

## HEALTH POLICY

# Association of Patient Social, Cognitive, and Functional Risk Factors with Preventable Hospitalizations: Implications for Physician Value-Based Payment



Kenton J. Johnston, PhD<sup>1</sup>, Hefei Wen, PhD<sup>2</sup>, Mario Schootman, PhD<sup>3</sup>, and Karen E. Joynt Maddox, MD, MPH<sup>4</sup>

<sup>1</sup>Department of Health Management and Policy and Center for Outcomes Research, College for Public Health and Social Justice, Saint Louis University, St. Louis, MO, USA; <sup>2</sup>Department of Health Management and Policy, University of Kentucky, Lexington, KY, USA; <sup>3</sup>Department of Clinical Analytics and Insights, Center for Clinical Excellence, SSM Health, St. Louis, MO, USA; <sup>4</sup>Cardiovascular Division, Washington University School of Medicine, St. Louis, MO, USA.

**BACKGROUND:** Ambulatory care-sensitive condition (ACSC) hospitalizations are used to evaluate physicians' performance in Medicare value-based payment programs. However, these measures may disadvantage physicians caring for vulnerable populations because they omit social, cognitive, and functional factors that may be important determinants of hospitalization.

**OBJECTIVE:** To determine whether social, cognitive, and functional risk factors are associated with ACSC hospitalization rates and whether adjusting for them changes outpatient safety-net providers' performance.

**DESIGN:** Using data from the Medicare Current Beneficiary Survey, we conducted patient-level multivariable regression to estimate the association (as incidence rate ratios (IRRs)) between patient-reported social, cognitive, and functional risk factors and ACSC hospitalizations. We compared outpatient safety-net and non-safety-net providers' performance after adjusting for clinical comorbidities alone and after additional adjustment for social, cognitive, and functional factors captured in survey data.

**SETTING:** Safety-net and non-safety-net clinics.

**PARTICIPANTS:** Community-dwelling Medicare beneficiaries contributing 38,616 person-years from 2006 to 2013.

**MEASUREMENTS:** Acute and chronic ACSC hospitalizations.

**RESULTS:** After adjusting for clinical comorbidities, Alzheimer's/dementia (IRR 1.30, 95% CI 1.02–1.65), difficulty with 3–6 activities of daily living (ADLs) (IRR 1.43, 95% CI 1.05–1.94), difficulty with 1–2 instrumental ADLs (IADLs, IRR 1.54, 95% CI 1.26–1.90), and 3–6 IADLs (IRR 1.90, 95% CI 1.49–2.43) were associated with acute ACSC hospitalization. Low income (IRR 1.28, 95% CI 1.03–1.58), lack of educational attainment (IRR 1.33, 95% CI 1.04–1.69), being unmarried (IRR 1.18, 95% CI 1.01–1.36), difficulty with 1–2 IADLs (IRR 1.30, 95% CI 1.05–1.60), and 3–6 IADLs (IRR 1.44, 95% CI 1.16–1.80) were associated with chronic ACSC hospitalization.

Adding these factors to standard Medicare risk adjustment eliminated outpatient safety-net providers' performance gap ( $p < .05$ ) on ACSC hospitalization rates relative to non-safety-net providers.

**CONCLUSIONS:** Social, cognitive, and functional risk factors are independently associated with ACSC hospitalizations. Failure to account for them may penalize outpatient safety-net providers for factors that are beyond their control.

**KEY WORDS:** physician value-based payment; Medicare; safety-net providers.

J Gen Intern Med 34(8):1645–52

DOI: 10.1007/s11606-019-05009-3

© Society of General Internal Medicine 2019

## INTRODUCTION

Medicare is moving from traditional fee-for-service to value-based payment models, in which physicians are held accountable for quality and costs of care.<sup>1, 2</sup> One component of these programs is physicians' performance on preventable hospitalizations, which comprise a significant proportion of spending under the Medicare program. Medicare assesses performance on preventable hospitalizations using ambulatory care-sensitive condition (ACSC) hospitalizations, developed by the Agency for Healthcare Research and Quality (AHRQ). ACSCs are validated measures comprised of acute and chronic diagnoses commonly treated in the primary care setting like heart failure, chronic pulmonary disease, and urinary tract infection, where prompt access to high-quality outpatient care could plausibly prevent the need for hospital-based care.<sup>3, 4</sup>

