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Adding Socioeconomic Data To Hospital Readmissions Calculations May Produce More Useful Results

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ABSTRACT To better understand the degree to which risk-standardized thirty-day readmission rates may be influenced by social factors, we compared results for hospitals in Missouri under two types of models. The first type of model is currently used by the Centers for Medicare and Medicaid Services for public reporting of condition-specific hospital readmission rates of Medicare patients. The second type of model is an "enriched" version of the first type of model with census tract–level socioeconomic data, such as poverty rate, educational attainment, and housing vacancy rate. We found that the inclusion of these factors had a pronounced effect on calculated hospital readmission rates for patients admitted with acute myocardial infarction, heart failure, and pneumonia. Specifically, the models including socioeconomic data narrowed the range of observed variation in readmission rates for the above conditions, in percentage points, from 6.5 to 1.8, 14.0 to 7.4, and 7.4 to 3.7, respectively. Interestingly, the average readmission rates for the three conditions did not change significantly between the two types of models. The results of our exploratory analysis suggest that further work to characterize and report the effects of socioeconomic factors on standardized readmission measures may assist efforts to improve care quality and deliver more equitable care on the part of hospitals, payers, and other stakeholders.

Hospital readmissions, particularly within the Medicare population, have been identified as a common, costly, and undesired health care outcome.[1,2] Readmission rates have been viewed as a hospital quality measure.[3,4] In 2013 the Centers for Medicare and Medicaid Services (CMS) began assessing financial penalties known as "readmissions adjustment factors" for hospitals with excess readmissions.[5] A variety of interventions have been proposed for reducing readmission rates, including transitional care interventions and increased partnerships with community-based institutions.[6,7] Given the resource-intensiveness of many of these interventions[8] and concerns about the effect of penalties on resource prioritization toward other safety and quality efforts,[9] hospitals face questions about how to use nationally reported risk-standardized readmission rates and other readily available data to assess the effect of various factors that potentially contribute to the risk of hospital readmission.

Social factors can be important determinants of health outcomes.[10,11] Patient factors such as race, ethnicity, education, income, and payer have been found to be related to readmission risk in various studies.[12–18] Factors such as median income of the county in which the hospital is located, safety-net hospital status, and predominantly minority patient mix have been found to be related to which hospitals are at greater risk of

readmissions penalties.[13,19–22] These findings have led to some controversy and a great deal of public debate on whether the readmissions measures used by CMS to penalize hospitals should control for socioeconomic factors. On one side of the debate are supporters of the existing policy to exclude socioeconomic factors from risk-adjustment models in order to maintain the visibility of differences in health outcomes for groups with different socioeconomic characteristics. The opposing argument supports controlling for socioeconomic factors to avoid disproportionately penalizing hospitals that care for a large number of patients from disadvantaged backgrounds and communities. The question underlying the debate is centered on whether the quality of care received in the hospital can influence the portion of the patient's risk of readmission that is attributable to his or her socioeconomic circumstances.

In addition to their role in hospital quality reporting and accountability, standardized readmission rates derived from established risk-adjustment models can also influence efforts to improve hospital quality by helping to identify high-risk patients with the information estimated with the models, such as which clinical conditions and socioeconomic characteristics significantly increase the patient's risk of being readmitted. Although social factors may interact with readmission risk and prevention in complex ways,[7,23,24] the effect of including social factors in models quantifying readmission rates is not well understood. A 2011 systematic review of risk-prediction models for hospital readmissions concluded that few validated readmission risk-prediction models incorporate variables associated with social determinants of health, such as the patient's income level, educational attainment, or access to health care.[25] Without models that include these factors, hospitals lack not only potentially valuable data about which patient populations are most vulnerable to adverse post-discharge outcomes but also information about how to interpret and respond to comparisons with peers regionally or nationally via targeted quality improvement efforts.

To better understand the impact of including social factors in the hospital readmission rate calculus, we conducted an exploratory analysis comparing risk-standardized readmission rates calculated with models that included census-tract socioeconomic factors with baseline models that only controlled for patient demographics and comorbid conditions. Our findings suggest that including socioeconomic factors in standardized readmission measures might increase the usefulness of these measures for hospitals, payers, and other stakeholders.

