic and hierarchical models in order to evaluate the strength of the variable coefficients and analyze any changes in the distribution of RSRRs.
4. For the entire sample, we then performed logistic regression analyses with stepwise variable selection on only the county-level and dual status variables (significance level = 0.2 for entry), while forcing the original risk-adjusters from the full model to stay in during the selection process.
5. We identified the group of SDS variables that had been selected across all three of the PAC readmissions models (for SNF, IRF, and LTCH) through stepwise selection, and included only that set of variables in the full logistic and hierarchical models in order to evaluate the impact of including the selected SDS variables on the model's performance and the distribution of RSRRs.
6. The RSRRs from the model adjusting for the set of SDS variables in the previous step were then further stratified by several key SDS variables at the facility-level in order to further examine the relationship between facility performance and proportion of patients with certain SDS factors. This was also done for the model that adjusted for full dual status only.
7. In addition, we evaluated the changes in facilities' RSRRs to determine the magnitude and how SDS adjustment impacted facilities' performance on the measure (i.e. resulting in better or worse performance).
8. We compared *c*-statistics across the base logistic risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model.
9. We ran Pearson correlations and created scatterplots allowing us to visually inspect the correlations between facilities' RSRRs with and without SDS adjustment.

Results

Patient-Level Results. We found wide variation in the share of dually eligible beneficiaries that IRFs treat. The median percentage of any dually eligible patients in IRFs was 16.7 percent (interquartile range [IQR]: 11.8-23.4%). Of the IRF population, 18.2 percent of beneficiaries had some form of dual eligibility. The largest group was QMB with full Medicaid coverage (9.3%), followed by other dual eligibility with full Medicaid coverage (2.9%).

We examined the strength and significance of each separate category of dual eligibility variables when added as risk-adjusters to the full logistic models, as shown in ***Appendix Table A2***. When we included all of these variables in the model together, only the QMB with full Medicaid coverage (OR: 1.05; 95% CI: 1.02-1.08) and other with full Medicaid coverage (OR: 1.08; 95% CI: 1.03 – 1.13) variables were statistically significant.

We also adjusted for each binary indicator of dual eligibility that reflected specific income and Medicaid-coverage based statuses; the results of each logistic model with the indicator variables added are shown in ***Appendix Table A3***. All dual status variables besides non-Medicaid Dual and SLMB were statistically significant when included on their own, with the greatest magnitude of effect seen for the full dual (OR: 1.07; 95% CI: 1.04-01.09) and any dual (OR: 1.07; 95% CI: 1.04-1.09) variables. The coefficients in these models were somewhat larger in magnitude as compared to the previous model.

Next, when we evaluated the distribution of facility-level RSRRs before and after adjustment for dual eligibility status based on the models adjusting for different categories of dual eligibility, as shown in ***Appendix Table A4***, the difference in RSRRs between the base model and the models including dual eligibility as a risk-adjuster was quite small (mean = 0.0). The RSRRs from the model that included the full dual status indicator variable had a mean difference of 0 as compared with the original model, and the magnitude of the difference ranged from -0.18 to +0.31 percentage points. Overall, the changes in distribution of RSRRs were consistent across all 5 models adjusting for dual eligibility indicator categories.

When only the full dual status was adjusted for in the model (categories: full dual, duals without full Medicaid[5], non-dually eligible as reference), the coefficient was relatively strong (0.0689; $p<0.001$), as shown in ***Table 2*** below.

Table 2: Model Adjustment for Full Dual Status (N = 565,990) – IRF Readmission Measure (NQF #2502)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Full Dual	0.0689	0.0125	<.0001	1.071	1.045	1.098
Duals without Full Medicaid	0.0522	0.018	0.0037	1.054	1.017	1.091

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_141213.xlsx).

Note: Std. Error=Standard error; OR=Odds ratio; LCL=Lower confidence limit; UCL=Upper confidence limit.

Based on these results with the patient-level variables for dual eligibility (which did not differ by adding race/ethnicity), we decided to utilize only the full dual eligibility indicator for all subsequent testing of the county-level variables.

[5] Duals without Full Medicaid coverage are dual eligible patients with Medicare coverage but not receiving Medicaid services; these individuals receive financial assistance from Medicaid only

County-Level Results. To test the county-level derived SDS variables, we began with a comprehensive model that included the entire set of selected county-level variables and the full-dual variable as risk-adjusters (in addition to the original risk adjusters). The coefficients for the full set of SDS variables are reported below in ***Table 3***, under the model with all SDS variable columns. In this model, three SDS risk adjusters were significant at the $p < 0.05$ significance level. However, we found that some indicators associated with "higher SES" had non-significant results not in the hypothesized direction ($n = 7$), highlighted in pink. Median household income was significant and in the opposite direction: higher median household income was associated with increased odds of readmission. We found that full dual eligibility was significantly positive in the model that adjusted for all SDS variables.

Table 3: Model Adjustment for All County-Level SDS Variables and Full Dual Variable (N = 564,605) – IRF Readmission Measure (NQF #2502)

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
Local Economic Conditions						
Median Household Income	0.0027	0.0013	0.0413	0.0023	0.0011	0.0332
Percent of Residents on SNAP benefits	0.0014	0.0015	0.3555	0.0016	0.0015	0.2844
Percent of Residents Employed	-0.0008	0.0018	0.6667	-0.0006	0.0018	0.7582
Unemployment Rate	0.0037	0.0028	0.1851	0.0043	0.0028	0.1211
Percent of individuals <138% of poverty level	0.0021	0.0039	0.5840	—	—	—
Percent of individuals 138-200% of poverty level	0.0027	0.0102	0.7896	0.0063	0.0092	0.4895
Percent of individuals 200-400% of poverty level	-0.0057	0.0051	0.2646	-0.0065	0.0049	0.1918
Median Home Value	-0.0004	0.0001	<.0001	-0.0004	0.0001	<.0001
Education (Reference Group: Percent of Residents with High School Diploma)						
Percent of Residents with less than a	-0.0009	0.0022	0.6886	-0.0007	0.0021	0.7487

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
High School Diploma						
Percent of Residents with 4+ Years of College	-0.0005	0.0015	0.7215	-0.0004	0.0014	0.7628
Language						
Percent of Residents Not Speaking English	-0.0019	0.0029	0.5012	-0.0020	0.0028	0.4715
Disability						
Percent of Residents <18 who are Disabled	Omitted for model convergence			-0.0004	0.0044	0.9260
Percent of residents 18-64 who are disabled	-0.0036	0.0030	0.2245	-0.0036	0.0033	0.2756
Percent of residents 65+ who are disabled	0.0031	0.0017	0.0625	0.0033	0.0016	0.0470
Health Care Supply						
Primary Care Providers Per Capita	9.2393	32.0237	0.7730	0.6898	29.5777	0.9814
Specialist Providers Per Capita	-4.7516	12.6511	0.7072	-3.6463	12.6283	0.7728
Physical Therapists Per Capita	9.2393	32.0237	0.7730	—	—	—
County is Partial Primary Care HPSA	-0.0300	0.0176	0.0873	-0.0261	0.0156	0.0947
County is Full Primary Care HPSA	-0.0050	0.0182	0.7815	-0.0016	0.0167	0.9259
County is Partial Mental Health HPSA	0.0108	0.0181	0.5512	—	—	—
County is Full Mental Health HPSA	0.0016	0.0182	0.9281	-0.0062	0.0112	0.5786
Dual Eligibility						

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
Full Dual	0.0687	0.0126	<.0001	0.0328	0.0201	0.1028
Any Dual	—	—	—	0.0414	0.0180	0.0218

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_71213.xlsx).Note: Pink shading indicates results in the opposite of the expected decision.

Next, based on the model results described above, we ran logistic regression models for all three PAC measures (NQF #2510, 2502, 2512) using stepwise variable selection in order to further refine the number of SDS variables tested for in the risk models. The results from all three measures were combined to identify a slightly more parsimonious set of SDS variables that could be utilized for additional testing. The group of SDS variables identified across all three measures are shown in ***Table 4***, categorized by data source.

Table 4: Variables selected by stepwise selection process for SNF, IRF, and LTCH Readmission Measures

Census Variables	Area Health Resource File Variables	Patient-Level Variables
▪ Median Home Value ▪ Median Household Income ▪ Unemployment Rate ▪ Percent Employed ▪ Percent of Residents Greater than 65 who are Disabled ▪ Percent of Residents 18-64 who are Disabled ▪ Percent of Residents Less Than 18 who are Disabled ▪ Percent of Residents with 4+ Years of College ▪ Percent of Residents with Less than High School Diploma ▪ Percent of Residents who are Non-English Speakers ▪ Percent of Residents Between 138 -200% of Poverty Level ▪ Percent of Residents Between 200 -400% of Poverty Level	▪ One or more Parts of County are Primary Care HPSA ▪ Full County is Primary Care HPSA ▪ Full County is Mental Health HPSA ▪ MD Specialists Per Capita ▪ Primary Care Providers Per Capita	▪ Any Dual Status ▪ Full Dual Status

Census Variables	Area Health Resource File Variables	Patient-Level Variables
▪ Percent of residents on SNAP Benefits		

When the variables identified above were added to the full model, the coefficients were similar in magnitude and direction as the full model with all SDS factors included, as shown in ***Table 3*** under the columns for model with SDS variables from stepwise selection. Despite paring down the set of SDS factors, we found similar results. Median household income was significant and in the opposite direction. Other SDS factors were not in the hypothesized direction and were not significant. In this model, the estimates for the full dual eligibility is consistent with the previous results; however when any dual eligibility is added to the model, full dual eligibility becomes a bit less significant.

We also examined the impact of adjusting for these three models (all SDS variables, SDS variables from stepwise selection, and full dual eligibility) on the distribution of RSRRs at the facility-level, as shown in ***Table 5*** below. In terms of the distribution of RSRRs after adjusting for these sets of variables, the results did not differ substantially from the base model RSRRs to those from the model adjusting for all SDS factors (mean difference = 0.1 percentage points, with a range from -0.7 to 1.0 percentage points). The mean difference in facility RSRR before and after adjusting for full dual eligibility only was 0.01 percentage points, with the maximum difference approximately 0.3 percentage points. On average, adjustment for full set of SDS factors and the refined set of SDS factors resulted improved performance on the measure. However, the average effect on RSRRs when adjusting only for dual eligibility was small, but positive suggesting worse facility performance.

Given the inconsistency of results when adjusting for SDS factors at the individual-level as reported previously (***Table 3***), it is difficult to conclude from these distributions whether facilities with changes in RSRRs were those serving disproportionate shares of beneficiaries with certain SDS factors. This analysis also does note tell us whether the net effects from these adjustments were appropriate.

Table 5: Distribution of RSRRs across facilities before and after adjustment for SDS variables – IRF Readmission Measure (NQF #2502)

Variable	N	Mean (%)	Std Error	Minimum (%)	25th Pctl (%)	Median (%)	75th Pctl (%)	Maximum (%)
Base Model RSRR	1,164	13.03	0.02	10.75	12.58	13.00	0.1345	0.1617
RSRR adjusted for All SDS Variables	1,163	13.05	0.616	10.98	12.67	13.00	13.39	15.94
Base RSRR Minus RSRR adjusted for All SDS Variables	1,163	0.009	0.176	-0.68	-0.087	0.012	0.102	0.962

RSRR adjusted for SDS Variables from Stepwise Selection	1,163	13.045	0.62	10.99	12.66	13.01	13.39	15.98
Base RSRR Minus RSRR adjusted for SDS Variables from Stepwise Selection	1,163	0.01	0.174	-0.664	-0.086	0.011	0.103	0.957
RSRR adjusted for Full Dual/Non-Full Dual/Non Dual	1,164	13.05	0.712	10.77	12.60	13.01	13.46	16.27
Base RSRR Minus RSRR adjusted for Full Dual/Non-Full Dual/Non-Dual	1,164	0.012	0.049	-0.273	-0.007	0.012	0.027	0.279

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_7_irf_diff.xlsx, sp42\sp42irf\sp42irf_14_irf_diff.xlsx).

Note: RSRR=Risk-standardized readmission rate.

In order to take a closer look at the relationship between facility performance and facilities serving beneficiaries from counties with certain SDS characteristics, the RSRRs from the model adjusting for the group of SDS variables from stepwise selection were then further stratified by several key SDS variables at the facility-level. In ***Table 6***, we see the variation in RSRRs across facilities stratified by high/low proportions of full dual patients, percent Non-English speakers in the county, percent with 4+ years of college in the county, and percent with income <138% of the federal poverty level in the county. These tables suggest that the variation in SDS-adjusted RSRRs is similar when stratified by these factors, with very few differences in the median, minimum, and maximum adjusted RSRRs.

For a more specific comparison of the facilities with differing populations of dually eligible patients, ***Table 7*** below presents RSRRs before and after risk-adjustment for full dual only and for the SDS variables from stepwise selection, stratified by quartiles based on the proportion of fully dual eligible residents in each facility. Once again, for all three models, there were not large differences as compared to the base model in the variation of the RSRRs across quartiles. For example, among facilities that treat the highest proportion of dually eligible patients, the mean RSRR was 13.06 percent with no SDS adjustment; 13.07 percent with full SDS adjustment (from stepwise), and 13.05 percent after adjusting only for dual eligibility.

Furthermore, given the inconsistency of the estimates for the SDS factors adjusted for (as reported in ***Table 3***), it is difficult to determine whether the net effect of this adjustment resulting in changes in RSRRs are result in a more accurate estimate of healthcare quality.

Table 6. Variation in SDS-Adjusted RSRRs across Measured Entities by Proportion of Full Dual Patients and Patients from Counties with Low SES – IRF Readmission Measure (NQF #2502)

Data Element	Low proportion fully dual eligible patients (≤34.5%)	High proportion fully dual eligible patients (>34.5%)	Low proportion Percent Non English speakers in County (≤1.41%)	High proportion Percent Non English speakers in County (≥1.41%)	Low proportion Percent with 4+ Years College in County (≤24%)	High proportion Percent with 4+ Years College in County (>24%)	Low proportion Percent <138% Poverty in County (≤13.1%)	High proportion Percent <138 Poverty in County (>13.1%)
Number of Facilities	582	582	584	580	584	580	588	576
Number of Patients	312,056	252,055	243,059	321,052	258,092	306,019	303,755	260,356
Mean RSRR	12.98%	13.09%	13.06%	13.01%	13.10%	12.97%	12.96%	13.11%
Maximum RSRR	15.61%	16.17%	16.17%	14.98%	16.17%	15.61%	15.32%	16.17%
90th percentile RSRR	13.89%	14.05%	14.04%	13.88%	14.03%	13.89%	13.88%	14.03%
75th percentile RSRR	13.38%	13.49%	13.48%	13.42%	13.49%	13.40%	13.37%	13.52%
Median (50th percentile) RSRR	12.96%	13.04%	12.99%	13.00%	13.03%	12.96%	12.95%	13.05%
25th percentile RSRR	12.52%	12.66%	12.58%	12.57%	12.67%	12.52%	12.51%	12.66%
10th percentile RSRR	12.11%	12.24%	12.20%	12.13%	12.24%	12.09%	12.07%	12.30%
Minimum RSRR	10.98%	10.75%	10.99%	10.75%	10.75%	10.98%	10.98%	10.75%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 20122013 (program reference: sp42\sp42irf\sp42irf_9_table_c.xlsx). Note: RSRR=Risk-standardized readmission rate.

Table 7. RSRRs stratified by % Full Duals in Facility (Base model vs. Model adjusted for Stepwise variables; model adjusted for Full Dual) – IRF Readmission Measure (NQF #2502)

Raw population readmission rate (all facilities): 13.02%								
Base Model RSRRs (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	271	12.99%	0.67%	10.97%	12.55%	13.00%	13.38%	14.98%
25th %ile - Median Full_Dual_Prop	252	12.96%	0.73%	10.99%	12.50%	12.92%	13.35%	15.61%
Median - 75th %ile Full_Dual_Prop	294	13.11%	0.75%	11.25%	12.66%	13.04%	13.55%	16.17%
75th %ile - Max Full_Dual_Prop	347	13.06%	0.71%	10.75%	12.64%	13.03%	13.46%	15.33%
RSRRs after adjusting for SDS variables from Stepwise Selection (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	270	13.03%	0.59%	11.69%	12.62%	13.03%	13.37%	14.72%
25th %ile - Median Full_Dual_Prop	252	12.98%	0.64%	11.09%	12.60%	12.92%	13.33%	15.30%
Median - 75th %ile Full_Dual_Prop	294	13.09%	0.64%	11.41%	12.72%	13.05%	13.47%	15.98%
75th %ile - Max Full_Dual_Prop	347	13.07%	0.61%	10.99%	12.68%	13.02%	13.41%	15.09%
RSRRs after adjusting for Full Dual/Dual without Full Medicaid/Non-Medicaid (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	271	13.03%	0.67%	11.04%	12.59%	13.01%	13.43%	14.93%
25th %ile - Median Full_Dual_Prop	252	12.98%	0.73%	10.99%	12.52%	12.94%	13.36%	15.69%
Median - 75th %ile Full_Dual_Prop	294	13.12%	0.74%	11.17%	12.67%	13.04%	13.55%	16.27%
75th %ile - Max Full_Dual_Prop	347	13.05%	0.70%	10.77%	12.64%	13.02%	13.46%	15.33%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_10_c.xlsx). Note: RSRR=Risk-standardized readmission rate.

*6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach.

Methods:

For all three measures, we created hierarchical logistic regression models that added patient- and county-level SDS variables to the risk-adjustment models in use for the all-cause readmission quality measures for each respective setting. In order to evaluate models with all SDS variables added, we performed stepwise versions of logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. We then evaluated the *c*-statistic for each model.

The *c*-statistic is equal to the area under a receiver operating characteristic (ROC) curve. The ROC curve graphs the hit rate of a predictive model against the false alarm rate of that model in a unit square. If the hit rate of a model is always equal to the false alarm rate, then the area under the curve is 0.5 and the model is no better than chance at predicting a binary outcome. If the hit rate of a model is always 1.0, then so is the area under the curve. Thus, the *c*-statistic ranges between 0.5 and 1.0, with larger values indicating increased predictive power.

Results:

We compared *c*-statistics across the base risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model (c-statistics for each of the models with race/ethnicity included are not shown, but did not differ significantly). There was essentially no difference between the SDS-adjusted and base models, suggesting that adding these SDS factors do not result in much improvement in model fit. The stepwise regression models for the model with all patient- and county-level variables included had a c-statistic of 0.70. The original model had a c-statistic of 0.70, so no improvement was observed with the addition of SDS-related predictors.

Table 8: C-Statistics of Readmission Models with SDS Risk-Adjustment – IRF (NQF #2502)

SNF Readmission Model	C-Statistic
Original Model	0.70
Original Model + Full Dual/Dual without Medicaid/Non-Medicaid	0.70
Original Model + All SDS Vars + Full Dual	0.70
Original Model + All SDS Vars Chosen through Stepwise Regression	0.70

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_18_irf1213.xlsx).

*7. Discuss the risks for misuse of the specified performance measure.

Since this measure was NQF-endorsed in December 2014, it was adopted by CMS for the IRF Quality Reporting Program for public reporting which will begin in late 2016. As described in our measure submission materials, no unintended or negative consequences were identified during the measure development and testing. We have not identified any unintended consequences during the ongoing evaluation or testing associated with the NQF trial period. However, since this measure has not yet been publicly reported, our ability to fully conduct analysis is somewhat limited.

We note that one potential unintended consequence that should be monitored is that IRFs may be deterred from admitting certain patients or types of patients with higher acuity or greater complexity, as they may be more likely to have a subsequent readmission post IRF discharge; this behavior might occur despite the risk adjustment. If so, this could result in barriers to access for some Medicare beneficiaries who may otherwise benefit from inpatient rehabilitation. Another potential unintended consequence is that IRFs could increase the rate at which they transfer patients back to the acute care setting in order to exclude these transfers from the measure denominator. These potential issues could be mitigated by training, and making it clear that there is no expectation of a perfect score (where no patients are ever readmitted). We remain committed to the ongoing monitoring and evaluation for these potential unintended consequences for this measures.

Through the federal rulemaking process to adopt this measure for the QRP, we received numerous comments on the topic of risk adjusting for SDS. The primary concern has been that not risk adjusting for SDS factors will penalize facilities that treat larger numbers of patients with marginalized SDS. However, we have not found consistent and sufficient evidence to demonstrate that adjusting for these factors impacts facilities' performance on this measure.

*8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables.

N/A

*9. Please enter the details of the final statistical risk model and variables here.

Risk-adjustment variables include demographic and eligibility characteristics; principal diagnoses; types of surgery or procedure from the prior short-term stay; comorbidities; length of stay and ICU/CCU utilization from the immediately prior short-term stay; and number of admissions in the year preceding the IRF admission. This measure also risk adjusts for function using the IRF case-mix groups associated with the IRF Prospective Payment System (PPS).

Following are the final set of risk adjustment variables for this measure:

- Age/sex categories
- Original reason for Medicare entitlement (age, disability or ESRD)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the Clinical Classification Software (CCS) classes for ICD-9 procedures developed by the Agency for Healthcare Research and Quality (AHRQ)*
- Receiving dialysis in prior short-term stay, defined by presence of revenue code
- Principal diagnosis on prior short-term bill as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ.
- IRF case-mix groups
- Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before IRF admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS)
- Length of stay in the prior short-term hospital stay (categorical to account for nonlinearity)
- Prior acute ICU/CCU utilization (days) (categorical)
- Count of prior short-term discharges in the 365 days before the IRF admission (categorical)

*Note: Measure development was conducted using ICD-9 data; however, we are currently incorporating our ICD-9/ICD-10 crosswalks for claims data submitted after ICD-10 implementation (i.e., October 1, 2015). When finalized, RTI will make this information available as part of the measure specifications.

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*10. Compare measure performance scores with and without SDS factors in the risk adjustment model.

The analyses presented in our response to Question 5 allowed us to focus on the impact and significance of the SDS variables in the context of the multivariable model. The addition of these variables had little to no effect on mean facility performance. Further, the impact of the SDS variables and the extent to which they accurately capture SDS for this measure's outcome were unclear from the model results.

We also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise selection was approximately 0.01 percentage points (***Table 5***) suggesting a small net decrease in performance on average. The effect was similar after adjusting only for dual eligibility.

Next, we more closely examined the net changes in facilities scores after SDS adjustment in order to determine the number of facilities whose performance improved or worsened and by how much. In ***Table 9***, we summarize the results of facilities' changes in RSRRs. We found that the impact of adjusting for dual eligibility only was small: no facilities' performance improved or declined by more than 1 percentage point. However, more facilities' scores worsened than improved (approximately 68% versus 32%). We observed slightly more movement after adjusting for the refined set of SDS factors. Specifically, the performance of 0.3 percent of facilities improved by between one half and 1 percentage point, and 1.3 percent of facilities' scores worsened by between one half and 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise model). Results from both analyses suggest that performance for the majority of facilities declined as a result of the additional SDS adjustment.