The ACSCs are currently used in Medicare Accountable Care Organization (ACO) programs as well as in the Physician Value-Based Payment Modifier program,<sup>5, 6</sup> and are under consideration for use for the Merit-based Incentive Payment System (MIPS).<sup>7</sup> However, the ACSC hospitalization measures are currently only risk adjusted for age and gender.<sup>3</sup> As a result, their use as performance measures has been controversial because unmeasured patient risk factors may lead to biased physician performance scores and unwarranted financial penalties.

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s11606-019-05009-3>) contains supplementary material, which is available to authorized users.

Received August 18, 2018

Revised December 4, 2018

Accepted March 4, 2019

Published online April 25, 2019

For other performance measures, the Centers for Medicare and Medicaid Services (CMS) adjusts for medical risk using clinical comorbidities from the hierarchical condition categories (HCCs), which include a number of medical conditions such as heart failure, diabetes, and kidney disease.<sup>8</sup> However, most outcome or quality measures used by CMS for value-based payment (VBP) are not adjusted for social risk factors such as poverty, cognitive risk factors such as mental health diagnoses or dementia, or functional status. These unaccounted patient risk factors are known to be associated with health outcomes and are largely outside of physicians' control.<sup>9–16</sup>

In the presence of inadequate risk adjustment, the ACSC hospitalization measures could lead to inappropriate penalties for outpatient providers, such as safety-net clinics, that serve a high proportion of individuals with social, cognitive, and functional needs.<sup>17, 18</sup> Penalties to such providers, often operating on already-thin margins, could be harmful.<sup>19, 20</sup> Understanding relationships between these patient risk factors and ACSC hospitalizations, as well as the impact of these relationships on outpatient safety-net providers' performance on the acute and chronic ACSCs, is crucial as VBP models proliferate more broadly. While these issues have been studied in inpatient VBP, there is a current lack of evidence in the literature on how these risk factors may impact provider performance in outpatient care.

Therefore, we set out to answer two research questions. First, are patient social, cognitive, and functional risk factors associated with higher incidence of acute and chronic ACSC hospitalizations? Second, does adjusting for these patient risk factors impact outpatient safety-net provider performance on ACSC hospitalizations relative to non-safety-net providers?

## METHODS

### Data and Study Sample

We conducted a retrospective observational study using secondary cohort data from the Medicare Current Beneficiary Survey (MCBS) linked to survey respondents' fee-for-service (FFS) Medicare claims and administrative data for the years 2006–2013. The MCBS is an annual nationally representative survey of the Medicare population with a rotating 4-year cohort design.<sup>21</sup>

We limited the sample to community-dwelling beneficiaries who had at least 2 years of continuous enrollment in part A and part B, and at least one annual physician/clinic visit in the baseline year as identified by evaluation and management visits (BETOS codes M1A, M1B, M4A, M4B, M5C, M5D, M6 and revenue center codes 0521, 0522, 0525) and positive covered dollar amounts. This requirement ensures that all patients included in the performance measure were treated by outpatient providers prior to the potential occurrence of the "preventable" hospitalization for which the providers were held accountable. We used MCBS longitudinal survey weights to compute nationally representative estimates of the Medicare

fee-for-service population. These weights account for the overall selection probability of each person sampled and include adjustments for stratified sampling design, survey non-response, and coverage error.