Study Data And Methods

We studied hospital readmissions for patients discharged from nonfederal acute care or critical-access hospitals in Missouri between June 1, 2009, and May 31, 2012, with principal diagnoses of acute myocardial infarction, heart failure, or pneumonia. The study's primary outcome was all-cause rehospitalization occurring within thirty days of an index admission discharge date (thirty-day all-cause readmission). To examine the effect of including social factors on calculated readmission rates, we used data from two sources. Patient-level discharge and clinical health history data were drawn from inpatient and outpatient administrative data sets compiled by the Missouri Hospital Association, Hospital Industry Data Institute. Census-tract variables were drawn from 2011 Truven Health Analytics and Nielsen Pop-Facts data.[26] For further information, see the online Appendix.[27] Census-tract data were used because of their wide availability for the statewide cohort of patients present in the discharge data set.

BASELINE AND SOCIOECONOMIC-FACTOR-ENRICHED MODELS We replicated the risk-standardized hierarchical models employed by CMS[28–30] to assess hospital performance on thirty-day readmissions for acute myocardial infarction, heart failure, and pneumonia, and we extended the models to include census-tract socioeconomic factors. For more information on the analytic methods used, see the online Appendix.[27] Although a variety of risk-prediction models exist that incorporate the relationship between clinical factors and readmission, the CMS models are widely used baseline measures that draw from data sources commonly available to hospitals and health systems; they also serve as the benchmark for penalties imposed by the CMS Hospital Readmission Reduction Program.[5]

Our analysis was informed by the conceptual model of Linda Calvillo-King and colleagues for the social factors that influence hospital readmissions.[18] This model divides social factors into multiple levels on the basis of the factor's ability to directly affect outcomes after hospital discharge and on data availability. Given our study's purpose as an exploratory analysis investigating the usefulness of social-factor indicators that are readily available to hospital stakeholders, we limited consideration to commonly available data sets that included relevant indicators that were nearly or completely populated for the patient populations of interest. We chose to use census-tract data from Truven Health Analytics and Nielsen for this purpose, and we linked selected elements to the patient's most recent address.[26] This allowed us to explore the effect of social factors on patients' risk of readmission while

using sources of data available for patients statewide. In addition, we included whether a patient was discharged to a skilled nursing facility within the thirty days prior to an admission and whether the effect of discharging a patient to home varied across levels of census-tract attributes. These two elements served as proxies for the potential influence of the discharge setting and the availability of community-based postacute care. For example, we tested whether patients discharged home to a high-poverty census tract (defined as quintile 5) faced greater risk of readmission compared to patients discharged home to more affluent census tracts (defined quintiles 1–4). Essentially identical results were found with and without the inclusion of these discharge disposition factors.

INCLUSION AND EXCLUSION CRITERIA This analysis included Missouri Medicare fee-for-service patients ages sixty-five and older discharged from Missouri hospitals with principal diagnoses of acute myocardial infarction, heart failure, or pneumonia (Appendix Exhibit 1).[27] Discharges with an inpatient hospital death, transfer on discharge to another acute care facility, zero days to the next admission, discharges against medical advice, nonacute patients, and records with invalid addresses or unique patient identifiers were excluded (Appendix Exhibit 2).[27] In accordance with the CMS methodology, hospitalizations for revascularization procedures following an admission for acute myocardial infarction were considered planned readmissions and were also excluded.[31]

ANALYSIS We compared thirty-day all-cause hospital readmission rates by patients' age, race, and sex as well as by census-tract poverty rate, median income, educational attainment, housing vacancy rate, and unemployment rate. We then created socioeconomic-factor-enriched models using a backward selection stepwise regression approach on a group of candidate socioeconomic variables interacted with race and whether the patient was discharged home following the index admission. A detailed description of the candidate variables, the variable selection process used, and the final enhanced models are presented in Appendix Exhibits 4 and 9.[27]

We calculated the risk-standardized readmission rates for each hospital using both the baseline and socioeconomic-factor-enriched models and compared the resulting differences in rates across hospitals for each condition.[32]

LIMITATIONS Our study had several limitations. First, our decision to use data sources and factors commonly available for patients across our statewide discharge data set meant that individual-level data on social factors were not included. Although this choice reflects the real-world limitations of standard hospital administrative data, the lack of social factors at the patient level means that this analysis cannot differentiate between effects due to individual factors, neighborhood factors, or differential treatment by health care providers.