Table 9: Summary of Incremental Changes in RSRRs across Facilities (N = 1,163) – IRF Readmissions (NQF #2502)

Model	Direction	Value	# of facilities	% of facilities
Full Dual	Improved	< .002	367	31.6
		0.002-0.005	4	0.3
		0.005-0.01	0	0
		>= 0.01	0	0
	Worsened	< .002	790	67.9
		0.002-0.005	3	0.3
		0.005-0.01	0	0
		>= 0.01	0	0
SDS Variables from Stepwise Selection	Improved	< .002	424	36.5
		0.002-0.005	111	9.5
		0.005-0.01	4	0.3
		>= 0.01	0	0
	Worsened	< .002	510	43.9
		0.002-0.005	99	8.5
		0.005-0.01	15	1.3
		>= 0.01	0	0

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_71213.xlsx).

Lastly, we examined the correlations of the original and SDS risk-adjusted RSRRs across facilities, as shown in ***Table 10*** and ***Figures 1 and 2***. The high degree of correlation between the RSRRs (>0.97 for all three SDS-adjusted models that are the focus of this work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different.

Table 10: Correlations of Original and SDS Risk-Adjusted Facility-Level RSRRs – IRF Readmission Measure (NQF #2502)

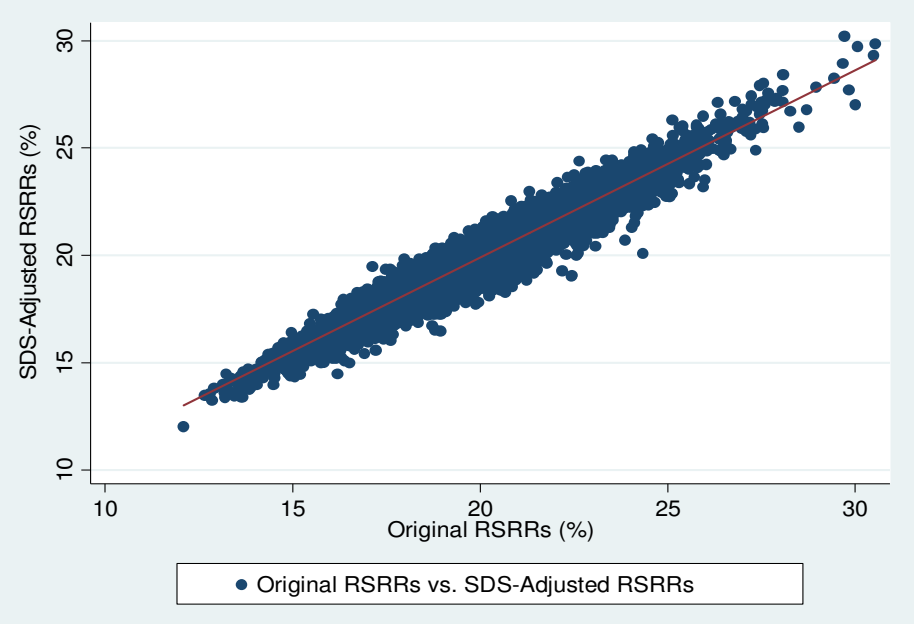
Model	Pearson Correlation*
All SDS Variables	0.9763
SDS Variables from Stepwise Selection	0.9765
Full Dual	0.9977

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013.

Note: RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status.

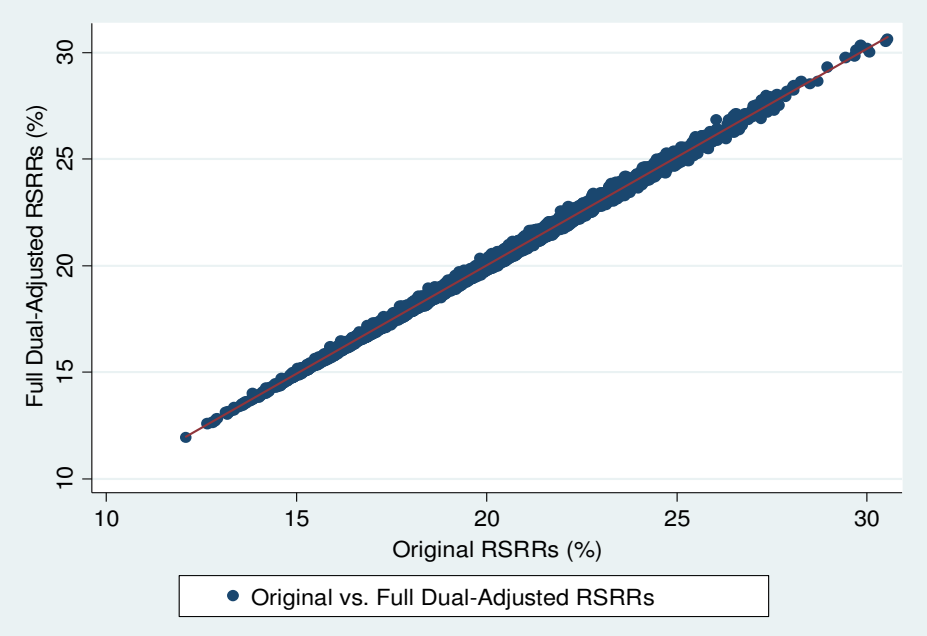
* $p < .0001$ for each model

Figure 1: Scatterplot of Original RSRRs and RSRRs Adjusted for All SDS Variables – IRF Readmission Measure (NQF #2502)



Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42irf_71213.xlsx).Note: There were 1,163 IRFs included in this analysis. SDS-Adjusted refers to the fully adjusted model with all 25 county-level SDS factors and full dual eligibility. RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status.

Figure 2: Scatterplot of Original RSRRs and RSRRs Adjusted for Full Dual Status – IRF Readmission Measure (NQF #2502)



Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: sp42\sp42snf\sp41_14_14_diff.xlsx).

Note: There were 1,163 IRFs included in this analysis. SDS-Adjusted refers to the fully adjusted model with all 25 county-level SDS factors and full dual eligibility. RSRR=Risk-standardized readmission rate.

11. APPENDIX

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Appendix Tables

Table A1: Final IRF Readmission Model Variables from NQF-Endorsed Model, 2010-2011

Risk Adjuster	Odds Ratio	P-value
Age-Sex Groups (Reference group: Male 18-54)		
Male age 55-59	1.036	0.3888
Male age 60-64	1.064	0.1008
Male age 65-69	1.055	0.0908
Male age 70-74	1.104	0.0017
Male age 75-79	1.209	<.0001
Male age 80-84	1.306	<.0001
Male age 85-89	1.368	<.0001
Male age 90+	1.539	<.0001
Female age 18-54	1.120	0.0017
Female age 55-59	1.056	0.1753
Female age 60-64	1.118	0.0024
Female age 65-69	1.115	0.0006
Female age 70-74	1.155	<.0001
Female age 75-79	1.186	<.0001
Female age 80-84	1.264	<.0001
Female age 85-89	1.345	<.0001
Female age 90+	1.475	<.0001
CCS Groupings - Based on principle diagnosis (Reference group includes Nerv Syst (84-94); Ot joint osteo (204, 206); Pregnancy (176-196); SprainSuperfic (232,239))		
Circ Syst: AMI & Cardiac arrst (100, 107)	1.556	<.0001
Resp Syst: Adlt Resp Fl (131)	1.373	<.0001
Circ Syst: Aneurysm (115)	1.307	<.0001
Fx arm (229)	1.227	<.0001
Circ Syst: Art embolism & Ot circul dx (116-117)	1.326	<.0001
Resp Syst: Asp Pneumonia (129)	1.433	<.0001
Back problem (205)	1.191	<.0001
Biliary Dx, Liver Dx, Other Liver Dx, Pancreas (149-152)	1.371	<.0001
Diseases of blood and blood-forming organs (56-57, 59-64)	1.521	<.0001

Circ Syst: CHF; NONHP (108)	1.609	<.0001
Resp Syst: COPD & Asthma (127-128)	1.772	<.0001
Circ Syst: CVD (109-111, 113)	1.313	<.0001
Circ Syst: Carditis & Other hart dx (97, 104)	1.350	0.0013
Circ Syst: Heart Valve (96)	1.418	<.0001
Circ Syst: HTN & Htn complicn (98-99)	1.404	<.0001
Complic Devi & Complic Proc (237-238)	1.411	<.0001
Circ Syst: Conduction & Dysrhythmia (105-106)	1.512	<.0001
Congenital Anomalies: 213-217	1.175	0.1069
Circ Syst: Coron Athero & Chest pain (101-102)	1.519	<.0001
Crush Injury (234)	1.265	0.0066
Diabetes based on 49-50	1.378	<.0001
Diseases of Digestive System (135-144, 146-148, 154-155)	1.475	<.0001
Endocrine includes 48, 51, 53, 54	1.519	<.0001
Dis Nerv Syst: Epilepsy/CNV (83)	1.309	<.0001
Fluid/elc dx (55)	1.456	<.0001
GI Hemorrhag (153)	1.275	<.0001
Gangrene (from Sx, Sign, Ill-defined conditions) (248)	1.660	<.0001
Diseases of the genitourinary system (156, 160-166, 168-175)	1.497	<.0001
Fx hip (226)	1.285	<.0001
Infect Arth (201)	1.304	0.0004
Infectious and parasitic diseases (1, 3-10)	1.390	<.0001
Digestive System-Int Obstruct (145)	1.257	<.0001
Intracrn Inj (233)	1.301	<.0001
Joint injury (225)	1.417	0.0021
Fx leg (230)	1.130	0.0011
Dis Nerv Syst: Meningitis, Encephalitis, Other CNS infx (76-78)	1.502	<.0001
Mental Illness (650-670)	1.224	0.0006
Secondary Malignant Neoplasm (42)	2.102	<.0001
Neoplasms-Benign (44-47) Neoplasms-Low (22-26, 28-31, 36)	1.509	<.0001
Neoplasms-Hi (16-17, 19, 27, 35	1.912	<.0001
Neoplasms-Medium (11-15, 18, 20-21, 32-34, 37-41, 43)	1.510	<.0001

Nutrit defic and oth nutrit dx (52, 58)	1.492	<.0001
Opn wnd head & extrem (235-236), Burns (240), Other Inj (244)	1.186	0.0277
Ot bone dx (212)	1.283	<.0001
Dis Nerv Syst: Oth Nerv Dx (95)	1.317	<.0001
Dis Nerv Syst: Parkinsons, MS, Ot hered CNS, Paralysis(79-82)	1.271	<.0001
Patholog Fx (207)	1.726	<.0001
Circ Syst: Perip Athero (114)	1.608	<.0001
Circ Syst: Phlebitis, Vericose vn, Hemorrhoids, Oth vein dx (118-121)	1.433	<.0001
Resp Syst: Pneum, Influ, Bronc, Ot up rsp (122-123, 125-126)	1.457	<.0001
Circ Syst: Pulm hart dx (103)	1.215	0.0012
Genitourinary: Ac & Chr renl fail (157-158)	1.577	<.0001
Resp Syst: Pleurisy, Lung externl, Oth low resp, Ot uppr resp, Tonsillitis (124, 130, 132-134)	1.485	<.0001
Rheum arth (202), SLE (210), OtConnTiss (211)	1.331	<.0001
Spin cor inj (227)	1.617	<.0001
Infect & Paras Dx: Septicemia (2)	1.330	<.0001
Diseases of the skin and subcutaneous tissue (167, 197-200)	1.477	<.0001
Fx skull fac (228) and Oth fracture (231)	1.279	<.0001
Symptoms, Signs, and Ill-Defined Conditions & Factors influencing health status (no gangrene) (245-247, 249-259)	1.432	<.0001
Circ Syst: TIA (112)	1.315	<.0001
Genitourinary: UTI (159)	1.448	<.0001
Surgical Groups		
General surgery, Obstetrics/Gynecology, and urologic surgical Procedures	0.872	<.0001
Cardio Thoracic	0.896	<.0001
Otolaryngology	0.828	0.0151
Plastic Surgery	0.978	0.4679
Dialysis Indicator		
Dialysis in acute hospital where HCC133 not indicated	1.065	0.0907
Modified Case-Mix Group (CMG) Groupings (Reference group: Fracture of lower extremity (M>42.15)(M>34.15 and M<42.15)(M>28.15 and M<34.15) & Replacement of lower extremity joint (M>49.44)(M>37.05 <49.55)(M>28.65 M<37.05 A>83.5)(M>28.65 M<37.05 A<83.5)		

Stroke: Motor score >44.45 (CMGs: 0101-0103)	1.154	0.0003
Stroke: Motor score 26.15-44.45 (CMGs: 0104-0107)	1.386	<.0001
Stroke: Motor score 22.35-26.15 (CMGs: 0108-0109)	1.712	<.0001
Stroke: Motor score <22.35 and Age <84.5 (CMG: 0110)	1.816	<.0001
Traumatic brain injury: Motor score >28.75 (CMGs: 0201-0205)	1.360	<.0001
Traumatic brain injury: Motor score <28.75 (CMGs: 0206-0207)	1.622	<.0001
Non-traumatic brain injury: Motor score >35.05 (CMGs:0301-0302)	1.378	<.0001
Non-traumatic brain injury: Motor score <35.05 (CMGs:0303-0304)	1.615	<.0001
Traumatic spinal cord injury: All (CMGs: 0401-0405)	1.269	<.0001
Non-traumatic spinal cord injury: Motor score >31.25 (CMGs: 0501-0503)	1.224	<.0001
Non-traumatic spinal cord injury: Motor score <31.25 (CMGs: 0504-0506)	1.454	<.0001
Neurological: Motor score >37.35 (CMGs: 0601-0602)	1.377	<.0001
Neurological: Motor score <37.35 (CMGs: 0603-0604)	1.609	<.0001
Fracture of lower extremity: Motor score <28.15 (CMG: 0704)	1.312	<.0001
Replacement of lower extremity joint: Motor score <28.65 (CMGs: 0805-0806)	1.399	<.0001
Other orthopedic: Motor score >24.15 (CMGs: 0901-0903)	1.076	0.0505
Other orthopedic: Motor score <24.15 (CMG: 0904)	1.500	<.0001
Amputation, lower extremity: Motor score >36.25 (CMGs:1001-1002)	1.337	<.0001
Amputation, lower extremity: Motor score <36.25 (CMG:1003) & Amputation, non-lower extremity: All (CMGs: 1101-1102)	1.460	<.0001
Osteoarthritis: All (CMGs: 1201-1203)	1.521	<.0001
Rheumatoid, Other arthritis: All (CMGs: 1301-1303)	1.560	<.0001
Cardiac: Motor score >38.55 (CMGs: 1401-1402)	1.353	<.0001
Cardiac: Motor score <38.55 (CMGs: 1403-1404) & Pulmonary: Motor score <39.05 (CMGs: 1503-1504)	1.703	<.0001

Pulmonary: Motor score >39.05 (CMGs: 1501-1502)	1.551	<.0001
Pain syndrome: All (CMGs: 1601-1603)	1.458	<.0001
Major multiple trauma without brain or spinal cord injury: All (CMGs: 1701-1704)	1.202	<.0001
Major multiple trauma with brain or spinal cord injury; All (CMGs: 1801-1803)	1.176	0.0342
Guillain Barre: All (CMGs; 1901-1903)	1.089	0.4318
Miscellaneous: All (CMGs: 2001-2004); Burns (CMG 2101); Short-stay cases (CMG: 5001)	1.538	<.0001
Comorbidities - Hierarchical Condition Categories (HCCs)*		
Septicemia, Sepsis, Systemic Inflamm Response Syndrome/Shock (HCC2), Bacterial, Fungal, and Parasitic CNS Infx (HCC3), Viral/Late Effects CNS Infx (HCC4), Other Infx Dis (HCC7)	0.993	0.5962
Metastatic Cancer and Acute Leukemia	1.341	<.0001
Lung and Other Severe Cancers/Other Respiratory and Heart Neoplasms	1.295	<.0001
Lymphoma and Other Cancers	1.167	<.0001
Diabetes with Acute Complications/Diabetes with Chronic Complications/Diabetes without Complication/Type I Diabetes Mellitus	1.058	<.0001
Protein-Calorie Malnutrition	1.043	0.0056
Morbid Obesity	1.059	0.0026
Other Significant Endocrine and Metabolic Disorders	1.080	0.0002
Disorders of Fluid/Electrolyte/Acid-Base Balance	1.058	<.0001
Disorders of Lipoid Metabolism	0.909	<.0001
End-Stage Liver Disease	1.373	<.0001
Cirrhosis of Liver	1.199	<.0001
Chronic Hepatitis	1.156	0.0114
Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	1.100	<.0001
Bone/Joint/Muscle Infections/Necrosis	0.898	<.0001
Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	1.114	<.0001
Disorders of the Vertebrae and Spinal Discs	0.961	0.0031
Osteoporosis and Other Bone/Cartilage Disorders	0.945	<.0001

Congenital/Developmental Skeletal and Connective Tissue Disorders/ Other Musculoskeletal and Connective Tissue Disorders	0.944	<.0001
Severe Hematological Disorders	1.188	<.0001
Coagulation Defects and Other Specified Hematological Disorders	1.030	0.0619
Delirium and Encephalopathy	1.018	0.2297
Dementia With Complications/ Dementia Without Complication	1.070	<.0001
Schizo/Major Depressive/Reactive and Unspecified Psychosis/Personality/Depression/Anxiety/Other Psychiatric Disorders	1.028	0.0045
Amyotrophic Lateral Sclerosis and Other Motor Neuron Disease	1.321	0.0724
Cerebral Palsy	0.787	0.0281
Polyneuropathy/ Mononeuropathy, Other Neurological Conditions/Injuries	1.039	0.0025
Parkinson's and Huntington's Diseases	0.962	0.0777
Seizure Disorders and Convulsions	1.064	0.0017
Congestive Heart Failure	1.109	<.0001
Acute Myocardial Infarction	1.196	<.0001
Unstable Angina and Other Acute Ischemic Heart Disease	1.103	0.0076
Coronary Atherosclerosis/Other Chronic Ischemic Heart Disease	1.068	<.0001
Valvular and Rheumatic Heart Disease	0.979	0.1026
Major Congenital Cardiac/Circulatory Defect/ Other Congenital Heart/Circulatory Disease	0.873	0.0072
Hypertensive Heart Disease	0.904	0.0030
Hypertension	0.932	<.0001
Specified Heart Arrhythmias	1.095	<.0001
Hemiplegia/Hemiparesis	0.956	0.0012
Atherosclerosis of the Extremities with Ulceration or Gangrene	1.092	0.0247
Vascular Disease with Complications	1.071	0.0199
Vascular Disease	1.039	0.0040
Chronic Obstructive Pulmonary Disease	1.167	<.0001
Fibrosis of Lung and Other Chronic Lung Disorders	1.063	0.0617

Pneumococcal Pneumonia, Empyema, Lung Abscess/Viral and Unspecified Pneumonia, Pleurisy	1.016	0.3041
Pleural Effusion/Pneumothorax	1.086	<.0001
Other Respiratory Disorders	0.938	<.0001
Legally Blind	1.107	0.0500
Glaucoma	0.880	<.0001
Kidney Transplant Status	1.657	<.0001
End Stage Renal Disease	1.492	<.0001
Acute Renal Failure	1.238	<.0001
Chronic Kidney Disease, Stage 5	1.546	<.0001
Chronic Kidney Disease, Severe (Stage 4)	1.348	<.0001
Chronic Kidney Disease, Moderate (Stage 3)	1.104	<.0001
Chronic Kidney Disease, Mild or Unspecified (Stages 1-2 or Unspecified)	1.137	<.0001
Urinary Obstruction and Retention	1.038	0.0371
Urinary Tract Infection	1.044	0.0002
Other Urinary Tract Disorders	1.054	0.0079
Male Genital Disorders	0.964	0.0156
Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone/ Pressure Ulcer of Skin with Full Thickness Skin Loss	1.099	0.0384
Cellulitis, Local Skin Infection	1.046	0.0421
Vertebral Fractures without Spinal Cord Injury	1.067	0.0315
Hip Fracture/Dislocation	1.049	0.1516
Major Fracture, Except of Skull, Vertebrae, or Hip	0.924	0.0224
Other Organ Transplant Status/Replacement	0.833	0.0432
Artificial Openings for Feeding or Elimination	1.187	<.0001
Post-Surgical States/Aftercare/Elective	0.948	<.0001
Supplemental Oxygen	1.222	<.0001
Original Reason for Entitlement Codes		
Original reason for entitlement: 1-Disability Insurance Benefits (DIB)	1.117	<.0001
Prior Acute ICU/CCU Days (Reference group: 0 ICU/CCU days)		
1-3 ICU/CCU days associated with prior acute stay	1.052	<.0001

4-6 ICU/CCU days associated with prior acute stay	1.068	<.0001
7-9 ICU/CCU days associated with prior acute stay	1.068	<.0001
10-13 ICU/CCU days associated with prior acute stay	1.048	0.0282
14-20 ICU/CCU days associated with prior acute stay	1.076	0.0061
21+ ICU/CCU days associated with prior acute stay	1.074	0.0427
Prior Acute Care Length of Stay (Reference group: LOS when prior acute was inpatient psychiatric facility)		
Prior Acute Length of Stay 1-3 days	1.078	0.5798
Prior Acute Length of Stay 4-5 days	1.161	0.2699
Prior Acute Length of Stay 6-8 days	1.290	0.0594
Prior Acute Length of Stay 9-13 days	1.420	0.0096
Prior Acute Length of Stay 14-30 days	1.489	0.0034
Prior Acute Length of Stay 30+ days	1.621	0.0006
Prior Acute Care Utilization-Count of prior stays		
1 Stay - Acute history	1.513	<.0001
2 Stays - Acute history	1.832	<.0001
3 Stays - Acute history	2.380	<.0001
4 Stays - Acute history	2.626	<.0001
5 Stays - Acute history	3.064	<.0001
6 Stays - Acute history	3.732	<.0001
7 Stays - Acute history	3.773	<.0001
8 Stays - Acute history	3.967	<.0001
9 Stays - Acute history	4.105	<.0001
10+ Stays - Acute history	5.398	<.0001

Note: Number of observations: 2010/2011: 590,120. There were 79,553 in 2010/2011 unplanned readmissions. The c-statistic was .69.

Source: RTI International analysis of Medicare claims data, 2007-2012. (RTI program reference: lc22_irf_gv150910.xlsx; lc22_lc22_irf0910par.xlsx; lc22_irf_gv15_mean_0910.xlsx; lc22_irf_gv151011.xlsx; lc22_lc22_irf1011par.xlsx; lc22_irf_gv15_mean_1011.xlsx)

* HCCs are derived from the prior acute claim secondary diagnoses or all inpatient claims in the year prior to the IRF admission.

Table A2: Model Adjustment for All 9 Dual Status Categories (N = 555,108) – IRF (NQF #2502)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Intercept	-3.5916		-3.5916			
QMB (01)	0.008774			0.008774		
QMB w/ Medicaid (02)		0.02547			0.02547	
SLMB (03)		0.7305			0.7305	
SLMB w Medicaid (04)		1.009			1.009	
QUAL (06)		0.96			0.96	
Other w/ Medicaid (08)		1.06			1.06	
Other (09)						

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: DB19)

Note: Only 1 stay was QDWI (05), so it was moved to the Baseline so the model would converge. Hence Baseline consists of INT_DUAL_STUS_CD=NA (Non-Medicaid) and the 1 QDWI stay.