### Predictor Variables

Our predictor variables were patient social, cognitive, and functional risk factors (online Appendix Table 1) measured in the baseline year. We assessed social risk factors using self-reported measures of material capital (annual income), human capital (highest level of education attained), and social support (marital status). For cognitive risk factors, we used patient self-report (or patient's proxy respondent's report) of having been diagnosed with depression or Alzheimer's/dementia or a confirmatory diagnosis in their medical claims using ICD-9-CM codes defined by CMS<sup>22</sup>; Alzheimer's/dementia is not included in the CMS-HCC risk model.<sup>23</sup> In addition, although the CMS-HCC model includes acute major depressive, bipolar, and paranoid disorders, it does not include diagnosis codes for less acute but more common types of depression such as persistent depressive disorders and depressive disorders not classified as major depression. For functional status, we grouped counts of self-reported activities of daily living (ADLs) and instrumental ADLs (IADLs) done with difficulty or unable to do into no limitations (0), mild/moderate limitations (1, 2), and severe limitations (3–6).<sup>24, 25</sup>

### Acute and Chronic Composite Ambulatory Care-Sensitive Hospitalization Measures

Our outcome variables were the acute and chronic composite ACSCs measured in the year after baseline. The acute ACSC measure includes hospitalizations for dehydration, bacterial pneumonia, and urinary tract infection.<sup>26</sup> The chronic ACSC measure includes hospitalizations for diabetes complications, lower extremity amputation, chronic obstructive pulmonary disease, asthma, hypertension, heart failure, and angina without procedure.<sup>27</sup>

### Safety-Net Versus Non-Safety-Net

We defined safety-net practices as federally qualified health centers (FQHCs) and rural health clinics (RHCs). We identified all patients that visited these facilities at least once during the year using revenue center codes beginning with "052" in their outpatient claims data. All other beneficiaries in the sample were considered non-safety-net.

### Statistical Analysis

First, we computed weighted descriptive statistics from the MCBS for our predictor variables and the CMS-HCC risk score version V1210.70.F2.<sup>23, 28</sup> This version of the HCC risk score includes age, gender, original reason for Medicare entitlement, dual enrollment in Medicaid, and a set of ICD-9-CM diagnosis codes; it ranges from 0.12 to 9.41 in our data and has

a mean of 0.98. A higher score implies a sicker patient and a score of 1.00 implies a patient of average severity across the entire Medicare population.<sup>23, 28</sup> We used the Wald test to compare differences in proportions (or means) across patient subgroups with versus without the acute and chronic ACSC hospitalizations as well as across safety-net versus non-safety-net patients. In addition, we computed overall mean annual acute and chronic ACSC hospitalization rates per 100 patients for each of the patient subgroups.

Next, we estimated two patient-level multivariable negative binomial regression models estimating the association between each predictor variable measured at baseline and the following-year ACSC hospitalization measures after adjusting for HCC risk score and risk score squared, which is the method used in CMS's Total per Capita Costs of Care measure. In the first model, we assessed the association of the social, cognitive, and functional risk factor variables with the acute composite ACSC hospitalization measure. In the second model, we assessed the association of the same variables with the chronic composite ACSC hospitalization measure. Both models included year fixed effects to control for secular trends and adjusted for the complex survey design of the MCBS and intra-person correlation over time. We report our negative binomial regression results as incidence rate ratios (IRRs) with 95% confidence intervals (CIs).

Lastly, we estimated safety-net versus non-safety-net providers' performance on predicted rates of acute and chronic composite ACSC hospitalizations under three modelling scenarios: (1) AHRQ specifications, which include only age and gender; (2) standard CMS-HCC risk adjustment; and (3) adding social, cognitive, and functional risk factors to the CMS-HCC model. We then compared safety-net with non-safety-net providers on their unadjusted ACSC hospitalization rates as well as their predicted rates under these three modelling scenarios to see if there were statistically significant differences. We further calculated observed-to-expected ratios under each scenario.

This study was approved by the Saint Louis University Institutional Review Board. We performed analyses using SAS version 9.4 and Stata version 14.

## RESULTS

### Patient Sample and Characteristics

Of 169,429,155 (weighted) patient years eligible for inclusion in the study, we excluded 11,505,273 (6.8%) for patients with end-stage renal disease, institutionalized in long-term care, or without a valid US zip code (online Appendix Figure 1). Our final study population consisted of 157,923,882 patient years (38,616 unweighted patient years).