Second, our exploratory use of individual census-tract factors rather than a derived census tract–level composite index[33] limited the ability of our analysis to examine the association of more complex census-tract socioeconomic or environmental constructs with readmissions. Our study was not designed to directly capture specific constructs with a potentially more direct association with postdischarge outcomes.

Third, we would be remiss to assume that the average traits of a census tract are representative of all of its residents. Social factors vary across census tracts, and these factors may affect individual patients in different ways.

Fourth, our study was restricted to discharges of Missouri residents from Missouri hospitals. It is unclear whether these specific results are applicable to other settings.

Fifth, because our analysis required a linkage to census-tract data, discharges without a patient residence were excluded. These excluded discharges had a higher proportion of African American patients than the patient cohorts used and may also lead to underrepresentation of patients who are homeless or otherwise transient.

Study Results

This analysis included 12,070 index admissions with a principal diagnosis of acute myocardial infarction involving 11,392 unique patients; 29,849 index admissions with a principal diagnosis of pneumonia involving 25,729 unique patients; and 29,874 index admissions with a principal diagnosis of heart failure involving 22,433 unique patients. The patients in these cohorts were generally elderly, with median ages of seventy-eight years for acute myocardial infarction, eighty-one years for heart failure, and eighty years for pneumonia. Each cohort consisted of predominantly white patients. The acute myocardial infarction cohort had a majority of male patients, while the pneumonia and heart failure groups were predominantly female (Appendix Exhibit 5).[27]

The census tracts represented in these discharges spanned a wide range of income, education, and housing characteristics. For example, the tenth and ninetieth interpercentile range for families in poverty was 25.5 points (2.4–27.9 percent). Wide ranges between the tenth and ninetieth percentiles were also found for the percentage of adults ages twenty-five and older with less

than a high school education (4.5–27.5 percent) and the percentage of housing unit vacancies (3.5–23.9 percent) (Appendix Exhibit 6).[27] Overall, the unadjusted readmission rate was 16.2 percent for discharges with a principal diagnosis of acute myocardial infarction, 19.3 percent for heart failure, and 15.0 percent for pneumonia.

Inclusion of census tract–level socioeconomic factors in the models significantly reduced the variation in risk-adjusted performance among hospitals (Exhibit 1). Although the average risk-standardized readmissions rate did not change significantly for any of the cohorts, the overall range of hospital performance in each of the measures was substantially narrower, declining from a range of 6.5 to 1.8 percentage points for acute myocardial infarction, 14.0 to 7.4 percentage points for heart failure, and 7.4 to 3.7 percentage points for pneumonia. In general, risk-standardized readmission rates calculated using the socioeconomic-factor-enriched models increased toward the mean for hospitals with low rates and decreased toward the mean for hospitals with high rates (Appendix Exhibit 10).[27]

Discussion

Multiple social factors have been associated with hospital readmissions, including patient-level characteristics such as race, income, and education[12–14,16,18] and community-level characteristics such as regional hospitalization rates[23] and county median income,[20] but many risk-prediction models do not include these factors. This exploratory analysis compared the performance of models for hospital readmissions that incorporate socioeconomic data from the patient's census tract with standard risk-prediction models that do not include these factors. We found that the inclusion of these factors had significant effects on calculated hospital performance, with greatly reduced variance in hospital risk-standardized readmission rates.

These findings demonstrate the potential contribution of selected, commonly available data on hospital performance measures for the three conditions included currently in the CMS Hospital Readmissions Reduction Program. The changes in calculated hospital performance when social factors are included suggest the potential importance of better understanding the different contributors to adverse postdischarge outcomes, both within and outside the hospital.

In this study we supplemented demographic and clinical information typically available in hospital discharge data with census-tract data across multiple domains. Because we were limited to the use of readily available census-tract factors rather than patient-level factors, this study could not distinguish specific social-factor mechanisms leading to increased hospital readmissions risk. However, it nevertheless suggests the extent to which these factors may contribute to variation in risk-standardized hospital readmission rates.

The exploratory nature of this analysis limits the strength of the conclusions that can be drawn. However, given the current policy discussions over whether CMS risk-standardized models should include socioeconomic factors, our findings raise the question of the degree to which the currently reported risk-standardized readmission rates may reflect the social factors of a hospital's patient mix as well as hospital quality.