Table A3: Model Adjustment for Dual Status Indicators – IRF (NQF #2502)

Model	N	Variable Tested	Estimate	Std. Error	P Value	OR	LCL	UCL
Base Model: SNFRM 2013	564,111	Intercept	-3.591	0.1351	<.0001			
Base + Any Dual	564,111	Any Dual	0.06373	0.0112	<.0001	1.066	1.043	1.089
Base + Full Dual	564,111	Full Dual	0.06458	0.01247	<.0001	1.067	1.041	1.093
Base + Non Medicaid Dual	555,108	Non- Dual	0.02712	0.01784	0.1285	1.027	0.992	1.064
Base + QMB	555,108	QMB	0.0452	0.01312	0.0006	1.046	1.02	1.073
Base + SLMB	555,108	SLMB	0.02463	0.02549	0.3339	1.025	0.975	1.077

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: DB19).

Table A4: Distribution of RSRRs across Facilities before and after adjustment for dual status

Variable	N	Mean	Std Error	Minimum	25th Pctl	Median	75th Pctl	Maximum
Base Model RSRR	1,164	13.03	0.02	10.75	12.58	13.00	13.45	16.17
RSRR account for Any Dual	1,164	13.03	0.02	10.77	12.58	13.00	13.45	16.17
Base RSRR – RSRR Any Dual	1,164	0	0	-0.05	-0.01	0	0	0.23
RSRR account for Full Dual	1,164	13.03	0.02	10.75	12.58	13.00	13.45	16.19
Base RSRR – RSRR Full Dual	1,164	0	0	-0.05	-0.01	0	0	0.25
RSRR account for Non Medicaid Dual	1,164	13.02	0.02	10.74	12.58	13.00	13.43	16.26
Base RSRR – RSRR Non Medicaid Dual	1,164	0.01	0	-0.16	-0.03	0	0.05	0.30
RSRR account for QMB	1,164	13.02	0.02	10.73	12.58	13.00	13.43	16.30
Base RSRR – RSRR QMB	1,164	0.01	0	-0.17	-0.03	0	0.05	0.30
RSRR account for SLMB	1,164	13.02	0.02	10.74	12.57	13.00	13.43	16.27
Base RSRR – RSRR SLMB	1,164	0.01	0	-0.18	-0.03	0	0.05	0.31

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2502, based on index IRF admissions in CY 2012-2013 (program reference: DB19).

RTI INTERNATIONAL | Memorandum

To: NQF Standing Committee

From: RTI International

Date: May 2, 2016

Subject: Developer Response for NQF SDS Trial Period – Measure NQF #2510

1. Enter measure # and title

Measure # 2510 Skilled Nursing Facility 30-Day All-Cause Readmission Measure (SNFRM)

*2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

When considering risk-adjustment for sociodemographic variables, we (RTI International measure development contractors for CMS) considered the available literature across three post-acute care (PAC) settings for which we developed readmissions measures and are conducting analysis for NQF's SES trial period: Skilled Nursing Facilities (SNFs) for NQF #2510, Inpatient Rehabilitation Facilities (IRFs) for NQF #2502, and Long-Term Care Hospitals (LTCHs) for NQF #2512. CMS seeks to harmonize PAC measures as much as possible. Thus, our response to this question summarizes the relevant literature across PAC.

The potential relationship between SDS risk factors and the outcome of readmissions from institutional post-acute settings, including SNFs, IRFs and LTCHs, is plausible. The literature exploring this relationship is most developed and evidenced for SNFs. In addition to demonstrations of poorer performance on quality of care indicators and higher rates of readmission by race (Howard et al., 2002; Mor et al., 2004; Grabowski 2004; Silverstein et al., 2008; Jencks, Williams, and Coleman 2009), racial and socio-demographic disparities in the quality of nursing facilities have also been demonstrated. This evidence also suggests that these disparities arise from vulnerable populations being admitted disproportionately into poorer quality homes, not differential quality of care by race within the same facility (Mor et al., 2004; Cai, Mukamel, Temkin-Greener 2010). Mor et al. (2004), suggested that lack of resources to dedicate to quality improvement may contribute to systematically poorer quality of care among facilities serving minority and low SES residents.

The evidence in IRFs is mixed. Some studies have found neither sex nor race to be a significant indicator of acute rehospitalization from inpatient rehabilitation (Ottenbacher et al., 2012; Dossa, Glickman, & Berlowitz, 2011). Others have found ethnicity (Ottenbacher et al., 2001) to be indicative of post-IRF readmissions for stroke patients. Older age has also been found to be a significant predictor of

readmission for patients with hip fracture after discharge from IRF (Ottenbacher et al., 2003) The IRF literature does not explore the links between disparities in outcomes and facility quality or poorer quality of care. For LTCHs, the topic has not been specifically explored.

Evidence from the literature review suggests that socioeconomic status is a potential patient-level risk factor for readmissions. Patient-level sociodemographic variables available in the Medicare claims data include the following: age, sex, race, and dual eligibility indicators. The dual eligibility indicator is a categorical variable in the Master Beneficiary Summary File that indicates what category of dual eligibility the patient is classified as, based on varying levels of income and assistance received. The Original Reason for Entitlement variable, which captures the original reason the beneficiary qualified for Medicare benefits (e.g., age, disability or ESRD) is also available, and this variable allows us to adjust for beneficiaries that originally qualified for Medicare on the basis of disability.

The NQF-endorsed all-cause readmission measures (NQF #2510, 2502, 2512) for SNFs, IRFs, and LTCHs have always used age-sex group variables in risk adjustment. The LTCH and IRF models also utilize the Original Reason for Entitlement variable as a risk adjuster; however, for the SNFRM, we use a version of this variable coded as "Disabled as original reason for Medicare coverage" in the risk adjustment model.

We conducted analyses at the time of submission for NQF endorsement using race and dual status. Results of these analyses suggested possible differences in readmission rate based on these factors, suggesting that they may capture an underlying relationship and are potential candidates for inclusion in the SDS risk-adjustment testing for these measures. However, the strength of this empirical evidence varied by measure and SDS risk adjuster. In some cases, the SDS variables were predictive in the risk-adjustment model, but there appeared to be minimal impacts at the facility level. We further investigated this topic by expanding upon these analyses and conducted several additional analyses as part of the trial period.

Recently published literature has focused on the potential relationship between hospital readmissions and community or neighborhood-level socioeconomic characteristics that can serve as a proxy for individual-level factors. A small number of studies (Herrin et al, 2014; Kind et al, 2014; McHugh and Ma, 2013) have shown a relationship between county-level measures of low SDS (based on factors such as income, employment rate, education level, rate of home ownership and literacy) and increased rates of hospital readmission.

This conceptual rationale—that neighborhood or community characteristics including general access to resources within the community influence the likelihood of readmission—was used by the RTI team to identify potential county-level SDS factors for inclusion in the analysis. Because the Medicare County Code specifies county of residence and may be a more reliable geographic identifier for Medicare beneficiaries than ZIP code over time, RTI focused on county-level measures of SDS for testing. The

literature suggests a range of variables as possible measures of SES. Guided largely by the Singh Area Deprivation Index (ADI), which uses 17 U.S. census items to describe socioeconomic context and was used by Kind et al. (2014) and Barnett et al. (2015) to assess readmissions, RTI developed a set of poverty, education, housing, and employment items. Additionally, RTI included measures of access to care within counties, as done by Herrin et al. (2015) who used per Medicare beneficiary counts of general practitioners, specialists, and cardiologists, as well as ratios of general practitioners to specialists. RTI used the Area Health Resources Files to access several county characteristics, including those census items in the ADI, similar to work done by Sheingold et al. (2016).

In addition to the testing for beneficiary-level factors (e.g., dual eligibility and race/ethnicity), RTI tested a broad set of community characteristics for the SNF, IRF, and LTCH readmission measures' risk models, including the following: median household income, percent of residents with qualification for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment, non-English speakers, and levels of educational attainment. RTI also tested measures of provider supply and access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care, specialist, and physical therapist providers per capita.

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3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

Based on the results of our comprehensive SDS testing for this measure, our recommendation as measure developers is to make no changes to the specifications of NQF measure #2510 Skilled Nursing Facility 30-Day All-Cause Readmission Measure (SNFRM) at this time.

The results of our testing of both patient-level and county-level SDS factors were inconsistent. Specifically, we found that:

- Adjustment for SDS variables and combinations of SDS variables yielded generally inconsistent results; for example, several SDS variables, including dual eligibility, were associated with lower odds of readmission when included in the model and others were not significant.
- We found that, overall, SNFs performance on the SNFRM with and without SDS adjustment was highly correlated, and that adjusting for these SDS factors and combinations of these factors did not have a substantial impact at the facility level.

Given the inconsistency and uncertain impact of SDS risk adjustment on SNFs' performance on this measure, particularly for SDS factors we tested where there is a plausible conceptual rationale as indicated in the literature, we believe that further study is warranted.

At the county or neighborhood level, the role of different SDS factors (such as the health supply variables we tested) may impact readmissions differently, creating additional challenges in recommending a one-size-fits-all approach to SDS risk adjustment. This is particularly of concern with adjusting for dual eligibility, as the relationship between dual eligibility and readmissions as assessed in this measure may be specific to the setting or the readmission window. Specifically, in the SNF setting, dual eligibility may be indicative of receiving long-term nursing home care rather than reflective of specific SDS factors (i.e. low income). We also believe that the 30-day readmission risk window for the SNFRM—which, in the majority of cases, captures hospital readmissions directly from the SNF in addition to capturing readmissions post-SNF discharge—is another relevant aspect of the measure's specifications. SDS factors may be more salient for readmissions that take place post-SNF discharge since SDS factors may come into play more directly for patients being readmitted from the community. SDS factors such as inadequate access to care or poor nutrition should be at least somewhat mitigated while patients are directly receiving inpatient SNF care. With this rationale, adjusting for dual eligibility would not improve the SNFRM model's assessment of quality differences. Additionally, the goodness of fit of the model (i.e. *c*-statistic) was not remarkably improved with the addition of SDS risk factors.

After considering the impact of the SDS factors selected, we also tested the impact of adjusting for race/ethnicity in our final models. Adjusting for race/ethnicity did not have a strong impact on the model results and measures of facility performance in these settings after adjusting for additional SDS factors, and as a result, we do not recommend adjusting for race/ethnicity. This is in line with the recommendation from the NQF that race/ethnicity not be used as a proxy for SDS, as the effects of race/ethnicity may be confounded by SDS and relevant factors such as income or education (which we tested at the county-level) and are more appropriate measures to consider when evaluating disparities in healthcare quality (NQF, 2015).

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*4. What were the statistical results of the analyses used to select risk factors?

This measure was developed to harmonize with the Hospital-Wide All-Cause Unplanned Readmission (HWR) measure (NQF #1789), and, as such, we used the same risk adjustment and statistical approach (Smith, West, Coots et al., 2015). We developed a hierarchical logistic regression model to predict the probability of an unplanned readmission. The risk adjusters are predictor variables. The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into SNFs. The statistical model estimates both the average predictive effect of the patient characteristics across all SNFs and the degree to which each facility has an effect on readmissions that

differs from that of the average facility. The facility effects are assumed to be randomly distributed around the average (according to a normal distribution). When computing the facility effect, hierarchical modeling accounts for the known predictors of readmissions, on average, such as patient characteristics, the observed facility rate, and the number of SNF stays included for the measure. The estimated facility effect is determined mostly by the facility's own data if the number of patient discharges is relatively large (as the estimate would be relatively precise), but is adjusted toward the average if the number of patient discharges is small (as that would yield an estimate of lower precision).

The estimated equation is used twice in the measure. The sum of the probabilities of readmission of all patients in the facility measure, including both the effects of patient characteristics and the SNF, is the "predicted number" of readmissions after adjusting for case mix. The same equation is used without the SNF effect to compute the "expected number" of readmissions for the same patients at the average SNF. The ratio of the predicted-to-expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This standardized risk ratio (SRR) is then multiplied by the mean readmission rate for all SNF stays to get the risk-standardized readmission rate (RSRR) for each facility. The SNFRM is calculated on 1 calendar year of fee-for-service claims data.

To test the impact of SDS variables for this measure, we began with risk-adjustment models based on clinical risk factors. The clinical risk factors used in the model were selected during the initial testing and measure development. Candidate risk factors were entered into a hierarchical logistic regression. RTI considered both statistical significance and predictive relationship with the dependent variable (all-cause readmission) in selecting clinical risk factors. This resulted in a final risk-adjustment model that included 309 variables. Risk factors for the SNFRM model used to test the impact of SDS variables included:

- Age/Sex categories
- Original reason for Medicare entitlement is disability
- End-stage renal disease (ESRD)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the Clinical Classification Software (CCS) classes for ICD-9 procedures developed by the Agency for Healthcare Research and Quality (AHRQ)*
- Principal diagnosis on prior proximal hospitalization as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ.
- Comorbidities from secondary diagnoses on the prior proximal hospital claim and diagnoses from earlier acute care hospitalizations up to 1 year before SNF admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS)]
- Presence of multiple comorbidities, modeled using two variables: (a) the count of HCCs if count is >2 and (b) the square of this count of HCCs
- Length of stay during prior proximal hospitalization (categorical to account for nonlinearity)

- Any time spent in the intensive care unit (ICU) during the prior proximal hospitalization
- Number of acute care hospitalizations in the 365 days prior to the prior proximal hospitalization (categorical)

Appendix Table A1 shows the final variables in the original model with associated OR and 95% CI. For the SDS testing, we used more recent data from calendar year 2013.

*5. Describe the analyses and interpretation resulting in the decision to select SDS factors.

Methods:

In order to test SDS factors for this measure, we performed a number of analyses based on NQF guidance. These included assessing variation in prevalence of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk-adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. All testing was done in parallel for the SNF, IRF and LTCH readmission measures (NQF #2510, 2502, 2512) using the same SDS factors and methodology.

Variables related to SDS were identified via a search of available datasets. We examined the availability of SDS data at the patient-level and at the county-level both were based on the beneficiaries' residence and not the location of the provider.

Patient-Level. At the patient level, we examined Medicare/Medicaid dual status indicators and racial/ethnic identifiers. Indicators of dual status were abstracted from a special intermediary file from Medicare's Part D data[1] at the beneficiary level. The advantage of the Part D intermediary file is that it contains more detailed categories of dual eligibility status which is valuable because this variable is intended to capture low income status. In the previous analyses we conducted at the time of NQF submission we used a less detailed proxy for dual eligibility which was the state buy-in code from the Denominator file. The values we used for this Part D variable are listed below.

- 01 = Qualified Medicare Beneficiary (QMB) only
- 02 = QMB and full Medicaid coverage, including prescription drugs
- 03 = Specified Low-Income Medicare Beneficiary (SLMB) only
- 04 = SLMB and full Medicaid coverage including prescription drugs
- 05 = Qualified Disabled Working Individual (QDWI)
- 06 = Qualifying individuals (QI)
- 08 = Other dual eligible (not QMB, SLMB, QWDI, or QI) with full Medicaid coverage, including prescription drugs
- 09 = Other dual eligible, but without Medicaid coverage

[1] Note: Part D claims data are produced for all beneficiaries, regardless of whether they have Medicare Part D coverage

We conducted analyses using the 9 values above individually and also categorized these to create binary indicators as follows:

- **Any Dual Eligibility:** Indicates the presence of any of the above indicators. This variable captures any level of dual eligibility and is the most inclusive.
- **Full Dual Status:** Qualified Medicare Beneficiary (QMB) and full Medicaid coverage, Specified Low-Income Medicare Beneficiary (SLMB) Program and full Medicaid coverage, and other dual eligible with full Medicaid coverage. This variable indicates if a beneficiary has met certain low-income guidelines and receives full Medicaid benefits along with additional Medicare cost-sharing assistance.
- **Non-Medicaid Dual Status:** QMB only, SLMB only, Qualified Disabled Working Individuals (QWDI), Qualified Individual (QI), or other dual eligible *without* Medicaid coverage. These individuals qualify for dual eligibility based on either meeting low-income requirements or disability, but do not qualify for full Medicaid coverage.

Note: In merging the Part D intermediary data onto our analytic file we were unable to match approximately 1 percent of our sample.

The full dual indicator variable seemed to most accurately capture variation in SDS across beneficiaries. While each of the measures of dual eligibility were tested in this trial period, results for the models adjusting for full dual are the focus of our discussion.

County-Level. The county-level data we examined came from publicly available federal data sources including the American Community Survey, the Area Health Resources File (AHRF), and the U.S. Census. The measures we tested included all of the variables shown in ***Table 1*** from 2013. One benefit of testing the variables from the AHRF was that it provided some measures of health supply in beneficiaries' county of residence, which may be a contributor to disparities in quality of care, such as whether the county was a full or partial Health Professional Shortage Area (HPSA). We merged county-level data from 2013; when 2013 data were unavailable, we used the most recently available estimates. Variables were merged to the files using FIPS codes.

Table 1: County-Level SDS Factors Tested for PAC Hospital Readmission Measures (NQF #2510, 2502, and 2512)

Data Source	Variables
American Community Survey[2]	▪ Median household income ▪ Percent of individuals <138% of poverty level ▪ Percent of individuals 138-200% of poverty level ▪ Percent of people <200% of poverty level ▪ Percent of people <400% of poverty level ▪ Percent of county residents on SNAP benefits ▪ Median home value ▪ Percent of residents in county above 18 not English-speaking ▪ Percent of residents below age 18 who are disabled ▪ Percent of residents 18-64 who are disabled ▪ Percent of residents 65+ who are disabled ▪ Percent of residents with less than a High School diploma ▪ Percent of residents with more than a High School diploma ▪ Percent of residents with 4 or more years of college ▪ Percent Aged 16 and Above who are Employed ▪ Unemployment Rate for those Aged 16 and Above
Area Health Resources File[3]	▪ # of Primary care physicians per capita ▪ # of specialists (medical and surgical) per capita ▪ # of physical therapists/capita (last measured in 2009) ▪ Primary Care Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA) ▪ Mental Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA)

Source: RTI developed list of county-level variables used for SDS risk adjustment testing, 2016.
Note: 0.1% of beneficiaries did not successfully merge to the county-level variables based on the FIPS codes.

We conducted a series of analyses to determine both the relationship between SDS variables and our outcome of all-cause readmissions as well as the impact that including SDS variables has on facilities' risk-standardized readmission rates (RSRR). This involved the steps detailed below. (Note: each step was performed with and without the addition of the patient-level race/ethnicity using the RTI Race variable[4] which is also available in the Part D intermediary file described previously.)

1. We first summarized provider-level variation of selected SDS factors among SNF patients in our sample using data from 2013.
2. We then evaluated the impact on coefficients, distribution of RSRRs, and model fit after including the 9 patient-level dual status variables, as well as each individual dual status

2 Data available at: https://www.census.gov/acs/www/data/data-tables-and-tools/index.php

3 Data available from: http://ahrf.hrsa.gov/download.htm

4 Eicheldinger C, Bonito A. More Accurate Racial and Ethnic Codes for Medicare Administrative Data. Health Care Financing review 29(3): 27-42, 2008.

category indicator, as risk adjusters in both the original logistic and hierarchical models. In each of these and the following analyses, the logistic models were primarily used to evaluate the coefficients and odds ratios for each risk adjuster. The hierarchical models were used to then estimate the facility-level RSRRs.

3. Next, all county-level SDS variables and the full-dual indicator variable were added as risk-adjusters at once to the full logistic and hierarchical models in order to evaluate the strength of the variable coefficients and analyze any changes in the distribution of RSRRs.
4. For the entire sample, we then performed logistic regression analyses with stepwise variable selection on only the county-level and dual status variables (significance level = 0.2 for entry), while forcing the original risk-adjusters from the full model to stay in during the selection process.
5. We identified the group of SDS variables that had been selected across all three of the PAC readmissions models (for SNF, IRF, and LTCH) through stepwise selection, and included only that set of variables in the full logistic and hierarchical models in order to evaluate the impact of including the selected SDS variables on the model's performance and the distribution of RSRRs.
6. The RSRRs from the model adjusting for the set of SDS variables in the previous step were then further stratified by several key SDS variables at the facility-level in order to further examine the relationship between facility performance and proportion of patients with certain SDS factors. This was also done for the model that adjusted for full dual status only.
7. In addition, we evaluated the changes in facilities' RSRRs to determine the magnitude and how SDS adjustment impacted facilities' performance on the measure (i.e. resulting in better or worse performance).
8. We compared *c*-statistics across the base logistic risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model.
9. We ran Pearson correlations and created scatterplots allowing us to visually inspect the correlations between facilities' RSRRs with and without SDS adjustment.

Results

Patient-Level Results. We found wide variation in the share of dually eligible beneficiaries that SNFs treat. The median percentage of any dually eligible patients in SNFs was 39.6 percent (interquartile range [IQR]: 22.4-59.5%). Of the SNF population, 37.6 percent of beneficiaries had some form of dual eligibility. The largest group was QMB with full Medicaid coverage (15.7%), followed by other dual eligibility with full Medicaid coverage (11.8%).

We examined the strength and significance of the dual eligibility categories individually when each was added as a risk adjuster in the full logistic models, as shown in ***Appendix Table A2***. When we included all dual variables in the model simultaneously, only the SLMB (OR: 1.04; 95% CI: 1.01-1.07), SLMB with full Medicaid coverage (OR: 0.95; 95% CI: 0.93-0.97) and Other with full Medicaid coverage (OR: 0.94; 95% CI: 0.93-0.95) variables were statistically significant. Notably, the latter two were associated with reduced the odds of readmission when included in the model.

We also adjusted for each binary indicator of dual eligibility that reflected specific income and Medicaid-coverage based statuses; the results of each logistic model with the indicator variables added are shown in ***Appendix Table A3***. All dual status variables were statistically significant when included individually, with the greatest magnitude of effect found for the Full Dual (OR: 0.97; 95% CI: 0.96-0.98) and Non-Medicaid dual (OR: 1.04; 95% CI: 1.02-1.06) variables. Our results indicated that full dual status was protective or associated with decreased odds of readmission relative to patients with no dual eligibility. The coefficients in these models were somewhat larger in magnitude as compared to the previous models.

Next, when we evaluated the distribution of facility-level RSRRs before and after adjustment for dual eligibility status based on the models adjusting for different categories of dual eligibility, as shown in ***Appendix Table A4***, the difference in RSRRs between the base model and the models including dual eligibility was quite small (the mean difference rounded to 0.0). The RSRRs from the model that included the full dual eligibility also had a mean difference of 0 as compared with the original model, but the magnitude of the difference ranged from -1.3 to +4.1 percentage points (positive differences indicate facilities performed worse after SDS adjustment). Overall, the changes in distribution of RSRRs were consistent across all 5 models adjusting for the various dual eligibility categories.

When only full dual status was accounted for in the model (categories: full dual, duals without full Medicaid[5], and non-duals as referent), the coefficient on full dual eligibility was again negative (-0.0754; $p<0.001$), as shown in ***Table 2*** below.

Table 2: Model Adjustment for Full Dual Status (N = 2,104,813) – SNFRM (NQF #2510)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Full Dual	-0.0754	0.0043	<0.0001	0.927	0.92	0.935
Duals without Full Medicaid	-0.0222	0.0093	0.0177	0.978	0.96	0.996

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_14_sp41_15.xlsx).