The mean annual acute and chronic ACSC hospitalization rates were 2.2 and 3.7 per 100 beneficiaries, respectively (Table 1). Beneficiaries with ACSC hospitalizations were older, more likely to be dually enrolled in Medicare and

Medicaid, and had higher HCC risk scores ( $p < .001$ ). Individuals with lower income, less educational attainment, unmarried status, depression, dementia, and difficulty with three or more ADLs or IADLs had markedly higher observed acute and chronic ACSC hospitalization rates ( $p < .001$ ). In addition, as shown in Table 1, beneficiaries who were safety-net patients were more likely to be younger, disabled, dually enrolled in Medicaid, have lower HCC risk scores, have lower income, have less educational attainment, be unmarried, have depression, and have more ADLs or IADLs with difficulty ( $p < .05$ ).

### Relationship Between Social, Cognitive, and Functional Risk Factors and ACSCs

The mean annual acute and chronic ACSC rates were 2.2 and 3.7 per 100 beneficiaries, respectively (Table 2). After applying the CMS-HCC risk adjustment, having Alzheimer's/dementia (IRR 1.30, 95% CI 1.02–1.65), difficulty with 3–6 ADLs (IRR 1.43, 95% CI 1.05–1.94), difficulty with 1–2 IADLs (IRR 1.54, 95% CI 1.26–1.90), and difficulty with 3–6 IADLs (IRR 1.90, 95% CI 1.49–2.43) were associated with higher incidence of acute ACSC hospitalization (Table 2). There was no relationship between acute ACSC hospitalization and income, education, marital status, or depression.

After adjusting for the CMS-HCC risk score, income less than \$25,000 (IRR 1.28, 95% CI 1.03–1.58), no high school or college education (IRR 1.33, 95% CI 1.04–1.69), being unmarried (IRR 1.18, 95% CI 1.01–1.36), difficulty with 1–2 IADLs (IRR 1.30, 95% CI 1.05–1.60), and difficulty with 3–6 IADLs (IRR 1.44, 95% CI 1.16–1.80) were associated with higher incidence of chronic ACSC hospitalization (Table 2). There was no relationship between chronic ACSC hospitalization and depression, dementia, or difficulty with ADLs.

### Impact of Adding Social, Cognitive, and Functional Factors to Risk Adjustment

Patients who utilized safety-net providers had similar ( $p = 0.247$ ) observed acute ACSC hospitalization rates compared with patients who utilized non-safety-net providers (2.50 vs. 2.15 per 100 patients, respectively, Table 3). However, under both the age and gender risk adjustment model and the standard CMS-HCC risk adjustment model, safety-net providers' patients were predicted to have a significantly ( $p < .05$ ) lower rate of acute ACSC hospitalization than non-safety-net providers' patients. Adding patient social, cognitive, and functional risk factor variables to the standard CMS-HCC risk adjustment in the third modelling scenario increased the predicted acute ACSC hospitalization rate for safety-net providers' patients from 2.06 to 2.27 (per 100), so that there was no longer a significant difference between the predicted rates for safety-net versus non-safety-net providers. The observed-to-expected acute ACSC ratio (Fig. 1) for safety-net providers was 1.21 under age/gender adjustment and 1.23 under HCC adjustment, indicating performance roughly 20% worse than expected, but fell to 1.10 after adding the

Table 1 Prevalence of Patient Social, Cognitive, and Functional Health Risk Factors in Fee-for-Service Medicare Beneficiaries