A recent expert panel convened by the Commonwealth Fund and the Institute for Healthcare Improvement[34] highlighted the important distinction between the use of metrics for accountability and the use of metrics for improvement. This distinction is important in assessing the potential policy implications of our analysis. We do not suggest that the results of our analysis be used to support the adjustment of rates to make the presence of disparities less apparent or to hold health systems caring for populations at risk for poorer health outcomes less accountable. Rather, we suggest that a better understanding of the effect of social factors on publicly reported rates used for hospital comparison is important in order to help target quality improvement efforts to reduce the impact of social factors on readmissions and to support hospitals' efforts to care for vulnerable populations.

Understanding the relative effects of social factors on reported readmission rates may help

EXHIBIT 1

Hospital Risk-Standardized Readmission Rates, By Calculation Method, June 2009 To May 2012

		Hospital risk-standardized readmission rates			
		Baseline model		Socioeconomic-factor-enriched model	
Principal diagnosis	No. of hospitals	Mean (%)	Range (%)	Mean (%)	Range (%)
Acute myocardial infarction	49	16.4	14.0–20.5	16.3	15.3–17.1
Heart failure	100	19.3	14.5–28.5	19.5	17.6–25.0
Pneumonia	109	15.1	11.2–18.6	15.1	13.4–17.1

SOURCE Authors' analysis of 2009–12 data from the Missouri Hospital Association, Hospital Industry Data Institute, and 2011 Truven Health Analytics and Nielsen data. **NOTES** The decreased variance in risk-standardized readmission rates between the two models was significant for all three diagnoses ($p < 0.001$). Differences in the mean readmission rates between the two models were not significant.

hospitals better target improvement efforts at an organizational level by providing information about how to interpret comparisons with peers regionally or nationally.

If risk-standardized readmission rates for hospital comparison reflect the influence of social factors as well as hospital quality, potential policy implications include the need to support efforts to create standardized methods for representing and quantifying the effect of social factors on metrics used for quality reporting as well as the need for reporting of these effects along with risk-standardized rates that do not include these factors.

An additional issue illustrated is the limitations of data routinely available to hospitals. The interactions between social factors and health outcomes are complex.[10,18] In the area of readmissions, the Calvillo-King conceptual model for the potential effect of social factors on risk of readmission and mortality for pneumonia and heart failure includes social, clinical, provider, and system factors.[18] Social factors are divided into three levels based on both ease of data collection and on the potential to directly affect outcomes. Sociodemographic (level 1) factors are readily available in administrative databases and were already present in the hospital discharge data available to us. Socioeconomic (level 2), behavioral, sociocognitive, social environmental, and neighborhood (level 3) factors may require additional data collection such as patient interviews or medical record review. These factors were largely unavailable in our hospital administrative data. The additional data, resources, and expertise required to implement studies to assess and intervene on factors mediating associations between demographic factors and preventable readmission risk may not be readily available to institutions with limited resources. Additionally, prioritizing factors and areas to study will also be important for organizations, given the potentially resource-intensive nature of these studies.[8] Policies that support efforts to create standardized methods for representing and quantifying the effect of social factors on metrics used for quality reporting could help organizations in these efforts.

Understanding the relative effects of social factors on reported readmission rates may help hospitals better target improvement efforts at an organizational level.

Conclusion

The decreased variation in the risk-standardized readmission rates in our results may raise concerns that the inclusion of social factors simply decreases the ability to discriminate among hospitals with different performance. It may also raise concerns about the extent to which the inclusion of these factors may obscure the detection of important disparities in care. However, these results are not presented to suggest that these factors be included in the models used to assess differences in hospital performance and assess penalties. They are presented, rather, to demonstrate empirical information that can be gleaned from commonly available data sources. Determining how such factors should be considered in assessing differences in hospital performance and assessing penalties was not the purpose of our investigation; however, we believe careful consideration should be given to potential limitations of current approaches.

As health care providers change the way care is delivered, it is important that care for patients from vulnerable populations not be compromised. Having an improved understanding of the role of social factors in postdischarge outcomes can assist hospitals' decision making around prioritizing and evaluating interventions to improve transitional care. ■

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