Note: Std. Error=Standard error; OR=Odds ratio; LCL=Lower confidence limit; UCL=Upper confidence limit.

Based on these results with the patient-level variables for dual eligibility (which did not differ by adding race/ethnicity), we decided to utilize only the full dual eligibility indicator for all subsequent testing of the county-level variables.

[5] Duals without Full Medicaid coverage are dual eligible patients with Medicare coverage but not receiving Medicaid services; these individuals receive financial assistance from Medicaid only

County-Level Results. To test the county-level derived SDS variables, we began with a comprehensive model that included the entire set of selected county-level variables and the full-dual variable as risk-adjusters (in addition to the original risk adjusters). The coefficients for the full set of SDS variables are reported below in ***Table 3***, under the model with all SDS variable columns. In this model, several (n = 11) SDS risk adjusters were significant at the $p < 0.05$ significance level. However, we found that some indicators associated with "higher SES" had results not in the expected direction (n = 9). For example, beneficiaries living in counties with higher median household incomes had lower odds of readmission relative to beneficiaries in counties with lower median household incomes. Of the 10 SDS factors that were not in the expected direction, five were significant at $p < 0.05$. In addition to household income, partial primary care HPSA and full primary care HPSA were also negative suggesting that beneficiaries in counties with shortages of primary care providers had lower odds of readmission compared to beneficiaries in non-shortage areas. Specialist providers per capita was positive and significant suggesting that higher per capita specialists in a county was associated with higher odds of readmission. We also found that full dual eligibility was significantly and negative in the model that adjusted for all SDS variables. For ease of interpretation, we highlighted in pink the SDS factors with estimates that were not expected based on our conceptual model and literature review.

Table 3: Model Adjustment for All County-Level SDS Variables and Full Dual Variable (n = 2,009,557) – SNFRM (NQF #2510)

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
Local Economic Conditions						
Median Household Income	0.0042	0.000627	<.0001	0.004009	0.000513	<.0001
Percent of Residents on SNAP benefits	0.004384	0.000751	<.0001	0.004502	0.000717	<.0001
Percent of Residents Employed	-0.00617	0.000888	<.0001	-0.00598	0.000882	<.0001
Unemployment Rate	-0.00024	0.001388	0.8652	-0.00005	0.001361	0.9708
Percent of individuals <138% of poverty level	0.000668	0.001926	0.7288	—	—	—
Percent of individuals 138-200% of poverty level	0.001495	0.005219	0.7746	0.001942	0.004622	0.6743
Percent of individuals 200-400% of poverty level	0.000845	0.002534	0.7388	0.000452	0.002446	0.8534
Median Home Value	-0.00023	0.000042	<.0001	-0.00022	0.000041	<.0001
Education (Reference Group: Percent of Residents with High School Diploma)						
Percent of Residents with less than a High School Diploma	-0.00112	0.001064	0.293	-0.0012	0.001058	0.2554
Percent of Residents with 4+ Years of College	0.000254	0.00072	0.7238	0.000288	0.000679	0.6718

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
Language						
Percent of Residents Not Speaking English	0.006413	0.001485	<.0001	0.006551	0.001479	<.0001
Disability						
Percent of Residents <18 who are Disabled	Omitted for model convergence			-0.00139	0.00216	0.5212
Percent of residents 18-64 who are disabled	-0.00265	0.001512	0.0799	-0.00213	0.001633	0.1924
Percent of residents 65+ who are disabled	0.004775	0.000836	<.0001	0.004774	0.000819	<.0001
Health Care Supply						
Primary Care Providers Per Capita	-117.73	15.0466	<.0001	-117.05	14.13	<.0001
Specialist Providers Per Capita	48.0471	5.6906	<.0001	48.558	5.665	<.0001
Physical Therapists Per Capita	0.8633	14.0441	0.951	—	—	—
County is Partial Primary Care HPSA	-0.02429	0.008732	0.0054	-0.01894	0.007842	0.0158
County is Full Primary Care HPSA	-0.03845	0.009212	<.0001	-0.0335	0.008573	<.0001
County is Partial Mental Health HPSA	0.01288	0.008901	0.148	—	—	—
County is Full Mental Health HPSA	0.007505	0.00909	0.409	-0.00301	0.0057	0.5978
Dual Eligibility						
Full Dual	-0.03623	0.004512	<.0001	-0.05299	0.009659	<.0001
Any Dual	—	—	—	0.01866	0.009479	0.049

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program references: sp42\sp42snf\sp413_glimmix.xlsx, sp42\sp42snf\sp41_77_glimmix.xlsx).

Note: Pink shading indicates results in the opposite of the expected direction.

Next, based on the model results described above, we ran logistic regression models for all three PAC measures (NQF #2510, 2502, 2512) using stepwise variable selection in order to further refine the number of SDS variables tested for in the risk models. The results from all three measures were combined to identify a slightly more parsimonious set of SDS variables that could be utilized for additional testing. The group of SDS variables identified across all three measures are shown in ***Table 4***, categorized by data source.

Table 4: Variables selected by stepwise selection process for SNF, IRF, and LTCH Readmission Measures

Census Variables	Area Health Resource File Variables	Patient-Level Variables
▪ Median Home Value ▪ Median Household Income ▪ Unemployment Rate ▪ Percent Employed ▪ Percent of Residents Greater than 65 who are Disabled ▪ Percent of Residents 18-64 who are Disabled ▪ Percent of Residents Less Than 18 who are Disabled ▪ Percent of Residents with 4+ Years of College ▪ Percent of Residents with Less than High School Diploma ▪ Percent of Residents who are Non-English Speakers ▪ Percent of Residents Between 138 -200% of Poverty Level ▪ Percent of Residents Between 200 -400% of Poverty Level ▪ Percent of residents on SNAP Benefits	▪ One or more Parts of County are Primary Care HPSA ▪ Full County is Primary Care HPSA ▪ Full County is Mental Health HPSA ▪ MD Specialists Per Capita ▪ Primary Care Providers Per Capita	▪ Any Dual Status ▪ Full Dual Status

When the variables identified above were added to the full SNFRM model, the coefficients were similar in magnitude and direction as the full model with all SDS factors included, as shown in ***Table 3*** under the columns for model with SDS variables from stepwise selection. Despite paring down the set of SDS factors, we found similar results. Consistent with our previous results, estimates for multiple SDS factors (highlighted in pink) were not consistent with the expected relationship between low SES and increased odds of readmission. Specifically, household income, per capita specialist providers, primary care shortage areas, and dual eligibility remained significant and in the opposite direction. In the model

derived from stepwise selection, we risk adjusted for dual eligibility using full dual status and any dual status as selected by the stepwise selection process. In this model, the estimates for the full dual eligibility is consistent with the previous results. The negative estimate for any dual eligibility may indicate that dually eligible beneficiaries that do not receive full Medicaid services are at a slightly higher risk of readmission, but given that the model adjusting for any dual eligibility only (see ***Appendix Table A3***) showed a negative estimate for this factor, these results remain contradictory and inconclusive.

We also examined the impact of adjusting for these three models (all SDS variables, SDS variables from stepwise selection, and full dual eligibility) on the distribution of RSRRs at the facility-level, as shown in ***Table 5*** below. In terms of the distribution of RSRRs after adjusting for these sets of variables, the results did not differ substantially from the base model RSRRs to those from the model adjusting for all SDS factors (mean difference = -0.1 percentage points, with a range from -4.3 to 2.4 percentage points). The mean difference in facility RSRR before and after adjusting for full dual eligibility only was 0.002 percentage points, with the maximum difference 0.8 percentage points. On average, adjustment for full set of SDS factors and the refined set of SDS factors resulted in improved performance on the measure. However, the average effect on RSRRs when adjusting only for dual eligibility was small, but positive suggesting worse facility performance.

Given the inconsistency of results when adjusting for SDS factors at the individual-level as reported previously (***Table 3***), it is difficult to conclude from these distributions whether facilities with changes in RSRRs were those serving disproportionate shares of beneficiaries with certain SDS factors. This analysis also does note tell us whether the net effects from these adjustments were appropriate.

Table 5: Distribution of RSRRs across facilities before and after adjustment for SDS variables – SNFRM (NQF #2510)

Variable	N	Mean (%)	Std Error	Minimum (%)	25th Pctl (%)	Median (%)	75th Pctl (%)	Maximum (%)
Base Model RSRR	16,688	19.32	0.02	12.09	18.00	19.12	20.45	30.53
RSRR adjusted for All SDS Variables	16,676	19.31	1.83	12.02	18.11	19.14	20.33	30.20
Base RSRR Minus RSRR adjusted for All SDS Variables	16,676	-0.01	0.535	-4.27	-0.289	0.071	0.335	2.35
RSRR adjusted for SDS Variables from Stepwise Selection	16,676	19.31	1.83	12.02	18.12	19.14	20.33	30.21
Base RSRR Minus RSRR adjusted for SDS Variables from Stepwise Selection	16,676	-0.01	0.536	-4.265	-0.287	0.072	0.336	2.34

RSRR adjusted for Full Dual/Non-Full Dual/Non Dual	16,688	19.32	2.067	11.92	17.97	19.12	20.48	30.64
Base RSRR Minus RSRR adjusted for Full Dual/Non-Full Dual/Non-Dual	16,688	0.002	0.104	-0.394	-0.059	-0.006	0.054	0.806

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program references: sp42\sp42snf\sp413_glimmix.xlsx, sp42\sp42snf\sp41_77_glimmix.xlsx, sp42\sp42snf\sp41_1414_glimmix.xlsx).

Note: RSRR=Risk-standardized readmission rate.

In order to take a closer look at the relationship between facility performance and facilities serving beneficiaries from counties with certain SDS characteristics, the RSRRs from the model adjusting for the group of SDS variables from stepwise selection were then further stratified by several key SDS variables at the facility-level. In ***Table 6***, we see the variation in RSRRs across facilities stratified by high/low proportions of full dual patients, percent Non-English speakers in the county, percent with 4+ years of college in the county, and percent with income <138% of the federal poverty level in the county. This table suggests that the variation in SDS-adjusted RSRRs is similar when stratified by these factors, with very few differences in the median, minimum, and maximum adjusted RSRRs. However, where there are small differences, they suggest that SDS risk adjustment results in worse performance for facilities that serve more patients with these SDS characteristics. For example, after adjusting for the refined set of SDS factors from the stepwise, the mean RSRR for facilities that treat a high proportion of dually eligible patients was 19.48 percent compared to 19.15 percent for facilities that treat a low proportion.

For a more specific comparison of the facilities with differing populations of dually eligible patients, ***Table 7*** below presents RSRRs before and after risk-adjustment for full dual only and for the SDS variables from stepwise selection, stratified by quartiles based on the proportion of fully dual eligible residents in each facility. Once again, for all three models, there were not large differences as compared to the base model in the variation of the RSRRs across quartiles. There is some evidence that adjusting for SDS may result in worse performance for facilities that treat the more dually eligible patients. For example, among facilities that treat the highest proportion of dually eligible patients (75-100 percent), the mean RSRR was 19.55 percent with no SDS adjustment; 19.48 percent with full SDS adjustment (from stepwise), and 19.64 percent after adjusting only for dual eligibility.

Furthermore, given the inconsistency of the estimates for the SDS factors adjusted for (as reported in ***Table 3***), it is difficult to determine whether the net effect of this adjustment resulting in changes in RSRRs are result in a more accurate estimate of healthcare quality.

Table 6. Variation in SDS-Adjusted RSRRs across Measured Entities by Proportion of Full Dual Patients and Patients from Counties with Low SES – SNFRM (NQF #2510)

Data Element	Low proportion fully dual eligible patients (≤34.5%)	High proportion fully dual eligible patients (>34.5%)	Low proportion Percent Non English speakers in County (≤1.41%)	High proportion Percent Non English speakers in County (≥1.41%)	Low proportion Percent with 4+ Years College in County (≤24%)	High proportion Percent with 4+ Years College in County (>24%)	Low proportion Percent <138% Poverty in County (≤13.1%)	High proportion Percent <138 Poverty in County (>13.1%)
Number of Facilities	8,347	8,341	8,353	8,335	8,358	8,330	8,350	8,338
Number of Patients	1,321,596	783,361	830,236	1,274,721	791,655	1,313,302	1,077,241	1,027,716
Mean RSRR	19.15%	19.48%	19.23%	19.40%	19.32%	19.32%	19.12%	19.51%
Maximum RSRR	30.53%	30.01%	30.53%	30.49%	30.53%	30.49%	29.71%	30.53%
90th percentile RSRR	21.80%	22.04%	21.67%	22.15%	21.79%	22.10%	21.68%	22.17%
75th percentile RSRR	20.29%	20.59%	20.29%	20.62%	20.37%	20.55%	20.22%	20.68%
Median (50th percentile) RSRR	19.01%	19.25%	19.06%	19.20%	19.12%	19.12%	18.96%	19.31%
25th percentile RSRR	17.82%	18.18%	17.98%	18.02%	18.08%	17.91%	17.86%	18.16%
10th percentile RSRR	16.69%	17.22%	16.99%	16.92%	17.11%	16.78%	16.83%	17.11%
Minimum RSRR	12.09%	13.14%	12.65%	12.09%	12.85%	12.09%	12.65%	12.09%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_9_table_c.xlsx).

Note: RSRR=Risk-standardized readmission rate.

Table 7. RSRRs stratified by % Full Duals in Facility (Base model vs. Model adjusted for Stepwise variables; model adjusted for Full Dual) – SNFRM (NQF #2510)

Raw population readmission rate (all facilities): 19.26%								
Base Model RSRRs (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	3,075	19.06%	1.98%	12.09%	17.87%	18.98%	20.11%	28.72%
25th %ile - Median Full_Dual_Prop	3,253	19.19%	2.13%	12.65%	17.78%	19.05%	20.43%	30.49%
Median - 75th %ile Full_Dual_Prop	4,209	19.25%	2.05%	13.14%	17.87%	19.02%	20.43%	30.53%
75th %ile - Max Full_Dual_Prop	6,146	19.55%	1.95%	13.37%	18.27%	19.31%	20.65%	30.01%
RSRRs after adjusting for SDS variables from Stepwise Selection (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	3,072	19.10%	1.82%	12.02%	18.05%	19.03%	20.05%	28.01%
25th %ile - Median Full_Dual_Prop	3,252	19.23%	1.94%	13.40%	17.93%	19.10%	20.37%	29.74%
Median - 75th %ile Full_Dual_Prop	4,208	19.26%	1.85%	13.38%	18.03%	19.07%	20.31%	29.82%
75th %ile - Max Full_Dual_Prop	6,144	19.48%	1.74%	14.28%	18.34%	19.27%	20.45%	30.21%
RSRRs after adjusting for Full Dual/Dual without Full Medicaid/Non-Medicaid (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	3,075	18.95%	1.98%	11.92%	17.76%	18.89%	20.01%	28.67%
25th %ile - Median Full_Dual_Prop	3,253	19.13%	2.14%	12.59%	17.71%	18.99%	20.39%	30.51%
Median - 75th %ile Full_Dual_Prop	4,209	19.25%	2.08%	13.13%	17.85%	19.03%	20.44%	30.64%
75th %ile - Max Full_Dual_Prop	6,146	19.64%	2.01%	13.34%	18.32%	19.39%	20.77%	30.35%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_10_c.xlsx).

Note: RSRR=Risk-standardized readmission rate.

*6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach.

Methods:

For all three measures, we created hierarchical logistic regression models that added patient- and county-level SDS variables to the risk-adjustment models in use for the all-cause readmission quality measures for each respective setting. In order to evaluate models with all SDS variables added, we performed stepwise versions of logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. We then evaluated the *c*-statistic for each model.

The *c*-statistic is equal to the area under a receiver operating characteristic (ROC) curve. The ROC curve graphs the hit rate of a predictive model against the false alarm rate of that model in a unit square. If the hit rate of a model is always equal to the false alarm rate, then the area under the curve is 0.5 and the model is no better than chance at predicting a binary outcome. If the hit rate of a model is always 1.0, then so is the area under the curve. Thus, the *c*-statistic ranges between 0.5 and 1.0, with larger values indicating increased predictive power.

Results:

We compared *c*-statistics across the base risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model (c-statistics for each of the models with race/ethnicity included are not shown, but did not differ significantly). There was essentially no difference between the SDS-adjusted and base models, suggesting that adding these SDS factors do not result in much improvement in model fit. The stepwise regression models for the SNFRM with all patient- and county-level variables included had a c-statistic of .671. The original SNFRM model had a c-statistic of 0.670 so the improvement was minimal.

Table 8: *C*-Statistics of Readmission Models with SDS Risk-Adjustment – SNFRM (NQF #2510)

SNF Readmission Model	C-Statistic
Original Model	0.670
Original Model + Full Dual/Dual without Medicaid/Non-Medicaid	0.671
Original Model + All SDS Vars + Full Dual	0.671
Original Model + All SDS Vars Chosen through Stepwise Regression	0.671

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_18_s182013.xlsx).

*7. Discuss the risks for misuse of the specified performance measure.

Since this measure was NQF-endorsed in December 2014, it was adopted by CMS for the SNF Value-Based Purchasing Program. As described in our measure submission materials, no unintended or negative consequences were identified during the measure development and testing. We have not identified any unintended consequences during the ongoing evaluation or testing associated with the NQF trial period. However, since this measure has not yet been used for this program, our ability to fully conduct analysis is somewhat limited.

We note that one potential unintended consequence is that SNFs may be deterred from admitting certain patients or types of patients with higher acuity or greater complexity, as they may be more likely to have a subsequent readmission post SNF discharge; this behavior might occur despite the risk adjustment. If so, this could result in barriers to access for some Medicare beneficiaries. Another potential unintended consequence is that SNFs could delay readmitting patients back to the acute care setting in order to beyond the 30-day readmission window. These potential issues could be mitigated by training, and making it clear that there is no expectation of a perfect score (where no patients are ever readmitted). We remain committed to the ongoing monitoring and evaluation for these potential unintended consequences for this measure.

Through the federal rulemaking process to adopt this measure for SNF VBP, we received numerous comments on the topic of risk adjusting for SDS. The primary concern has been that not risk adjusting for SDS factors will penalize facilities that treat larger numbers of patients with marginalized SDS. However, we have not found consistent and sufficient evidence to demonstrate that adjusting for these factors impacts facilities' performance on this measure.

*8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables.

N/A

*9. Please enter the details of the final statistical risk model and variables here.

Risk-adjustment variables include demographic and eligibility characteristics; principal diagnoses; types of surgery or procedure from the prior proximal hospitalization; comorbidities; length of stay during the patient's prior proximal hospitalization, whether patients were in the intensive care unit (ICU), and number of hospitalizations in the previous 365 days.

Following are the final set of risk adjustment variables for this measure:

- Age/Sex categories
- Original reason for Medicare entitlement is disability
- End-stage renal disease (ESRD)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the Clinical Classification Software (CCS) classes for ICD-9 procedures developed by the Agency for Healthcare Research and Quality (AHRQ)*
- Principal diagnosis on prior proximal hospitalization as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ.
- Comorbidities from secondary diagnoses on the prior proximal hospital claim and diagnoses from earlier acute care hospitalizations up to 1 year before SNF admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS)]
- Presence of multiple comorbidities, modeled using two variables: (a) the count of HCCs if count is >2 and (b) the square of this count of HCCs
- Length of stay during prior proximal hospitalization (categorical to account for nonlinearity)
- Any time spent in the intensive care unit (ICU) during the prior proximal hospitalization
- Number of acute care hospitalizations in the 365 days prior to the prior proximal hospitalization (categorical)

*Note: Measure development was conducted using ICD-9 data; however, we are currently incorporating our ICD-9/ICD-10 crosswalks for claims data submitted after ICD-10 implementation for future specifications of the measure.

*10. Compare measure performance scores with and without SDS factors in the risk adjustment model.

The analyses presented in our response to Question 5 allowed us to focus on the impact and significance of the SDS variables in the context of the multivariable model. The addition of these variables had little to no effect on mean facility performance. Further, the impact of the SDS variables and the extent to which they accurately capture SDS for this measure's outcome were unclear from the model results.

We also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise selection was -0.1 percentage points (***Table 5***) suggesting a net improvement in performance on average; whereas, the median change with the addition of full dual eligibility was 0.002 percentage points, suggesting a net decline in facilities' performance on the measure on average.

Next, we more closely examined the net changes in facilities scores after SDS adjustment in order to determine the number of facilities whose performance improved or worsened and by how much. In ***Table 9***, we summarize the results of facilities' changes in RSRRs. We found that the impact of adjusting for dual eligibility only was small: no facilities' performance improved or declined by more than 1 percentage point. However, slightly more facilities improved (53% versus 47%). We know from the earlier analysis that the facilities whose performance improved were likely those that treated smaller proportions of dually eligible patients. In contrast, we found more movement after adjusting for the refined set of SDS factors. Specifically, the performance of 5 percent of facilities improved greater than 1 percentage point, and 1 percent of facilities' scores worsened by greater than 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise model). Though more facilities appear to have improved as a result of the additional SDS adjustment, given the small magnitude of these changes and that observed model parameter estimates had paradoxical relationships with SDS factors, we are not confident that these improvements represent an accurate assessment of the SDS of beneficiaries in the facilities that improved.

Table 9: Summary of Incremental Changes in RSRRs across Facilities (N = 16,676) – SNFRM (NQF #2510)

Model	Direction	Value	# of facilities	% of facilities
Full Dual	Improved	< .002	8,621	51.70
		0.002-0.005	280	1.68
		0.005-0.01	0	0
		>= 0.01	0	0
	Worsened	< .002	7,091	42.52
		0.002-0.005	671	4.02
		0.005-0.01	25	0.15
		>= 0.01	0	0
SDS Variables from Stepwise Selection	Improved	< .002	2,241	13.44
		0.002-0.005	2,225	13.34
		0.005-0.01	1,836	11.01
		>= 0.01	853	5.12
	Worsened	< .002	3,289	19.72
		0.002-0.005	3,988	23.91
		0.005-0.01	2,034	12.20
		>= 0.01	210	1.26

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_14_sp41_15.xlsx).

Lastly, we examined the correlations of the original and SDS risk-adjusted RSRRs across facilities, as shown in ***Table 10*** and ***Figures 1 and 2***. The high degree of correlation between the RSRRs (>0.96 for all three SDS-adjusted models that are the focus of this work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different.

Table 10: Correlations of Original and SDS Risk-Adjusted Facility-Level RSRRs – SNFRM (NQF #2510)

Model	Pearson Correlation*
All SDS Variables	0.9667
SDS Variables from Stepwise Selection	0.9666
Full Dual	0.9989

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013.

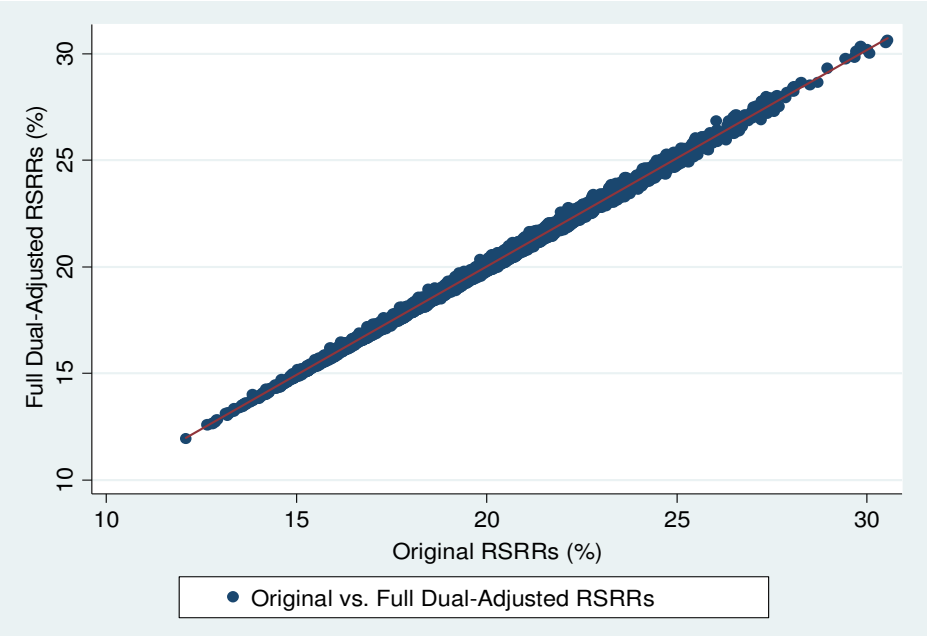
Note: * Indicates that all correlation coefficients were highly significant at $p < 0.001$. RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status

Figure 1: Scatterplot of Original RSRRs and RSRRs Adjusted for All SDS Variables – SNFRM (NQF #2510)

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_3_diff.xlsx).

Note: There were 16,676 SNFs included in this analysis. SDS-Adjusted refers to the fully adjusted model with all 25 county-level SDS factors and full dual eligibility. RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status.

Figure 2: Scatterplot of Original RSRRs and RSRRs Adjusted for Full Dual Status – SNFRM (NQF #2510)



Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: sp42\sp42snf\sp41_14_14_diff.xlsx).

Note: There were 16,676 SNFs included in this analysis. Full Dual-Adjusted refers to the model adjusted for full dual eligibility, categorized as Full Dual/Duals without Full Medicaid/Non-Dual.

RSRR=Risk-standardized readmission rate.

11. APPENDIX

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Appendix Tables

Table A1. Final SNF Readmission Model Variables from NQF-Endorsed Model, 2011

Risk Adjuster	Odds Ratio	LCL	UCL
Male age 18-64	0.999	0.978	1.021
Male age 65-69	1.004	0.983	1.025
Male age 70-74	1.079	1.056	1.103
Male age 75-79	1.128	1.105	1.151
Male age 80-84	1.134	1.112	1.157
Male age 85-89	1.142	1.119	1.166
Male age 90-94	1.120	1.094	1.147
Male age GT 95	1.054	1.015	1.095
Female age 18-64	1.012	0.990	1.034
Female age 65-69*	—	—	—
Female age 70-74	1.035	1.014	1.056
Female age 75-79	1.024	1.005	1.044
Female age 80-84	1.018	1.000	1.037
Female age 85-89	0.988	0.970	1.007
Female age 90-94	0.955	0.937	0.975
Female age GT 95	0.897	0.875	0.920
LOS btwn 1 & 3 days*	—	—	—
LOS btwn 4 & 7 days	1.136	1.126	1.147
LOS btwn 8 & 14 days	1.353	1.338	1.367
LOS GT 14 days	1.601	1.577	1.624
Originally disabled: based on denominator file	1.039	1.028	1.049
End Stage Renal Disease Indicator	1.400	1.376	1.424
Ophthalmology Surgery	0.904	0.661	1.238
Vascular Surgery	1.063	1.042	1.085
Orthopedics Surgery	0.924	0.907	0.941
General surgery	0.975	0.956	0.994
Cardio Thoracic Surgery	0.913	0.884	0.943
Urologic surgery	1.061	1.019	1.105
Neurosurgery	1.189	1.140	1.240
Plastic Surgery	0.963	0.934	0.992
Otolaryngology Surgery	0.940	0.863	1.024
Obstetrics/Gynecology Surgery	0.992	0.912	1.080

Risk Adjuster	Odds Ratio	LCL	UCL
0* hospitalizations	—	—	—
1-3 hospitalizations	1.062	1.052	1.072
4-6 hospitalizations	1.274	1.254	1.294
7-9 hospitalizations	1.604	1.561	1.647
10+ hospitalizations	2.197	2.102	2.297
At least one day in ICU (y/n)	1.106	1.097	1.115
1 Tuberculosis	1.740	1.247	2.428
2 Septicemia (except in labor)	1.796	1.739	1.855
3 Bacterial infection; unspecified site	1.363	1.082	1.717
4 Mycoses	2.225	2.053	2.412
5 HIV infection	1.759	1.508	2.051
6 Hepatitis	2.793	2.494	3.128
7 Viral infection	1.887	1.701	2.092
8 Other infections; including parasitic	1.355	1.074	1.710
11 Cancer of head and neck	2.058	1.729	2.449
12 Cancer of esophagus	1.938	1.448	2.593
13 Cancer of stomach	2.022	1.714	2.385
14 Cancer of colon	1.599	1.496	1.708
15 Cancer of rectum and anus	2.091	1.879	2.327
16 Cancer of liver and intrahepatic bile duct	1.852	1.306	2.625
17 Cancer of pancreas	2.478	2.098	2.928
18 Cancer of other GI organs; peritoneum	2.126	1.798	2.512
19 Cancer of bronchus; lung	1.751	1.574	1.948
21 Cancer of bone and connective tissue	2.282	1.829	2.846
23 Other non-epithelial cancer of skin	1.502	1.129	1.998
24 Cancer of breast	1.601	1.332	1.925
25 Cancer of uterus	1.970	1.641	2.365
27 Cancer of ovary	1.982	1.612	2.436
28 Cancer of other female genital organs	2.374	1.778	3.170
29 Cancer of prostate	1.577	1.251	1.988
32 Cancer of bladder	2.216	1.991	2.465
33 Cancer of kidney and renal pelvis	1.477	1.272	1.716
34 Cancer of other urinary organs	2.144	1.596	2.881
35 Cancer of brain and nervous system	1.863	1.518	2.286
37 Hodgkin`s disease	2.731	1.350	5.524
38 Non-Hodgkin`s lymphoma	2.443	2.071	2.881

Risk Adjuster	Odds Ratio	LCL	UCL
39 Leukemias	1.586	0.888	2.833
40 Multiple myeloma	1.962	1.372	2.805
41 Cancer; other and unspecified primary	1.688	1.015	2.808
42 Secondary malignancies	1.800	1.639	1.978
43 Malignant neoplasm without specification of site	2.079	1.340	3.223
44 Neoplasms of unspecified nature or uncertain behavior	1.865	1.515	2.295
47 Other and unspecified benign neoplasm	2.161	1.985	2.352
48 Thyroid disorders	1.623	1.404	1.875
49 Diabetes mellitus without complication	1.731	1.343	2.230
50 Diabetes mellitus with complications	1.612	1.550	1.677
51 Other endocrine disorders	1.841	1.718	1.974
52 Nutritional deficiencies	2.256	2.019	2.521
54 Gout and other crystal arthropathies	1.700	1.524	1.897
55 Fluid and electrolyte disorders	1.852	1.784	1.922
57 Immunity disorders	2.913	1.376	6.164
58 Other nutritional; endocrine; and metabolic disorders	1.793	1.681	1.912
59 Deficiency and other anemia	2.070	1.980	2.164
60 Acute posthemorrhagic anemia	1.882	1.738	2.038
61 Sickle cell anemia	2.428	1.772	3.326
62 Coagulation and hemorrhagic disorders	2.474	2.206	2.775
63 Diseases of white blood cells	1.886	1.693	2.100
64 Other hematologic conditions	2.315	1.650	3.247
76 Meningitis (except that caused by tuberculosis or sexually transmitted disease)	2.095	1.760	2.493
77 Encephalitis (except that caused by tuberculosis or sexually transmitted disease)	1.692	1.400	2.046
78 Other CNS infection and poliomyelitis	2.104	1.773	2.498
79 Parkinson`s disease	1.360	1.213	1.526
80 Multiple sclerosis	1.477	1.247	1.751
81 Other hereditary and degenerative nervous system conditions	1.592	1.471	1.723
82 Paralysis	1.781	1.386	2.287
83 Epilepsy; convulsions	1.712	1.628	1.800
84 Headache; including migraine	1.760	1.424	2.175
85 Coma; stupor; and brain damage	1.522	1.372	1.689
89 Blindness and vision defects	1.438	0.991	2.087

Risk Adjuster	Odds Ratio	LCL	UCL
90 Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)	2.245	1.827	2.759
91 Other eye disorders	1.746	1.220	2.500
93 Conditions associated with dizziness or vertigo	1.166	1.043	1.303
94 Other ear and sense organ disorders	1.437	1.010	2.043
95 Other nervous system disorders	1.652	1.584	1.723
96 Heart valve disorders	2.030	1.915	2.151
97 Periendo & myocarditis cardiomyopathy (except caused by tuberculosis or sexually transmitted disease)	2.207	2.026	2.405
98 Essential hypertension	1.436	1.260	1.637
99 Hypertension with complications and secondary hypertension	1.859	1.775	1.948
100 Acute myocardial infarction	2.175	2.095	2.258
101 Coronary atherosclerosis and other heart disease	1.915	1.823	2.012
102 Nonspecific chest pain	1.656	1.561	1.756
103 Pulmonary heart disease	1.696	1.613	1.783
104 Other and ill-defined heart disease	1.689	1.312	2.175
105 Conduction disorders	1.579	1.458	1.711
106 Cardiac dysrhythmias	1.955	1.885	2.027
107 Cardiac arrest and ventricular fibrillation	1.708	1.411	2.067
108 Congestive heart failure; nonhypertensive	2.011	1.947	2.077
109 Acute cerebrovascular disease	1.891	1.827	1.959
110 Occlusion or stenosis of precerebral arteries	1.431	1.292	1.584
111 Other and ill-defined cerebrovascular disease	1.561	1.356	1.799
112 Transient cerebral ischemia	1.506	1.420	1.596
113 Late effects of cerebrovascular disease	1.523	1.380	1.680
114 Peripheral and visceral atherosclerosis	1.967	1.871	2.068
115 Aortic; peripheral; and visceral artery aneurysms	1.831	1.695	1.978
116 Aortic and peripheral arterial embolism or thrombosis	2.231	2.044	2.435
117 Other circulatory disease	1.631	1.547	1.719
118 Phlebitis; thrombophlebitis and thromboembolism	1.674	1.593	1.758
119 Varicose veins of lower extremity	1.449	1.054	1.991
120 Hemorrhoids	2.000	1.790	2.234
121 Other diseases of veins and lymphatics	1.574	1.419	1.746
122 Pneumonia (except that caused by tuberculosis or sexually transmitted disease)	1.777	1.720	1.835
123 Influenza	1.276	1.132	1.438

Risk Adjuster	Odds Ratio	LCL	UCL
125 Acute bronchitis	1.432	1.312	1.562
126 Other upper respiratory infections	1.683	1.433	1.976
127 Chronic obstructive pulmonary disease and bronchiectasis	2.119	2.046	2.194
128 Asthma	2.055	1.937	2.179
129 Aspiration pneumonitis; food/vomitus	1.876	1.807	1.948
130 Pleurisy; pneumothorax; pulmonary collapse	1.913	1.801	2.031
131 Respiratory failure; insufficiency; arrest (adult)	2.043	1.967	2.122
132 Lung disease due to external agents	2.006	1.594	2.524
133 Other lower respiratory disease	2.044	1.909	2.188
134 Other upper respiratory disease	1.782	1.587	2.001
135 Intestinal infection	2.091	2.008	2.178
136 Disorders of teeth and jaw	1.677	1.273	2.211
137 Diseases of mouth; excluding dental	1.549	1.347	1.782
138 Esophageal disorders	1.796	1.679	1.921
139 Gastroduodenal ulcer (except hemorrhage)	1.779	1.603	1.975
140 Gastritis and duodenitis	1.766	1.640	1.902
141 Other disorders of stomach and duodenum	1.944	1.795	2.105
142 Appendicitis and other appendiceal conditions	1.805	1.578	2.065
143 Abdominal hernia	1.691	1.591	1.797
144 Regional enteritis and ulcerative colitis	2.409	2.150	2.699
145 Intestinal obstruction without hernia	1.841	1.763	1.921
146 Diverticulosis and diverticulitis	1.893	1.802	1.989
147 Anal and rectal conditions	1.825	1.657	2.011
148 Peritonitis and intestinal abscess	2.070	1.820	2.354
149 Biliary tract disease	1.608	1.527	1.693
151 Other liver diseases	2.496	2.347	2.655
152 Pancreatic disorders (not diabetes)	1.671	1.561	1.789
153 Gastrointestinal hemorrhage	1.819	1.749	1.891
154 Noninfectious gastroenteritis	1.761	1.633	1.899
155 Other gastrointestinal disorders	1.937	1.843	2.035
156 Nephritis; nephrosis; renal sclerosis	2.263	1.695	3.020
157 Acute and unspecified renal failure	1.971	1.906	2.039
158 Chronic renal failure	2.036	1.790	2.316
159 Urinary tract infections	1.738	1.682	1.796
160 Calculus of urinary tract	1.831	1.648	2.034
161 Other diseases of kidney and ureters	1.760	1.562	1.984

Risk Adjuster	Odds Ratio	LCL	UCL
162 Other diseases of bladder and urethra	1.876	1.662	2.116
163 Genitourinary symptoms and ill-defined conditions	1.953	1.785	2.136
164 Hyperplasia of prostate	1.615	1.449	1.801
165 Inflammatory conditions of male genital organs	1.536	1.316	1.793
166 Other male genital disorders	1.274	0.975	1.666
167 Nonmalignant breast conditions	1.858	1.395	2.476
168 Inflammatory diseases of female pelvic organs	2.138	1.682	2.718
170 Prolapse of female genital organs	1.386	1.022	1.879
173 Menopausal disorders	1.805	1.352	2.411
175 Other female genital disorders	1.871	1.575	2.222
197 Skin and subcutaneous tissue infections	1.629	1.567	1.693
198 Other inflammatory condition of skin	2.592	2.182	3.079
199 Chronic ulcer of skin	1.485	1.400	1.575
200 Other skin disorders	1.576	1.202	2.067
201 Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease)	1.560	1.470	1.656
202 Rheumatoid arthritis and related disease	1.334	1.141	1.559
203 Osteoarthritis*	—	—	—
204 Other non-traumatic joint disorders	1.428	1.314	1.552
205 Spondylosis; intervertebral disc disorders; other back problems	1.646	1.583	1.712
207 Pathological fracture	1.709	1.629	1.792
209 Other acquired deformities	1.512	1.380	1.656
210 Systemic lupus erythematosus and connective tissue disorders	2.184	1.755	2.718
211 Other connective tissue disease	1.425	1.353	1.502
212 Other bone disease and musculoskeletal deformities	1.471	1.364	1.587
213 Cardiac and circulatory congenital anomalies	1.540	1.147	2.067
214 Digestive congenital anomalies	2.224	1.409	3.512
215 Genitourinary congenital anomalies	1.754	0.958	3.212
217 Other congenital anomalies	1.652	1.339	2.038
225 Joint disorders and dislocations; trauma-related	1.740	1.545	1.960
226 Fracture of neck of femur (hip)	1.708	1.662	1.756
227 Spinal cord injury	2.391	2.014	2.840
228 Skull and face fractures	1.508	1.329	1.710
229 Fracture of upper limb	1.700	1.627	1.778
230 Fracture of lower limb	1.738	1.677	1.802

Risk Adjuster	Odds Ratio	LCL	UCL
231 Other fractures	1.537	1.481	1.595
232 Sprains and strains	1.379	1.241	1.532
233 Intracranial injury	1.993	1.901	2.090
234 Crushing injury or internal injury	1.844	1.695	2.006
235 Open wounds of head; neck; and trunk	1.401	1.205	1.629
236 Open wounds of extremities	1.776	1.533	2.057
237 Complication of device; implant or graft	1.851	1.793	1.911
238 Complications of surgical procedures or medical care	1.910	1.838	1.984
239 Superficial injury; contusion	1.578	1.471	1.693
240 Burns	1.990	1.664	2.381
241 Poisoning by psychotropic agents	1.497	1.260	1.778
242 Poisoning by other medications and drugs	1.382	1.254	1.522
243 Poisoning by nonmedicinal substances	1.423	0.993	2.041
244 Other injuries and conditions due to external causes	1.554	1.445	1.671
245 Syncope	1.451	1.377	1.529
246 Fever of unknown origin	1.820	1.653	2.003
248 Gangrene	1.863	1.754	1.978
249 Shock	1.593	1.088	2.333
250 Nausea and vomiting	1.990	1.780	2.225
251 Abdominal pain	1.909	1.747	2.086
252 Malaise and fatigue	1.515	1.405	1.633
253 Allergic reactions	1.962	1.640	2.346
257 Other aftercare	1.685	1.320	2.150
259 Residual codes; unclassified	1.719	1.630	1.812
651 Anxiety disorders	1.165	0.921	1.474
653 Delirium	1.196	1.148	1.247
654 Developmental disorders	1.537	1.082	2.185
657 Mood disorders	1.061	1.002	1.123
659 Schizophrenia and other psychotic disorders	1.166	1.103	1.233
660 Alcohol-related disorders	1.210	1.095	1.338
661 Substance-related disorders	1.449	1.330	1.578
663 Screening and history of mental health and substance abuse codes	2.196	1.956	2.465
670 Miscellaneous disorders	1.530	1.152	2.030
Non-significant CCS with Protective Effect	1.030	0.837	1.269
Nonsignificant CCS with effect that increases risk	1.306	1.160	1.471
HCC1 HIV/AIDS	1.157	1.078	1.241

Risk Adjuster	Odds Ratio	LCL	UCL
HCC2 Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	1.042	1.018	1.067
HCC6 Opportunistic Infections	1.175	1.133	1.219
HCC8 Metastatic Cancer and Acute Leukemia	1.290	1.252	1.329
HCC9 Lung and Other Severe Cancers	1.223	1.185	1.263
HCC10 Lymphoma and Other Cancers	1.176	1.138	1.216
HCC11 Colorectal, Bladder, and Other Cancers	1.080	1.041	1.120
HCC12 Breast, Prostate, and Other Cancers and Tumors	1.049	1.014	1.085
HCC17 Diabetes with Acute Complications	1.155	1.108	1.204
HCC18 Diabetes with Chronic Complications	1.112	1.085	1.139
HCC19 Diabetes without complication	1.076	1.052	1.100
HCC21 Protein-Calorie Malnutrition	1.124	1.098	1.150
HCC23 Other Significant Endocrine and Metabolic Disorders	1.087	1.059	1.115
HCC24 Disorders of Fluid/Electrolyte/Acid-Base Balance	1.080	1.056	1.105
HCC27 End-Stage Liver Disease	1.453	1.401	1.506
HCC28 Cirrhosis of Liver	1.155	1.107	1.204
HCC29 Chronic Hepatitis	1.054	0.999	1.112
HCC31 Other Hepatitis and Liver Disease	1.068	1.029	1.109
HCC32 Gallbladder and Biliary Tract Disorders	0.968	0.947	0.990
HCC33 Intestinal Obstruction/Perforation	1.063	1.037	1.090
HCC36 Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	1.100	1.075	1.126
HCC40 Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	1.135	1.106	1.166
HCC46 Severe Hematological Disorders	1.236	1.201	1.272
HCC48 Coagulation Defects and Other Specified Hematological Disorders	1.087	1.061	1.115
HCC49 Iron Deficiency and Other/Unspecified Anemias and Blood Disease	1.046	1.023	1.069
HCC50 Delirium and Encephalopathy	1.064	1.040	1.089
HCC51 Dementia with complications	0.964	0.947	0.982
HCC52 Dementia Without Complication	0.933	0.925	0.941
HCC61 Depression	0.968	0.958	0.979
HCC63 Other Psychiatric Disorders	1.027	1.000	1.056
HCC70 Quadriplegia	1.116	1.065	1.170
HCC82 Respirator Dependence/Tracheostomy Status	1.405	1.348	1.463

Risk Adjuster	Odds Ratio	LCL	UCL
HCC84 Cardio-Respiratory Failure and Shock	1.144	1.118	1.171
HCC85 Congestive Heart Failure	1.154	1.128	1.180
HCC86 Acute Myocardial Infarction	1.136	1.108	1.165
HCC87 Unstable Angina and Other Acute Ischemic Heart Disease	1.071	1.037	1.106
HCC88 Angina Pectoris	1.096	1.053	1.140
HCC89 Coronary Atherosclerosis/Other Chronic Ischemic Heart Diseases	1.054	1.031	1.078
HCC90 Heart Infection/ Inflammation, Except Rheumatic	1.102	1.065	1.141
HCC91 Valvular and Rheumatic Heart Disease	1.052	1.027	1.077
HCC96 Specified Heart Arrhythmias	1.106	1.081	1.131
HCC102 Cerebrovascular Atherosclerosis, Aneurysm, and Other Disease	0.987	0.964	1.011
HCC105 Late Effects of Cerebrovascular Disease, Except Paralysis	0.986	0.967	1.005
HCC106 Atherosclerosis of the Extremities with Ulceration or Gangrene	1.031	1.000	1.063
HCC107 Vascular Disease with Complications	1.060	1.031	1.090
HCC108 Vascular Disease	1.053	1.028	1.078
HCC111 Chronic Obstructive Pulmonary Disease	1.142	1.116	1.168
HCC112 Fibrosis of Lung and Other Chronic Lung Disorders	1.077	1.040	1.116
HCC114 Aspiration and Specified Bacterial Pneumonias	1.135	1.107	1.163
HCC116 Viral and Unspecified Pneumonia, Pleurisy	1.080	1.056	1.105
HCC117 Pleural Effusion/Pneumothorax	1.101	1.074	1.128
HCC132 Kidney Transplant Status	1.490	1.416	1.568
HCC138 Chronic Kidney Disease, Moderate Stage 3)	1.105	1.073	1.138
HCC139 Chronic Kidney Disease, Mild or Unspecified (Stages 1-2 or Unspecified)	1.127	1.099	1.157
HCC141 Nephritis	1.111	1.013	1.219
HCC142 Urinary Obstruction and Retention	1.049	1.024	1.075
HCC144 Urinary Tract Infection	1.039	1.016	1.063
HCC145 Other Urinary Tract Disorders	1.055	1.030	1.081
HCC157 Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone	1.226	1.183	1.270
HCC158 Pressure Ulcer of Skin with Full Thickness Skin Loss	1.207	1.169	1.245
HCC159 Pressure Ulcer of Skin with Partial Thickness Skin Loss	1.129	1.092	1.167
HCC160 Pressure Pre-Ulcer Skin Changes or Unspecified Stage	1.095	1.065	1.126
HCC161 Chronic Ulcer of Skin, Except Pressure	1.039	1.010	1.068

Risk Adjuster	Odds Ratio	LCL	UCL
HCC169 Vertebral Fractures without Spinal Cord Injury	1.017	0.989	1.046
HCC170 Hip Fracture/ Dislocation	0.943	0.929	0.958
HCC176 Complications of Specified Implanted Device	1.068	1.041	1.097
HCC177 Other Complications of Medical Care	1.050	1.024	1.075
HCC186 Major Organ Transplant or Replacement Status	1.203	1.123	1.289
HCC188 Artificial Openings for Feeding or Elimination	1.240	1.204	1.278
HCC197 Supplemental Oxygen	1.221	1.188	1.256
HCC: Advanced Chronic Kidney Disease and Dialysis (134, 135, 136, 137)	1.235	1.208	1.263
HCC134 Dialysis Status	—	—	—
HCC135 Acute Renal Failure	—	—	—
HCC136 Chronic Kidney Disease, Stage 5	—	—	—
HCC137 Chronic Kidney Disease, Severe (Stage 4)	—	—	—
HCC: Cerebral or Ischemic Hemorrhage/ Stroke (99, 100)	1.102	1.074	1.131
HCC99 Cerebral Hemorrhage	—	—	—
HCC100 Ischemic or Unspecified Stroke	—	—	—
Count of HCCs, if 2 or more	1.058	1.038	1.079
Square of count of HCCs, if 2 or more	0.995	0.995	0.996

Abbreviations and symbols: * indicates the referent category. LCL = lower confidence limit for the odds ratio; UCL = upper confidence interval for the odds ratio

Note: Sample size for 2011 = 2,215,398 index stays in 16,656 SNFs. Unadjusted readmission rates for 2011 = 21.08%.

Source: RTI analysis of Medicare claims (MedPAR files 2011). Program: \\wallsas03.waltham.rti.org\vol1\hipaa\0211942.004_PGM\100.008\pgm\stan\programs\ readmit104_idxSNF02_HLMFinal_inclDth.sas, readmit107_idxSNF02_BiVar_Descript_Model_nomiss_ForTable.sas

Table A2: Model Adjustment for All 9 Dual Status Categories (N = 2,012,231)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Intercept	-3.0615	0.01867	<.0001			
QMB (01)	0.02485	0.01331	0.0619	1.025	0.999	1.052
QMB w/ Medicaid (02)	0.00262	0.005564	0.6377	1.003	0.992	1.014
SLMB (03)	0.03918	0.01617	0.0154	1.040	1.008	1.073
SLMB w Medicaid (04)	-0.05113	0.01276	<.0001	0.950	0.927	0.974
QUAL (06)	0.01023	0.02086	0.6238	1.010	0.970	1.052
Other w/ Medicaid (08)	-0.06395	0.006151	<.0001	0.938	0.927	0.949
Other (09)	0.08993	0.06192	0.1464	1.094	0.969	1.235

Note: Only 1 stay was QDWI (05), so it was moved to the Baseline so the model would converge. Hence Baseline consists of INT_DUAL_STUS_CD=NA (Non-Medicaid) and the 1 QDWI stay.

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: SP27).

Table A3: Model Adjustment for Dual Status Indicators

Model	N	Variable Tested	Estimate	Std. Error	P Value	OR	LCL	UCL
Base Model: SNFRM 2013	2,104,813	Intercept	-3.0503	0.018	<.0001			
Base + Any Dual	2,012,231	Any Dual	-0.02096	0.004	<.0001	0.979	0.971	0.988
Base + Full Dual	2,012,231	Full Dual	-0.03065	0.004	<.0001	0.97	0.961	0.978
Base + Non Medicaid Dual	2,012,231	Non-Dual	0.0382	0.009	<.0001	1.039	1.02	1.058
Base + QMB	2,012,231	QMB	0.02105	0.005	<.0001	1.021	1.011	1.031
Base + SLMB	2,012,231	SLMB	-0.00793	0.010	0.4282	0.992	0.973	1.012

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: SP27).

Table A4: Distribution of RSRRs across Facilities before and after adjustment for dual status

Variable	N	Mean	Std Error	Minimum	25th Pctl	Median	75th Pctl	Maximum
Base Model RSRR	16,683	19.32	0.02	12.09	18.00	19.12	20.45	30.53
RSRR account for Any Dual	16,683	19.31	0.02	12.16	18.03	19.12	20.41	31.29
Base RSRR – RSRR Any Dual	16,683	0.00	0.00	-1.26	-0.25	-0.07	0.19	4.13
RSRR account for Full Dual	16,683	19.31	0.02	12.14	18.03	19.12	20.41	31.29
Base RSRR – RSRR Full Dual	16,683	0.00	0.00	-1.27	-0.25	-0.07	0.19	4.11
RSRR account for Non Medicaid Dual	16,683	19.31	0.02	12.21	18.04	19.12	20.40	31.21
Base RSRR – RSRR Non Medicaid Dual	16,683	0.00	0.00	-1.22	-0.25	-0.07	0.19	4.13
RSRR account for QMB	16,683	19.31	0.02	12.23	18.04	19.12	20.40	31.22
Base RSRR – RSRR QMB	16,683	0.00	0.00	-1.22	-0.25	-0.07	0.20	4.17
RSRR account for SLMB	16,683	19.31	0.02	12.20	18.04	19.12	20.40	31.24
Base RSRR – RSRR SLMB	16,683	0.00	0.00	-1.22	-0.25	-0.07	0.19	4.14

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2510, based on index SNF admissions in CY 2013 (program reference: SP27).

RTI INTERNATIONAL | Memorandum

To: NQF Standing Committee

From: RTI International

Date: May 2, 2016

Subject: Developer Response for NQF SDS Trial Period – LTCH Readmission Measure NQF #2512

1. Enter measure # and title

Measure # 2512 All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Long-Term Care Hospitals (LTCHs)

*2. What were the patient-level sociodemographic variables that were available and analyzed during measure development?

When considering risk-adjustment for sociodemographic variables, we (RTI International measure development contractors for CMS) considered the available literature across three post-acute care (PAC) settings for which we developed readmissions measures and are conducting analysis for NQF's SES trial period: Skilled Nursing Facilities (SNFs) for NQF #2510, Inpatient Rehabilitation Facilities (IRFs) for NQF #2502, and Long-Term Care Hospitals (LTCHs) for NQF #2512. CMS seeks to harmonize PAC measures as much as possible. Thus, our response to this question summarizes the relevant literature across PAC.

The potential relationship between SDS risk factors and the outcome of readmissions from institutional post-acute settings, including SNFs, IRFs and LTCHs, is plausible. The literature exploring this relationship is most developed and evidenced for SNFs. In addition to demonstrations of poorer performance on quality of care indicators and higher rates of readmission by race (Howard et al., 2002; Mor et al., 2004; Grabowski 2004; Silverstein et al., 2008; Jencks, Williams, and Coleman 2009), racial and socio-demographic disparities in the quality of nursing facilities have also been demonstrated. This evidence also suggests that these disparities arise from vulnerable populations being admitted disproportionately into poorer quality homes, not differential quality of care by race within the same facility (Mor et al., 2004; Cai, Mukamel, Temkin-Greener 2010). Mor et al. (2004), suggested that lack of resources to dedicate to quality improvement may contribute to systematically poorer quality of care among facilities serving minority and low SES residents.

The evidence in IRFs is mixed. Some studies have found neither sex nor race to be a significant indicator of acute rehospitalization from inpatient rehabilitation (Ottenbacher et al., 2012; Dossa, Glickman, & Berlowitz, 2011). Others have found ethnicity (Ottenbacher et al., 2001) to be indicative of post-IRF

readmissions for stroke patients. Older age has also been found to be a significant predictor of readmission for patients with hip fracture after discharge from IRF (Ottenbacher et al., 2003) The IRF literature does not explore the links between disparities in outcomes and facility quality or poorer quality of care. For LTCHs, the topic has not been specifically explored.

Evidence from the literature review suggests that socioeconomic status is a potential patient-level risk factor for readmissions. Patient-level sociodemographic variables available in the Medicare claims data include the following: age, sex, race, and dual eligibility indicators. The dual eligibility indicator is a categorical variable in the Master Beneficiary Summary File that indicates what category of dual eligibility the patient is classified as, based on varying levels of income and assistance received. The Original Reason for Entitlement variable, which captures the original reason the beneficiary qualified for Medicare benefits (e.g., age, disability or ESRD) is also available, and this variable allows us to adjust for beneficiaries that originally qualified for Medicare on the basis of disability.

The NQF-endorsed all-cause readmission measures (NQF #2510, 2502, 2512) for SNFs, IRFs, and LTCHs have always used age-sex group variables in risk adjustment. The LTCH and IRF models also utilize the Original Reason for Entitlement variable as a risk adjuster; however, for the SNFRM, we use a version of this variable coded as "Disabled as original reason for Medicare coverage" in the risk adjustment model.

We conducted analyses at the time of submission for NQF endorsement using race and dual status. Results of these analyses suggested possible differences in readmission rate based on these factors, suggesting that they may capture an underlying relationship and are potential candidates for inclusion in the SDS risk-adjustment testing for these measures. However, the strength of this empirical evidence varied by measure and SDS risk adjuster. In some cases, the SDS variables were predictive in the risk-adjustment model, but there appeared to be minimal impacts at the facility level. We further investigated this topic by expanding upon these analyses and conducted several additional analyses as part of the trial period.

Recently published literature has focused on the potential relationship between hospital readmissions and community or neighborhood-level socioeconomic characteristics that can serve as a proxy for individual-level factors. A small number of studies (Herrin et al, 2014; Kind et al, 2014; McHugh and Ma, 2013) have shown a relationship between county-level measures of low SDS (based on factors such as income, employment rate, education level, rate of home ownership and literacy) and increased rates of hospital readmission.

This conceptual rationale—that neighborhood or community characteristics including general access to resources within the community influence the likelihood of readmission—was used by the RTI team to identify potential county-level SDS factors for inclusion in the analysis. Because the Medicare County Code specifies county of residence and may be a more reliable geographic identifier for Medicare

beneficiaries than ZIP code over time, RTI focused on county-level measures of SDS for testing. The literature suggests a range of variables as possible measures of SES. Guided largely by the Singh Area Deprivation Index (ADI), which uses 17 U.S. census items to describe socioeconomic context and was used by Kind et al. (2014) and Barnett et al. (2015) to assess readmissions, RTI developed a set of poverty, education, housing, and employment items. Additionally, RTI included measures of access to care within counties, as done by Herrin et al. (2015) who used per Medicare beneficiary counts of general practitioners, specialists, and cardiologists, as well as ratios of general practitioners to specialists. RTI used the Area Health Resources Files to access several county characteristics, including those census items in the ADI, similar to work done by Sheingold et al. (2016).

In addition to the testing for beneficiary-level factors (e.g., dual eligibility and race/ethnicity), RTI tested a broad set of community characteristics for the SNF, IRF, and LTCH readmission measures' risk models, including the following: median household income, percent of residents with qualification for Supplemental Nutrition Assistance Program (SNAP), median home value, and levels of poverty (such as the percent of residents below several poverty thresholds), disability, employment, non-English speakers, and levels of educational attainment. RTI also tested measures of provider supply and access in communities using the Health Professional Shortage Area (HPSA) indicators specific to degrees of shortage of primary care and mental health providers, and measures of primary care, specialist, and physical therapist providers per capita.

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3. From the measure developer perspective, what is your recommendation for the Standing Committee to consider on whether SDS factors should be included in the measure's final risk adjustment model?

Based on the results of our comprehensive SDS testing for this measure, our recommendation as measure developers is to make no changes to the specifications of NQF measure #2512 All-Cause Unplanned Readmission Measure for 30 Days Post Discharge for LTCHs at this time.

The results of our testing of both patient-level and county-level SDS factors were inconsistent. Specifically, we found that:

- Adjustment for SDS variables and combinations of SDS variables yielded generally inconsistent results; for example, several SDS variables were associated with lower odds of readmission when included in the model and others were not significant.
- We found that, overall, LTCHs performance on the measure with and without SDS adjustment was highly correlated, and that adjusting for these SDS factors and combinations of these factors did not have a substantial impact at the facility level.

Though we found that patient-level information on dual eligibility was significantly associated with lower odds of readmission, the results for the county-level risk adjusters were inconsistent. We found that

adjusting for SDS and dual eligibility had a small impact on facilities' performance on the measure and there was no remarkable change in the model's performance (i.e. *c*-statistic) with the addition of SDS risk factors. Given the inconsistency and limited impact of SDS risk adjustment on LTCHs' performance, particularly for SDS factors we tested where there is a plausible conceptual rationale as indicated in the literature, we believe that further study is warranted.

After considering the impact of the SDS factors selected, we also tested the impact of adjusting for race/ethnicity in our final models. Adjusting for race/ethnicity did not have a strong impact on the model results and measures of facility performance in these settings after adjusting for additional SDS factors, and as a result, we do not recommend adjusting for race/ethnicity. This is in line with the recommendation from the NQF that race/ethnicity not be used as a proxy for SDS, as the effects of race/ethnicity may be confounded by SDS and relevant factors such as income or education (which we tested at the county-level) and are more appropriate measures to consider when evaluating disparities in healthcare quality (NQF, 2015).

*4. What were the statistical results of the analyses used to select risk factors?

This measure was developed to harmonize with the Hospital-Wide All-Cause Unplanned Readmission (HWR) measure (NQF #1789) and other measures developed for PAC. As such, we used the same risk adjustment and statistical approach. We developed a hierarchical logistic regression model to predict the probability of an unplanned readmission. The risk adjusters are predictor variables. The equation is hierarchical in that both individual patient characteristics are accounted for as well as the clustering of patients into LTCHs. The statistical model estimates both the average predictive effect of the patient characteristics across all LTCHs and the degree to which each facility has an effect on readmissions that differs from that of the average facility. The facility effects are assumed to be randomly distributed around the average (according to a normal distribution). When computing the facility effect, hierarchical modeling accounts for the known predictors of readmissions, on average, such as patient characteristics, the observed facility rate, and the number of LTCH stays included for the measure. The estimated facility effect is determined mostly by the facility's own data if the number of patient discharges is relatively large (as the estimate would be relatively precise), but is adjusted toward the average if the number of patient discharges is small (as that would yield an estimate of lower precision).

The estimated equation is used twice in the measure. The sum of the probabilities of readmission of all patients in the facility measure, including both the effects of patient characteristics and the LTCH, is the "predicted number" of readmissions after adjusting for case mix. The same equation is used without the LTCH effect to compute the "expected number" of readmissions for the same patients at the average LTCH. The ratio of the predicted-to-expected number of readmissions evaluates the degree to which the readmissions are higher or lower than what would otherwise be expected. This standardized risk ratio

(SRR) is then multiplied by the mean readmission rate for all LTCH stays to get the risk-standardized readmission rate (RSRR) for each facility. This measure is calculated on 2 consecutive calendar year of fee-for-service claims data.

To test the impact of SDS variables for this measure, we began with risk-adjustment models based on clinical risk factors. The clinical risk factors used in the model were selected during the initial testing and measure development. Candidate risk factors were entered into a hierarchical logistic regression. RTI considered both statistical significance and predictive relationship with the dependent variable (all-cause readmission) in selecting clinical risk factors. This resulted in a final risk-adjustment model that included 128 variables. Risk factors for the model used to test the impact of SDS variables included:

- Age/sex categories
- Original reason for Medicare entitlement (age, disability or ESRD)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the Clinical Classification Software (CCS) classes for ICD-9 procedures developed by the Agency for Healthcare Research and Quality (AHRQ)*
- Long-term ventilator patient in LTCH, defined by ICD-9 procedure code
- Principal diagnosis on prior short-term bill as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ.
- Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before LTCH admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS).
- Length of stay in the prior short-term hospital stay (categorical to account for nonlinearity)
- Prior acute ICU/CCU utilization (days) (categorical)
- Count of prior short-term discharges in the 365 days before the LTCH admission (categorical)

Appendix Table A1 shows the final variables in the original model with associated OR and 95% CI. For the SDS testing, we used more recent data from calendar years 2012-2013.

*5. Describe the analyses and interpretation resulting in the decision to select SDS factors.

Methods:

In order to test SDS factors for this measure, we performed a number of analyses based on NQF guidance. These included assessing variation in prevalence of the factor across measured entities, evaluating facility performance as stratified by proportion of patients with certain SDS factors, examining the association of SDS factors with the outcome, and looking at the incremental effect of SDS variables in the original risk-adjustment model, including analyzing how the addition of the group of selected SDS variables affected the performance of the model. All testing was done in parallel for the SNF, IRF and LTCH readmission measures (NQF #2510, 2502, 2512) using the same SDS factors and methodology.

Variables related to SDS were identified via a search of available datasets. We examined the availability of SDS data at the patient-level and at the county-level both were based on the beneficiaries' residence and not the location of the provider.

Patient-Level. At the patient level, we examined Medicare/Medicaid dual status indicators and racial/ethnic identifiers. Indicators of dual status were abstracted from a special intermediary file from Medicare's Part D data[1] at the beneficiary level. The advantage of the Part D intermediary file is that it contains more detailed categories of dual eligibility status which is valuable because this variable is intended to capture low income status. In the previous analyses we conducted at the time of NQF submission we used a less detailed proxy for dual eligibility which was the state buy-in code from the Denominator file. The values we used for this Part D variable are listed below.

- 01 = Qualified Medicare Beneficiary (QMB) only
- 02 = QMB and full Medicaid coverage, including prescription drugs
- 03 = Specified Low-Income Medicare Beneficiary (SLMB) only
- 04 = SLMB and full Medicaid coverage including prescription drugs
- 05 = Qualified Disabled Working Individual (QDWI)
- 06 = Qualifying individuals (QI)
- 08 = Other dual eligible (not QMB, SLMB, QWDI, or QI) with full Medicaid coverage, including prescription drugs
- 09 = Other dual eligible, but without Medicaid coverage

[1] Note: Part D claims data are produced for all beneficiaries, regardless of whether they have Medicare Part D coverage

We conducted analyses using the 9 values above individually and also categorized these to create binary indicators as follows:

- **Any Dual Eligibility:** Indicates the presence of any of the above indicators. This variable captures any level of dual eligibility and is the most inclusive.
- **Full Dual Status:** Qualified Medicare Beneficiary (QMB) and full Medicaid coverage, Specified Low-Income Medicare Beneficiary (SLMB) Program and full Medicaid coverage, and other dual eligible with full Medicaid coverage. This variable indicates if a beneficiary has met certain low-income guidelines and receives full Medicaid benefits along with additional Medicare cost-sharing assistance.
- **Non-Medicaid Dual Status:** QMB only, SLMB only, Qualified Disabled Working Individuals (QWDI), Qualified Individual (QI), or other dual eligible *without* Medicaid coverage. These individuals qualify for dual eligibility based on either meeting low-income requirements or disability, but do not qualify for full Medicaid coverage.

Note: In merging the Part D intermediary data onto our analytic file we were unable to match approximately 4 percent of our sample.

The full dual indicator variable seemed to most accurately capture variation in SDS across beneficiaries. While each of the measures of dual eligibility were tested in this trial period, results for the models adjusting for full dual are the focus of our discussion.

County-Level. The county-level data we examined came from publicly available federal data sources including the American Community Survey, the Area Health Resources File (AHRF), and the U.S. Census. The measures we tested included all of the variables shown in ***Table 1*** from 2013. One benefit of testing the variables from the AHRF was that it provided some measures of health supply in beneficiaries' county of residence, which may be a contributor to disparities in quality of care, such as whether the county was a full or partial Health Professional Shortage Area (HPSA). We merged county-level data from 2013; when 2013 data were unavailable, we used the most recently available estimates. Variables were merged to the files using FIPS codes.

Table 1: County-Level SDS Factors Tested for PAC Hospital Readmission Measures (NQF #2510, 2502, and 2512)

Data Source	Variables
American Community Survey[2]	▪ Median household income ▪ Percent of individuals <138% of poverty level ▪ Percent of individuals 138-200% of poverty level ▪ Percent of people <200% of poverty level ▪ Percent of people <400% of poverty level ▪ Percent of county residents on SNAP benefits ▪ Median home value ▪ Percent of residents in county above 18 not English-speaking ▪ Percent of residents below age 18 who are disabled ▪ Percent of residents 18-64 who are disabled ▪ Percent of residents 65+ who are disabled ▪ Percent of residents with less than a High School diploma ▪ Percent of residents with more than a High School diploma ▪ Percent of residents with 4 or more years of college ▪ Percent Aged 16 and Above who are Employed ▪ Unemployment Rate for those Aged 16 and Above
Area Health Resources File[3]	▪ # of Primary care physicians per capita ▪ # of specialists (medical and surgical) per capita ▪ # of physical therapists/capita (last measured in 2009) ▪ Primary Care Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA) ▪ Mental Health Professional Shortage Area (HPSA) county indicators ([1] Part of County is HPSA; [2] Full County is HPSA)

Source: RTI developed list of county-level variables used for SDS risk adjustment testing, 2016.
Note: 0.2% of beneficiaries did not successfully merge to the county-level variables based on the FIPS codes.

We conducted a series of analyses to determine both the relationship between SDS variables and our outcome of all-cause readmissions as well as the impact that including SDS variables has on facilities' risk-standardized readmission rates (RSRR). This involved the steps detailed below. (Note: each step was performed with and without the addition of the patient-level race/ethnicity using the RTI Race variable[4] which is also available in the Part D intermediary file described previously.)

1. We first summarized provider-level variation of selected SDS factors among SNF patients in our sample using data from 2012-2013.
2. We then evaluated the impact on coefficients, distribution of RSRRs, and model fit after including the 9 patient-level dual status variables, as well as each individual dual status

2 Data available at: https://www.census.gov/acs/www/data/data-tables-and-tools/index.php

3 Data available from: http://ahrf.hrsa.gov/download.htm

4 Eicheldinger C, Bonito A. More Accurate Racial and Ethnic Codes for Medicare Administrative Data. Health Care Financing review 29(3): 27-42, 2008.

category indicator, as risk adjusters in both the original logistic and hierarchical models. In each of these and the following analyses, the logistic models were primarily used to evaluate the coefficients and odds ratios for each risk adjuster. The hierarchical models were used to then estimate the facility-level RSRRs.

3. Next, all county-level SDS variables and the full-dual indicator variable were added as risk-adjusters at once to the full logistic and hierarchical models in order to evaluate the strength of the variable coefficients and analyze any changes in the distribution of RSRRs.
4. For the entire sample, we then performed logistic regression analyses with stepwise variable selection on only the county-level and dual status variables (significance level = 0.2 for entry), while forcing the original risk-adjusters from the full model to stay in during the selection process.
5. We identified the group of SDS variables that had been selected across all three of the PAC readmissions models (for SNF, IRF, and LTCH) through stepwise selection, and included only that set of variables in the full logistic and hierarchical models in order to evaluate the impact of including the selected SDS variables on the model's performance and the distribution of RSRRs.
6. The RSRRs from the model adjusting for the set of SDS variables in the previous step were then further stratified by several key SDS variables at the facility-level in order to further examine the relationship between facility performance and proportion of patients with certain SDS factors. This was also done for the model that adjusted for full dual status only.
7. In addition, we evaluated the changes in facilities' RSRRs to determine the magnitude and how SDS adjustment impacted facilities' performance on the measure (i.e. resulting in better or worse performance).
8. We compared *c*-statistics across the base logistic risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model.
9. We ran Pearson correlations and created scatterplots allowing us to visually inspect the correlations between facilities' RSRRs with and without SDS adjustment.

Results

Patient-Level Results. The provider-level variation of dual eligibility among LTCH patients from 2012-2013 was relatively wide. The median percentage of any dually eligible patients in LTCH was 40.5 percent (interquartile range [IQR]: 33.0% – 50.3%). Of the LTCH population, 43.9 percent of beneficiaries had some form of dual eligibility. The largest group was QMB with full Medicaid coverage (22.9%), followed by other dual eligibility with full Medicaid coverage (10.0%).

We examined the strength and significance of each separate category of dual eligibility variables when added as risk-adjusters to the full logistic models, as shown in ***Appendix Table A2***. When we included all of these variables in the model together, only the QMB with full Medicaid coverage (OR: 1.07; 95% CI: 1.04-1.10) variable was statistically significant. We also adjusted for each binary indicator of dual eligibility that reflected specific income and Medicaid-coverage based statuses; the results of each logistic model with the indicator variables added are shown in ***Appendix Table A3***. All dual status variables

besides non-Medicaid dual and SLMB were statistically significant when included on their own, with the greatest magnitude of effect seen for the full dual (OR: 1.08; 95% CI: 1.05-1.11) and any dual (OR: 1.08; 95% CI: 1.06-1.11) variables. The coefficients in these models were somewhat larger in magnitude as compared to the previous model.

When we evaluated the distribution of facility-level RSRRs before and after adjustment for dual eligibility based on the models adjusting for different categories of dual eligibility, as shown in ***Appendix Table A4***, the difference in RSRRs between the base model and the models including dual eligibility as a risk-adjuster was quite small, with a mean difference of 0.0 percentage points. The RSRRs from the model that included full dual eligibility had a mean difference of 0 as compared with the original model, and the magnitude of the difference ranged from -0.16 to +0.49 percentage points. Overall, the changes in distribution of RSRRs were consistent across all 5 models adjusting for dual eligibility indicator categories, with the largest variation in RSRRs seen in the SLMB-only model.

When just the Full Dual status was accounted for in the model (categories: full dual, duals without full Medicaid[5], and non-dual eligibility as the referent), the coefficient was relatively strong (0.1032; $p<0.001$), as shown in ***Table 2*** below. These results suggest that LTCH patients with dual eligibility—both full and dual eligibility without full Medicaid—were associated with increased odds of readmission compared to LTCH patients with no dual eligibility.

Table 2: Model Adjustment for Full Dual Status (*n* = 178,433) – LTCH (NQF #2512)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Full Dual	0.1032	0.0133	<.0001	1.109	1.08	1.138
Duals without Full Medicaid	0.0572	0.0214	0.0074	1.059	1.015	1.104

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_141213.xlsx).

Note: Std. Error=Standard error; OR=Odds ratio; LCL=Lower confidence limit; UCL=Upper confidence limit.

Based on these results with the patient-level variables for dual eligibility (which did not differ by adding race/ethnicity), we decided to utilize only the full dual eligibility indicator for all subsequent testing of the county-level variables.

[5] Duals without Full Medicaid coverage are dual-eligible patients with Medicare coverage but not receiving Medicaid services; these individuals receive financial assistance from Medicaid only

County-Level Results. To test the county-level derived SDS variables, we began with a comprehensive model that included the entire set of selected county-level variables and the full-dual variable as risk-adjusters (in addition to the original risk adjusters). The coefficients for the full set of SDS variables are reported below in ***Table 3***, under the model with all SDS variable columns. In this model, some ($n = 4$) SDS risk adjusters were significant at the $p < 0.05$ significance level. However, we found that some indicators associated with "higher SES" had results not in the expected direction ($n = 7$). For example, beneficiaries living in counties with higher percentages of individuals with 4 or more years of college had lower odds of readmission relative to beneficiaries in counties with lower educational levels ($p < 0.10$). Of the 7 SDS factors that were not in the expected direction, only one were significant at $p < 0.05$. For ease of interpretation, we highlighted in pink the SDS factors with estimates that were not expected based on our conceptual model and literature review. Importantly, we found that LTCH patients with full dual eligibility had significantly higher odds of readmission compared to LTCH patients without dual eligibility.

Table 3: Model Adjustment for All County-Level SDS Variables and Full Dual Variable (N = 178,225) – LTCH (NQF #2512)

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
	Estimate	Std. Error	P Value	Estimate	Std. Error	P Value
Local Economic Conditions						
Median Household Income	-0.00057	0.002084	0.7856	0.000137	0.001645	0.9338
Percent of Residents on SNAP benefits	0.00123	0.002284	0.5903	0.000754	0.002141	0.7248
Percent of Residents Employed	-0.00645	0.002586	0.0127	-0.00664	0.002589	0.0103
Unemployment Rate	0.01149	0.003899	0.0032	0.01147	0.003807	0.0026
Percent of individuals <138% of poverty level	-0.00294	0.005886	0.6169	-0.03901	0.01337	0.0035
Percent of individuals 138-200% of poverty level	-0.03736	0.01474	0.0113	—	—	—
Percent of individuals 200-400% of poverty level	0.0135	0.007463	0.0705	0.01481	0.007257	0.0413
Median Home Value	-0.0001	0.000142	0.4901	-0.00011	0.000138	0.4321
Education (Reference Group: Percent of Residents with High School Diploma)						
Percent of Residents with less than a High School Diploma	0.001009	0.003065	0.7419	0.00091	0.003052	0.7655
Percent of Residents with 4+ Years of College	0.004195	0.002276	0.0653	0.003405	0.002107	0.1061
Language						
Percent of Residents Not Speaking English	0.005534	0.003968	0.1631	0.00607	0.003958	0.1251
Disability						

Variable	Model with All SDS Variables			Model with SDS Variables from Stepwise Selection		
Percent of Residents <18 who are Disabled	Omitted for reference			-0.0013	0.006266	0.836
Percent of residents 18-64 who are disabled	-0.0049	0.004095	0.2318	-0.00407	0.004466	0.3624
Percent of residents 65+ who are disabled	0.002801	0.002331	0.2295	0.002768	0.002296	0.2279
Health Care Supply						
Primary Care Providers Per Capita	-4.6756	49.8131	0.9252	-21.3015	45.9223	0.6427
Specialist Providers Per Capita	23.4205	17.5758	0.1827	25.0775	17.4605	0.1509
Physical Therapists Per Capita	-52.0741	46.4221	0.262	—	—	—
County is Partial Primary Care HPSA	-0.01104	0.0267	0.6791	-0.0073	0.02416	0.7624
County is Full Primary Care HPSA	0.003832	0.02744	0.8889	0.00822	0.02544	0.7466
County is Partial Mental Health HPSA	0.01107	0.02691	0.6808	—	—	—
County is Full Mental Health HPSA	-0.02335	0.02664	0.3808	-0.03201	0.01605	0.0461
Dual Eligibility						
Full Dual	0.07317	0.0132	<.0001	0.02588	0.02206	0.2406
Any Dual	—	—	—	0.05774	0.02167	0.0077

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_71213.xls).

Note: Pink shading indicates results in the opposite of the expected direction.

Next, based on the model results described above, we ran logistic regression models for all three PAC measures (NQF #2510, 2502, 2512) using stepwise variable selection in order to further refine the number of SDS variables tested for in the risk models. The results from all three measures were combined to identify a slightly more parsimonious set of SDS variables that could be utilized for additional testing. The group of SDS variables identified across all three measures are shown in ***Table 4***, categorized by data source.

Table 4: Variables selected by stepwise selection process for SNF, IRF, and LTCH Readmission Measures

Census Variables	Area Health Resource File Variables	Patient-Level Variables
▪ Median Home Value ▪ Median Household Income ▪ Unemployment Rate ▪ Percent Employed ▪ Percent of Residents Greater than 65 who are Disabled ▪ Percent of Residents 18-64 who are Disabled ▪ Percent of Residents Less Than 18 who are Disabled ▪ Percent of Residents with 4+ Years of College ▪ Percent of Residents with Less than High School Diploma ▪ Percent of Residents who are Non-English Speakers ▪ Percent of Residents Between 138 -200% of Poverty Level ▪ Percent of Residents Between 200 -400% of Poverty Level ▪ Percent of residents on SNAP Benefits	▪ One or more Parts of County are Primary Care HPSA ▪ Full County is Primary Care HPSA ▪ Full County is Mental Health HPSA ▪ MD Specialists Per Capita ▪ Primary Care Providers Per Capita	▪ Any Dual Status ▪ Full Dual Status

When the variables identified above were added to the full LTCH model, the coefficients were similar in magnitude and direction as the full model with all SDS factors included, as shown in ***Table 3*** under the columns for model with SDS variables from stepwise selection. Despite paring down the set of SDS factors, we found similar results. Consistent with our previous results, estimates for multiple SDS factors (highlighted in pink) were not consistent with the expected relationship between low SES and increased odds of readmission, though not all were significant.

In the model derived from stepwise selection, we risk adjusted for dual eligibility using full dual status and any dual status as selected by the stepwise selection process. In this model, the estimates for the full dual eligibility was not significant at $p<0.05$ due to the additional of the any dual status variable, but the direction of the effect was similar to the previous results.

We also examined the impact of adjusting for these three models (all SDS variables, SDS variables from stepwise selection, and full dual eligibility) on the distribution of RSRRs at the facility-level, as shown in ***Table 5*** below. In terms of the distribution of RSRRs after adjusting for these sets of variables, the results did not differ substantially from the base model RSRRs to those from the model adjusting for all SDS factors (mean difference = -0.1 percentage points, with a range from -2.1 to 1.5 percentage points). The mean difference in facility RSRR before and after adjusting for full dual eligibility only was 0.02 percentage points, with the maximum difference -0.6 percentage points and a minimum of 0.4. On average, adjustment for all SDS factors including dual eligibility resulted in slightly worse performance on the measure.

Given the inconsistency of results when adjusting for SDS factors at the individual-level as reported previously (***Table 3***), it is difficult to conclude from these distributions whether facilities with changes in RSRRs were those serving disproportionate shares of beneficiaries with certain SDS factors. This analysis also does note tell us whether the net effects from these adjustments were appropriate.

Table 5: Distribution of RSRRs across facilities before and after adjustment for SDS variables – LTCH (NQF #2512)

Variable	N	Mean (%)	Std Error	Minimum (%)	25th Pctl (%)	Median (%)	75th Pctl (%)	Maximum (%)
Base Model RSRR	439	24.98	0.10	19.32	23.56	24.88	26.28	32.72
RSRR adjusted for All SDS Variables	439	24.99	1.78	20.60	23.74	0.24893	26.10	31.46
Base RSRR Minus RSRR adjusted for All SDS Variables	439	0.013	0.55	-2.09	-0.27	0.00099	0.4	1.51
RSRR adjusted for SDS Variables from Stepwise Selection	439	24.99	1.76	20.56	2.40	0.249	26.08	31.34
Base RSRR Minus RSRR adjusted for SDS Variables from Stepwise Selection	439	0.012	0.57	-2.16	-0.28	0.00092	0.41	1.56
RSRR adjusted for Full Dual/Non-Full Dual/Non Dual	439	24.99	2.04	19.69	23.57	0.24903	26.24	32.55

Base RSRR Minus RSRR adjusted for Full Dual/Non-Full Dual/Non-Dual	439	0.017	0.14	-0.62	-0.04	0.00023	0.09	0.38

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_7_irf_diff.xlsx, sp42\sp42ltc\sp42ltc_14_ltc_diff.xlsx).
Note: RSRR=Risk-standardized readmission rate.

In order to take a closer look at the relationship between facility performance and facilities serving beneficiaries from counties with certain SDS characteristics, the RSRRs from the model adjusting for the group of SDS variables from stepwise selection were then further stratified by several key SDS variables at the facility-level. In ***Table 6***, we see the variation in RSRRs across facilities stratified by high/low proportions of full dual patients, percent Non-English speakers in the county, percent with 4+ years of college in the county, and percent with income <138% of the federal poverty level in the county. This table suggest that the variation in SDS-adjusted RSRRs is similar when stratified by these factors, with very few differences in the median, minimum, and maximum adjusted RSRRs. There were some differences to note when the results were stratified by dual eligibility which suggest that SDS risk adjustment would results in worse performance for facilities that serve more dually eligible patients. After adjusting for the refined set of SDS factors from the stepwise, the mean and median RSRRs for facilities that treat a high proportion of dually eligible patients were 25.2 percent and 25.4 percent compared to 24.4 percent and 24.6 percent for facilities that treat a lower proportion of dually eligible patients.

For a more specific comparison of the facilities with differing populations of dually eligible patients, ***Table 7*** below presents RSRRs before and after risk-adjustment for full dual only and for the SDS variables from stepwise selection, stratified by quartiles based on the proportion of fully dual eligible patients in each facility. Once again, for all three models, there were not major differences as compared to the base model in the variation of the RSRRs across quartiles. Furthermore, given the inconsistency of the estimates for the SDS factors adjusted for (as reported in ***Table 3***), it is difficult to determine whether the net effect of this adjustment resulting in changes in RSRRs are result in a more accurate estimate of healthcare quality.

Table 6. Variation in SDS-Adjusted RSRRs across Measured Entities by Proportion of Full Dual Patients and Patients from Counties with Low SES – LTCH (NQF #2512)

Data Element	Low proportion fully dual eligible patients (≤31.7%)	High proportion fully dual eligible patients (>31.7%)	Low proportion Percent Non English speakers in County (≤1.83%)	High proportion Percent Non English speakers in County (≥1.83%)	Low proportion Percent with 4+ Years College in County (≤26.3%)	High proportion Percent with 4+ Years College in County (>26.3%)	Low proportion Percent <138% Poverty in County (≤14.4%)	High proportion Percent <138 Poverty in County (>14.4%)
Number of Facilities	220	219	220	219	228	211	222	217
Number of Patients	90,329	87,506	74,899	102,936	80,793	97,042	83,088	94,747
Mean RSRR	24.56%	25.41%	24.98%	24.99%	24.95%	25.02%	24.89%	25.08%
Maximum RSRR	30.84%	32.72%	30.84%	32.72%	32.72%	30.84%	32.72%	30.07%
90th percentile RSRR	26.97%	28.48%	27.29%	28.48%	27.65%	27.67%	27.54%	27.68%
75th percentile RSRR	25.87%	26.61%	26.19%	26.47%	26.32%	26.21%	26.08%	26.35%
Median (50th percentile) RSRR	24.40%	25.20%	24.94%	24.81%	24.88%	24.88%	24.75%	25.09%
25th percentile RSRR	23.13%	24.07%	23.61%	23.31%	23.47%	23.60%	23.52%	23.58%
10th percentile RSRR	22.37%	22.83%	22.67%	22.43%	22.53%	22.70%	22.43%	22.64%
Minimum RSRR	19.32%	20.44%	20.14%	19.32%	19.32%	20.25%	20.14%	19.32%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42irf\sp42ltc_9_table_c.xlsx).

Note: RSRR=Risk-standardized readmission rate.

Table 7. RSRRs stratified by % Full Duals in Facility (Base model vs. Model adjusted for Stepwise variables; model adjusted for Full Dual) – LTCH (NQF #2512)

Raw population readmission rate (all facilities): 24.96%								
Base Model RSRRs (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	112	24.37%	2.15%	19.32%	22.91%	24.16%	25.71%	30.14%
25th %ile - Median Full_Dual_Prop	106	24.76%	1.81%	20.76%	23.48%	24.55%	25.91%	30.84%
Median - 75th %ile Full_Dual_Prop	118	25.24%	2.11%	20.44%	23.77%	25.15%	26.14%	32.72%
75th %ile - Max Full_Dual_Prop	103	25.57%	2.07%	20.46%	24.25%	25.25%	26.90%	29.93%
RSRRs after adjusting for SDS variables from Stepwise Selection (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	112	24.53%	1.84%	20.55%	23.19%	24.51%	25.78%	29.19%
25th %ile - Median Full_Dual_Prop	106	24.90%	1.60%	21.06%	23.73%	24.78%	25.92%	29.70%
Median - 75th %ile Full_Dual_Prop	118	25.26%	1.79%	20.97%	24.02%	25.29%	26.08%	31.34%
75th %ile - Max Full_Dual_Prop	103	25.28%	1.70%	21.18%	24.17%	25.08%	26.58%	29.36%
RSRRs after adjusting for Full Dual/Dual without Full Medicaid/Non-Medicaid (%)								
Full Dual Category	**N**	**Mean**	**Std Error**	**Minimum**	**25th Pctl**	**Median**	**75th Pctl**	**Maximum**
Min - 25th %ile Full_Dual_Prop	112	24.48%	2.13%	19.69%	23.04%	24.26%	25.85%	30.18%
25th %ile - Median Full_Dual_Prop	106	24.82%	1.80%	20.86%	23.56%	24.62%	25.97%	30.89%
Median - 75th %ile Full_Dual_Prop	118	25.24%	2.09%	20.61%	23.77%	25.18%	26.12%	32.55%
75th %ile - Max Full_Dual_Prop	103	25.47%	1.99%	20.59%	24.22%	25.14%	26.68%	29.98%

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_10_cs7.xlsx).

Note: RSRR=Risk-standardized readmission rate.

*6. Describe the method of testing/analysis used to develop and validate the adequacy of the statistical model or stratification approach.

Methods:

For all three measures, we created hierarchical logistic regression models that added patient- and county-level SDS variables to the risk-adjustment models in use for the all-cause readmission quality measures for each respective setting. In order to evaluate models with all SDS variables added, we performed stepwise versions of logistic regression, a method that allows for the evaluation of the separate predictive contribution of each variable to the model. We then evaluated the *c*-statistic for each model.

The *c*-statistic is equal to the area under a receiver operating characteristic (ROC) curve. The ROC curve graphs the hit rate of a predictive model against the false alarm rate of that model in a unit square. If the hit rate of a model is always equal to the false alarm rate, then the area under the curve is 0.5 and the model is no better than chance at predicting a binary outcome. If the hit rate of a model is always 1.0, then so is the area under the curve. Thus, the *c*-statistic ranges between 0.5 and 1.0, with larger values indicating increased predictive power.

Results:

We compared *c*-statistics across the base risk-adjustment models and all additional models tested in order to assess how adjusting for SDS factors affected the performance of the model (c-statistics for each of the models with race/ethnicity included are not shown, but did not differ significantly). There was essentially no difference between the SDS-adjusted and base models, suggesting that adding these SDS factors do not result in much improvement in model fit. The stepwise regression models for the LTCH measure with all patient- and county-level variables included had a c-statistic of 0.648. The original model had a c-statistic of 0.646 so the improvement was minimal.

Table 8: C-Statistics of Readmission Models with SDS Risk-Adjustment – LTCH (NQF #2512)

SNF Readmission Model	C-Statistic
Original Model	0.646
Original Model + Full Dual/Dual without Medicaid/Non-Medicaid	0.647
Original Model + All SDS Vars + Full Dual	0.648
Original Model + All SDS Vars Chosen through Stepwise Regression	0.648

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: lc52\lc52_ltc_model\lc52_ltch_ltc1213logistic.xlsx, sp42\sp42ltc\sp42ltc_18_ltc1213.xlsx).

*7. Discuss the risks for misuse of the specified performance measure.

Since this measure was NQF-endorsed in December 2014, it was adopted by CMS for the LTCH Quality Reporting Program. As described in our measure submission materials, no unintended or negative consequences were identified during the measure development and testing. We have not identified any unintended consequences during the ongoing evaluation or testing associated with the NQF trial period. However, since this measure has not yet been publicly reported, our ability to fully conduct analysis is somewhat limited.

We note that one potential unintended consequence is that LTCHs may be deterred from admitting certain patients or types of patients with higher acuity or greater complexity, as they may be more likely to have a subsequent readmission post LTCH discharge; this behavior might occur despite the risk adjustment. If so, this could result in barriers to access for some Medicare beneficiaries. Another potential unintended consequence is that LTCHs could increase the rate at which they transfer patients back to the acute care setting in order to exclude these transfers from the measure denominator. These potential issues could be mitigated by training, and making it clear that there is no expectation of a perfect score (where no patients are ever readmitted). We remain committed to the ongoing monitoring and evaluation for these potential unintended consequences for this measure.

Through the federal rulemaking process to adopt this measure for the LTCH QRP, we received numerous comments on the topic of risk adjusting for SDS. The primary concern has been that not risk adjusting for SDS factors will penalize facilities that treat larger numbers of patients with marginalized SDS. However, we have not found consistent and sufficient evidence to demonstrate that adjusting for these factors impacts facilities' performance on this measure.

*8. If a performance measure includes SDS variables in its risk adjustment model, the measure developer should provide the information required to stratify a clinically-adjusted only version of the measure results for those SDS variables.

N/A

*9. Please enter the details of the final statistical risk model and variables here.

Risk-adjustment variables include demographic and eligibility characteristics; principal diagnoses; types of surgery or procedure from the prior short-term stay; comorbidities; length of stay and ICU/CCU utilization from the immediately prior short-term stay; and number of admissions in the year preceding the LTCH admission.

Following are the final set of risk adjustment variables for this measure:

- Age/sex categories
- Original reason for Medicare entitlement (age, disability or ESRD)
- Surgery category if present (e.g., cardiothoracic, orthopedic), defined as in the HWR model software; the procedures are grouped using the Clinical Classification Software (CCS) classes for ICD-9 procedures developed by the Agency for Healthcare Research and Quality (AHRQ)*
- Long-term ventilator patient in LTCH, defined by ICD-9 procedure code.
- Principal diagnosis on prior short-term bill as in the HWR measure. The ICD-9 codes are grouped clinically using the CCS for ICD-9 diagnoses developed by AHRQ.
- Comorbidities from secondary diagnoses on the prior short-term bill and diagnoses from earlier short-term stays up to 1 year before LTCH admission (these are clustered using the Hierarchical Condition Categories [HCC] groups used by CMS)
- Length of stay in the prior short-term hospital stay (categorical to account for nonlinearity)
- Prior acute ICU/CCU utilization (days) (categorical)
- Count of prior short-term discharges in the 365 days before the LTCH admission (categorical)

*Note: Measure development was conducted using ICD-9 data; however, we are currently incorporating our ICD-9/ICD-10 crosswalks for claims data submitted after ICD-10 implementation into the measure specifications.

*10. Compare measure performance scores with and without SDS factors in the risk adjustment model.

The analyses presented in our response to Question 5 allowed us to focus on the impact and significance of the SDS variables in the context of the multivariable model. The addition of these variables had little to no effect on mean facility performance. Further, the impact of the SDS variables and the extent to which they accurately capture SDS for this measure's outcome were unclear from the model results.

We also analyzed the change in facility-level RSRRs after adjusting for these variables. The median change in facility RSRRs when adding the SDS variables selected through stepwise selection was very small—0.00092 percentage points (***Table 5***) suggesting very little impact in performance on average. The median change with the addition of full dual eligibility was even smaller, suggesting that risk adjusting for dual eligibility also has a minimal impact and results in worse performance on average.

Next, we more closely examined the net changes in facilities scores after SDS adjustment in order to determine the number of facilities whose performance improved or worsened and by how much. In ***Table 9***, we summarize the results of facilities' changes in RSRRs. We found that the impact of adjusting for dual eligibility only was small: no facilities' performance improved or declined by more than 1 percentage point. However, the majority of facilities had worse performance after adjusting for dual eligibility (61% versus 39%).

In contrast, we found a bit more movement after adjusting for the refined set of SDS factors. Specifically, the performance of 5 percent of facilities improved greater than 1 percentage point, and less than 1 percent of facilities' scores worsened by greater than 1 percentage point after adjusting for the refined set of SDS adjusters (from the stepwise model). The performance for the majority of facilities appears to have declined as a result of the additional SDS adjustment.

Table 9: Summary of Incremental Changes in RSRRs across Facilities (N = 439) – LTCH (NQF #2512)

Model	Direction	Value	# of facilities	% of facilities
Full Dual	Improved	< .002	147	33.5
		0.002-0.005	23	5.2
		0.005-0.01	1	0.2
		>= 0.01	0	0
	Worsened	< .002	242	55.1
		0.002-0.005	26	5.9
		0.005-0.01	0	0
		>= 0.01	0	0
SDS Variables from Stepwise Selection	Improved	< .002	62	14.1
		0.002-0.005	49	11.2
		0.005-0.01	56	12.8
		>= 0.01	21	4.8
	Worsened	< .002	72	16.4
		0.002-0.005	102	23.2
		0.005-0.01	73	16.6
		>= 0.01	3	0.7

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_14_ltc.xlsx).

Lastly, we examined the correlations between the original and SDS risk-adjusted RSRRs across facilities, as shown in ***Table 10*** and ***Figures 1 and 2***. The high degree of correlation between the RSRRs (>0.97 for all three SDS-adjusted models that are the focus of this work) suggests that for most facilities, the base and SDS-adjusted models are not significantly different.

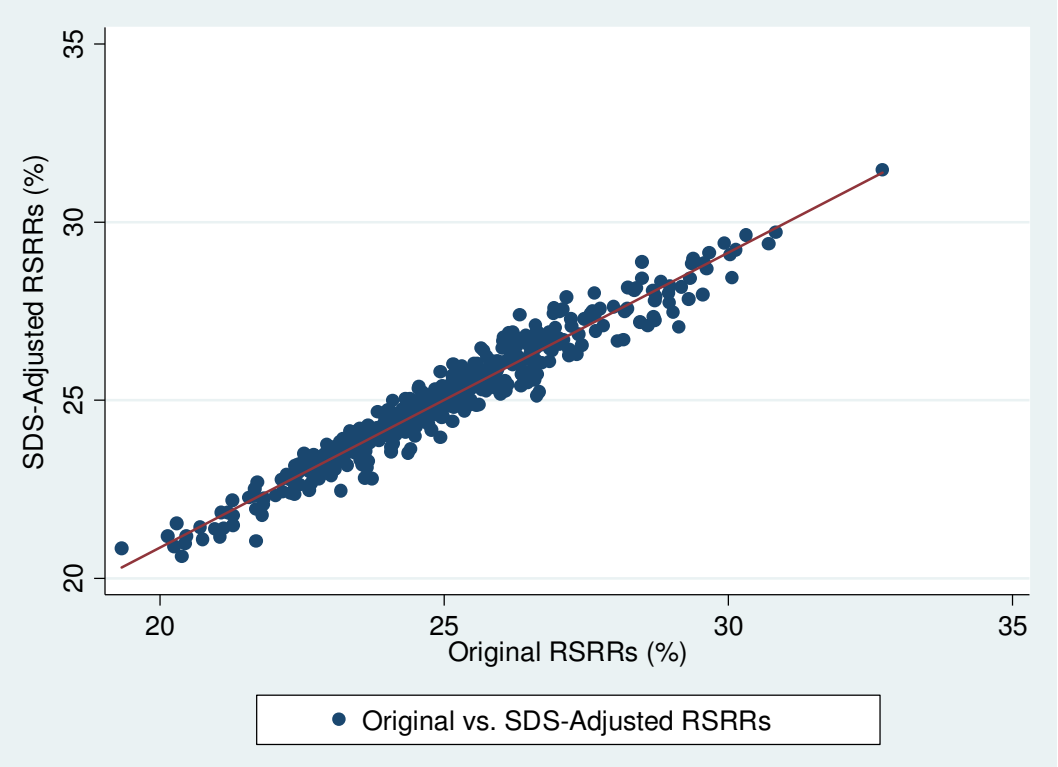
Table 10: Correlations of Original and SDS Risk-Adjusted Facility-Level RSRRs – LTCH (NQF #2512)

Model	Pearson Correlation*
All SDS Variables	0.9721
SDS Variables from Stepwise Selection	0.9706
Full Dual	0.9981

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013.

Note: All results were significant at $p < 0.001$. RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status

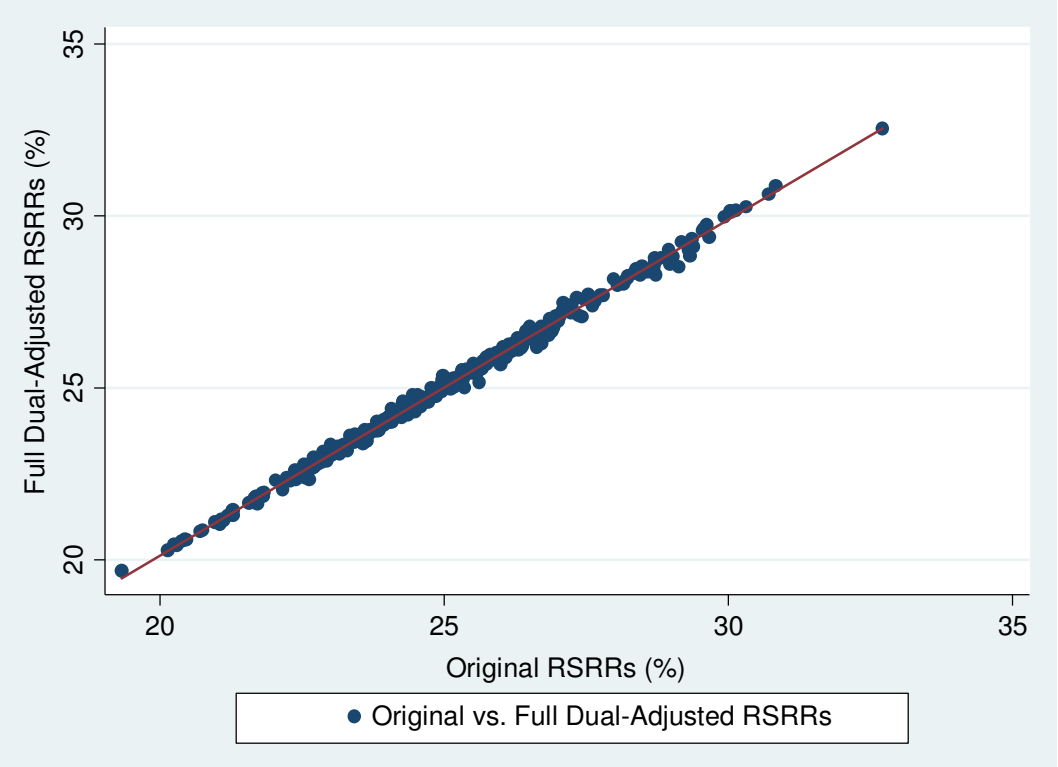
Figure 1: Scatterplot of Original RSRRs and RSRRs Adjusted for All SDS Variables – LTCH (NQF #2512)



Source: RTI analysis of Medicare and Areas Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_1213_3_diff.xlsx).

Note: There were 439 LTCHs included in this analysis. SDS-Adjusted refers to the fully adjusted model with all 25 county-level SDS factors and full dual eligibility. RSRR=Risk-standardized readmission rate; SDS=Sociodemographic status

Figure 2: Scatterplot of Original RSRRs and RSRRs Adjusted for Full Dual Status – LTCH (NQF #2512)



Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: sp42\sp42ltc\sp42ltc_14_14_diff.xlsx).
Note: There were 439 LTCHs included in this analysis. Full Dual refers to the original risk-adjusted model additional adjusted for full dual eligibility, categorized as Full Dual/Duals without Full Medicaid/Non-Dual. RSRR=Risk-standardized readmission rate.

11. APPENDIX

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Appendix Tables

Table A1. Final LTCH Readmission Model Variables from NQF-Endorsed Model, 2010-2010

Covariate	Odds Ratio	P-value
Age-Sex Groups (Reference group: Male 18-54)		
Male age 45-54	1.049	0.2652
Male age 55-59	1.104	0.0284
Male age 60-64	1.136	0.0039
Male age 65-69	1.165	0.0002
Male age 70-74	1.293	<.0001
Male age 75-79	1.314	<.0001
Male age 80-84	1.414	<.0001
Male age 85+	1.445	<.0001
Female age 18-44	1.174	0.0019
Female age 45-54	1.166	0.0006
Female age 55-59	1.148	0.0030
Female age 60-64	1.200	<.0001
Female age 65-69	1.242	<.0001
Female age 70-74	1.354	<.0001
Female age 75-79	1.342	<.0001
Female age 80-84	1.377	<.0001
Female age 85+	1.378	<.0001
CCS Groupings - Based on principal diagnosis (Reference group includes BackProb (205); Gangrene (248); MiscNeg (241-243); Park MS CNS Par (79-82); Ortho (54, 201, 203-204, 206, 208-209, 211-212))		
Resp Syst: Adlt Resp Fl (131)	1.325	<.0001
Circ Syst: AMI & Cardiac arrst (100, 107)	1.446	<.0001
Circ Syst: Aneurysm (115) Art embolism and Ot circul dx (116-117)	1.193	0.0053
Resp Syst: Asp Pneumonia (129)	1.349	<.0001
Biliary Dx, Liver Dx, Other Liver Dx, Pancreas (149-152); Diabetes (49-50)	1.163	0.0001
Diseases of blood and blood-forming organs (56-57, 59-64)	1.303	0.0004
Circ Syst: CHF, Nonhypertensive (108)	1.322	<.0001
Circ Syst: Carditis and Other heart dx (97, 104) Heart Valve (96)	1.186	0.0038

Circ Syst: Htn & Htn complicn (98-99)	1.480	<.0001
Complic Devi & Complic Proc (237-238)	1.229	<.0001
Circ Syst: Conduction & Dysrhythmia (105-106)	1.260	0.0002
Resp Syst: COPD & Asthma (127-128)	1.451	<.0001
Circ Syst: Coron Athero & Chest pain (101-102)	1.399	<.0001
Circ Syst: CVD (109-111, 113)	1.413	<.0001
Diseases of Digestive System (135-144, 146-148, 154-155)	1.224	<.0001
Fluid/elec dx (55)	1.417	<.0001
Diseases of the genitourinary system (156, 160-166, 168-173, 175) UTI (159)	1.264	<.0001
GI Hemorrhage (153)	1.237	0.0009
Fx hip (226)	1.237	0.0004
Infectious and parasitic diseases (1, 3-10)	1.288	0.0001
Digestive System-Int Obstruct (145)	1.178	0.0034
Intracrn Inj (233)	1.287	<.0001
Dis Nerv Syst: Meningitis, Encephalitis, Other CNS infx (76-78)	1.326	0.0022
Mental Illness (650-670)	1.109	0.1345
Neoplasms-Medium (11-15, 18, 20-21, 32-34, 37-41, 43), 2nd Malign (42) Neoplasms Hi (16-17, 19, 27, 35, 42)	1.234	<.0001
Circ Syst: Phlebitis, Varicose vn, Hemorrhoids, Oth vein dx (118-121) Perip Athero (114)	1.187	0.0012
Resp Syst: Pneum, Influ, Bronc, Ot up rsp (122-123, 125-126)	1.333	<.0001
Circ Syst: Pulm hart dx (103)	1.278	0.0016
Genitourinary: Ac & Chr renl fail (157-158)	1.367	<.0001
Resp Syst: Pleurisy, Lung externl, Oth low resp, Oth uppr resp, Tonsillitis (124, 130, 132-134)	1.151	0.0150
Rheum arth (202), SLE (210), OthConnTiss (211), NeoplBenign (44-47), Endocrn (48, 51, 53), NutritDef (52, 58), TIA (112), CongAnom (213-217) (miscellaneous positive signed groups)	1.240	0.0008
Spin cor inj (227)	1.521	0.0010
Infect & Paras Dx: Septicemia (2)	1.227	<.0001

Symptoms, Signs, and Ill-Defined Conditions and Factors influencing health status (245-247, 249-259)	1.157	0.0102
DisNervSyst: Epilepsy/CNV (83) & Oth Nerv Dx (95)	1.256	0.0001
Fractures regroup (Path, Skull, Arm, Leg, Oth) (207, 228-231)	1.181	0.0014
Injury(Joint inj, Sprain, Crush inj, Opn wnds, Superfic) (225, 232, 234-236, 239, 244) Skin-Diseases skin/subcut tissue; Burns (167, 197-200, 240)	1.091	0.0161
Surgical Groupings		
Cardio Thoracic	0.931	0.0192
General surgery, Obstetrics/Gynecology, and urologic surgical procedures	0.967	0.0617
Neurosurgery, Vascular Surgery	0.963	0.0736
Orthopedics	0.921	0.0004
Plastic Surgery	0.920	0.0007
Ventilator Indicator		
Prolonged Ventilation in LTCH	1.116	<.0001
Comorbidities - Hierarchical Condition Categories (HCCs)*		
HIV/AIDS	1.262	0.0011
Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	1.035	0.0205
Bacterial, Fungal, and Parasitic Central Nervous System Infections	0.931	0.1484
Opportunistic Infections, Other Infectious Diseases	0.982	0.1551
Diabetes: 17-with acute comp, 18-with chronic comp, 19-without comp, 20-Type 1	1.014	0.2299
Protein-Calorie Malnutrition, Disorders of Fluid/Electrolyte/Acid-Base Balance	1.035	0.0016
Other Significant Endocrine/Metabolic/Nutritional Disorders	0.938	<.0001
Disorders of Lipoid Metabolism	0.926	<.0001
End-Stage Liver Disease, Cirrhosis of Liver, Chronic Hepatitis, Other Hepatitis and Liver Disease	1.077	0.0075
Gallbladder and Biliary Tract Disorders	0.920	0.0078
Chronic Pancreatitis	1.254	<.0001

Inflammatory Bowel Disease, Other Gastrointestinal Disorders	0.975	0.0255
Peptic Ulcer, Hemorrhage, Other Specified Gastrointestinal Disorders	1.047	0.0046
Bone/Joint/Muscle Infections/Necrosis	0.888	<.0001
Vert/Spinal Discs, Osteoarth/Hip/Knee, Osteopor Bone/Cart Disord, Congen/Dev Skeletal/Connect Tis, Other Musculoskel/Connect Tis	0.948	<.0001
Severe Hematological Disorders	1.090	0.0167
Delirium and Encephalopathy	1.031	0.0458
Dementia With Complications	1.117	0.0108
Dementia Without Complication	1.032	0.0851
Nonpsychotic Organic Brain Syndromes/Conditions	1.121	0.2028
Drug/Alcohol Psychosis, Dependence, Abuse Without Dependence	0.928	0.0002
Schizophrenia	0.854	0.0003
Disorders: Major Depressive, Bipolar, Paranoid/Reactive and Unspecified Psychosis/Personality/Depression/Anxiety/Other Psychiatric	1.029	0.0764
Profound, Severe, Moderate, Mild Mental Retardation/Developmental Disability, Autism, Down Syndrome	1.084	0.0504
Neuropathies: 75-poly; 76-MD; 77-MS; 78-Park/Hunt; 79-Seiz; 80-Coma; 81-Mononeur	1.042	0.0035
Respiratory Arrest, Cardio-Respiratory Failure and Shock	1.031	0.0275
Congestive Heart Failure	1.019	0.1445
Acute Myocardial Infarction	1.062	0.0281
Hypertension	0.952	0.0003
Cerebral Hemorrhage Merge, Ischemic or Unspecified Stroke	1.090	0.0059
Atherosclerosis of the Extremities with Ulceration or Gangrene	0.898	<.0001
COPD, Fibrosis of Lung and Other Chronic Lung Disorders	1.073	<.0001
Aspiration/Specified Bacterial Viral/Unspecified Pneumonias, Pneumococcal Pneumonia, Empyema, Lung Abscess, Pleurisy	1.051	0.0001
Kidney Transplant Status	1.234	0.0007
End Stage Renal Disease	1.152	<.0001

Acute Renal Failure	1.086	<.0001
Chronic Kidney Disease, Stage 5/Severe (Stage 4)/Unspecified Renal Failure	1.125	0.0156
Urinary Obstruction and Retention/Urinary Tract Infection	1.041	0.0013
Pelvic Inflammatory Disease and Other Specified Female Genital Disorders	0.817	0.0230
Other Female Genital Disorders, Male Genital Disorders	0.959	0.1238
Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or Bone, with Full Thickness Skin Loss	1.049	0.0116
Cellulitis, Local Skin Infection	0.973	0.1162
Traumatic Amputations and Complications, Amputation Status, Lower Limb/Amputation Complications	0.923	0.0270
Organ Transplant: 186-Major Organ; 187-Other Organ	1.148	0.0541
Artificial Openings for Feeding or Elimination	1.152	<.0001
Prior Acute Care Length of Stay (Reference group: LOS when prior acute was inpatient psychiatric facility)		
Prior Acute Length of Stay 1-7 days	1.432	0.0007
Prior Acute Length of Stay 8-11 days	1.491	0.0002
Prior Acute Length of Stay 12-30 days	1.603	<.0001
Prior Acute Length of Stay 30+ days	1.671	<.0001
Prior Acute ICU/CCU Days (Ref: p_ICU_CCU_0)		
1-3 ICU/CCU days associated with prior acute stay	1.030	0.1099
4-6 ICU/CCU days associated with prior acute stay	1.065	0.0006
7-9 ICU/CCU days associated with prior acute stay	1.062	0.0036
10-13 ICU/CCU days associated with prior acute stay	1.011	0.6267
14-18 ICU/CCU days associated with prior acute stay	1.030	0.2415
19-24 ICU/CCU days associated with prior acute stay	1.056	0.0555
25+ ICU/CCU days associated with prior acute stay	1.088	0.0082
Original Reason for Entitlement Codes		
Original reason for entitlement: 1-Disability Insurance Benefits (DIB)	1.071	<.0001

Original reason for entitlement: 2-ESRD; 3-BOTH Disability Insurance Benefit (DIB) and ESRD	1.154	<.0001
Prior Acute Care Utilization-Count of prior stays		
1 Stay - Acute history	1.366	<.0001
2 Stays - Acute history	1.576	<.0001
3 Stays - Acute history	1.865	<.0001
4 Stays - Acute history	2.134	<.0001
5 Stays - Acute history	2.366	<.0001
6 Stays - Acute history	2.691	<.0001
7 Stays - Acute history	2.746	<.0001
8 Stays - Acute history	3.147	<.0001
9 Stays - Acute history	3.149	<.0001
10+ Stays - Acute history	4.218	<.0001

Note: Number of observations: 2010/2011: 212,018. There were 51,438 in 2011/2012 unplanned readmissions. The c-statistic was .63.

Source: RTI International analysis of Medicare claims data, 2007-2012. (RTI program reference: lc22ltcv15gli0910.xlsx; lc22ltcv15gli_ltc0910_par.xlsx; lc22ltcv15gli_mean_0910.xlsx; lc22ltcv15gli1011.xlsx; lc22ltcv15gli_mean_1011.xlsx; lc22ltcv15gli_ltc1011_par.xlsx)

* The HCCs are derived from the prior acute claim secondary diagnoses or all inpatient claims in the year prior to the LTCH admission.

Table A2: Model Adjustment for All 9 Dual Status Categories (N = 177,835)

Variable	Estimate	Std. Error	P Value	OR	LCL	UCL
Intercept	-2.7952	0.1321	<.0001			
QMB (01)	0.02092	0.02795	0.4542	1.021	0.967	1.079
QMB w/ Medicaid (02)	0.07016	0.01425	<.0001	1.073	1.043	1.103
SLMB (03)	-0.03364	0.03709	0.3644	0.967	0.899	1.04
SLMB w Medicaid (04)	0.03456	0.0367	0.3464	1.035	0.963	1.112
QUAL (06)	0.01867	0.05033	0.7107	1.019	0.923	1.124
Other w/ Medicaid (08)	0.02594	0.01886	0.1691	1.026	0.989	1.065
Other (09)	0.1355	0.0794	0.0879	1.145	0.98	1.338

Note: Only 1 stay was QDWI (05), so it was moved to the Baseline so the model would converge. Hence Baseline consists of INT_DUAL_STUS_CD=NA (Non-Medicaid) and the 1 QDWI stay.
Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: DB19).

Table A3: Model Adjustment for Dual Status Indicators

Model	*n*	Variable	Estimate	Std. Error	*p*-Value	OR	LCL	UCL
Base Model: 2013 LTCH RM	177,835	Intercept	-2.7928	0.1321	<.0001			
Base + Any Dual	177,835	Any Dual	0.07832	0.01287	<.0001	1.081	1.055	1.109
Base + Full Dual	177,835	Full Dual	0.07633	0.01312	<.0001	1.079	1.052	1.107
Base + Non Medicaid Dual	171,009	Non Medicaid Dual	0.008934	0.02117	0.673	1.009	0.968	1.052
Base + QMB	171,009	QMB	0.06826	0.01384	<.0001	1.071	1.042	1.1
Base + SLMB	171,009	SLMB	-0.00054	0.02705	0.9842	0.999	0.948	1.054

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: DB19).

Table A4: Distribution of RSRRs across Facilities before and after adjustment for dual status

Variable	*n*	Mean	Std Error	Minimum	25th Pctl	Median	75th Pctl	Maximum
Base Model RSRR	439	24.98	0.10	19.32	23.56	24.88	26.28	32.72
RSRR account for Any Dual	439	24.98	0.10	19.44	23.56	24.88	26.23	32.67
Base RSRR – RSRR Any Dual	439	0.00	0.00	-0.17	-0.06	-0.02	0.04	0.45
RSRR Account for Full Dual	439	24.98	0.10	19.47	23.59	24.88	26.24	32.58
Base RSRR – RSRR Full Dual	439	0.00	0.00	-0.16	-0.06	-0.01	0.04	0.49
RSRR Account for Non Medicaid Dual	439	24.89	0.10	19.24	23.44	24.75	26.17	32.94
Base RSRR – RSRR Non-Medicaid Dual	439	0.09	0.01	-0.67	-0.09	0.06	0.26	0.92
RSRR Account for QMB	439	24.89	0.10	19.32	23.47	24.76	26.21	32.76
Base RSRR – RSRR QMB	439	0.09	0.01	-0.73	-0.11	0.07	0.29	1.11
RSRR Account for SLMB	439	24.89	0.10	19.25	23.44	24.75	26.18	32.93
Base RSRR – RSRR SLMB	439	0.09	0.01	-0.66	-0.09	0.06	0.26	0.92

Source: RTI analysis of Medicare and Area Health Resources File data for NQF #2512, based on index LTCH admissions in CY 2012-2013 (program reference: DB19).