	Overall	Annual prevalence by following year ambulatory care-sensitive complication (ACSC) hospitalizations				Annual prevalence by baseline safety-net versus non-safety-net patients		
		No ACSCs	Acute ACSCs	Chronic ACSCs	<i>p</i> value <sup>†</sup>	Safety-net	Non-safety-net	<i>p</i> value <sup>†</sup>
Total number of patient years, unweighted, <i>N</i>	38,616	36,682	842	1194	–	4437	34,179	–
Total number of patient years, weighted, <i>N</i> *	157,923,882	150,389,762	3,178,909	4,728,987	–	16,141,417		
141,782,465	–							
Acute ACSC hospitalizations, per 100	2.2	0.0	108.6	9.0	<.001	2.5	2.2	0.247
Chronic ACSC hospitalizations, per 100	3.7	0.0	18.3	123.5	<.001	4.2	3.6	0.339
Prior year risk factors								
CMS/Medicare HCC risk score adjustment factors								
Age in years								
< 65	16.0	16.1	14.4	13.7	0.527	28.0	14.7	<.001
65–75	45.0	45.5	30.9	35.7	<.001	40.8	45.4	<.001
75–84	29.6	29.2	37.0	37.1	<.001	23.9	30.2	<.001
≥ 85	9.4	9.1	17.7	13.6	<.001	7.3	9.6	<.001
Sex								
Female	57.3	57.4	59.5	54.1	0.082	59.0	57.1	0.155
Male	42.7	42.6	40.5	45.9		41.0	42.9	
Original reason for Medicare eligibility								
Disabled	15.5	15.6	13.6	13.1	0.454	26.9	14.2	<.001
Age ≥ 65 years	84.5	84.4	86.4	86.9	0.445	73.1	85.8	<.001
Dual enrollee in Medicaid and Medicare	16.3	16.0	23.3	22.5	<.001	31.5	14.6	<.001
HCC risk score (mean)	0.98	0.94	1.69	1.79	<.001	0.91	0.99	<.001
Social risk factors								
Annual income								
< \$25,000	42.5	41.9	53.6	54.3	<.001	61.4	40.3	<.001
≥ \$25,000	34.4	34.6	32.6	29.9	0.002	25.7	35.4	<.001
≥ \$50,000/unknown	23.1	23.5	13.8	15.7	<.001	12.9	24.3	<.001
Education								
No high school or college education	22.1	21.6	30.9	32.9	<.001	35.1	20.6	<.001
High school/some college education	57.3	57.5	54.5	52.0	0.001	56.2	57.4	0.392
College/graduate school education	20.6	20.9	14.6	15.1	<.001	8.7	22.0	<.001
Not married	47.5	47.1	56.3	56.3	<.001	53.6	46.8	0.001
Cognitive risk factors								
Depression	20.3	19.9	30.7	27.8	<.001	26.9	19.5	<.001
Alzheimer's/dementia	5.9	5.7	12.5	10.4	<.001	6.1	5.9	0.721
Functional risk factors								
ADLs with difficulty/cannot do								
0 ADLs	68.1	69.0	44.8	51.5	<.001	63.5	68.6	<.001
1–2 ADLs	22.2	21.7	32.2	32.9	<.001	24.7	21.9	0.015
3–6 ADLs	9.7	9.3	23.0	15.6	<.001	11.8	9.5	0.010
IADLs with difficulty/cannot do								
0 IADLs	59.2	60.2	32.6	39.9	<.001	52.0	60.0	<.001
1–2 IADLs	27.5	27.1	36.5	36.3	<.001	30.6	27.2	0.004
3–6 IADLs	13.3	12.7	30.8	23.8	<.001	17.4	12.8	<.001

*N*, number; HCC, hierarchical condition categories; ADLs, activities of daily living; IADLs, instrumental ADLs

\*Weighted estimates from the 2006–2013 Medicare Current Beneficiary Survey (MCBS) for all Medicare patients with at least 2 years of enrollment in Medicare part A and part B and having completed the fall survey rounds of the MCBS (after applying exclusion criteria). Using the MCBS longitudinal (with 1-year lookback) survey weights accounting for the overall annual selection probability of each person sampled and including adjustments for the stratified sampling design, survey nonresponse, and coverage error

†*p* values for difference in means within categories (Wald's test). Survey estimation commands were used to adjust *p* values for the complex survey design of the MCBS and robust clustered on individuals to account for within-person correlation due to the same persons appearing in the data more than once over multiple years

additional risk factors, suggesting that half of these providers' poor performance was explained by differences in patient population related to these parameters.

Patients who utilized safety-net providers also had similar ( $p = 0.339$ ) chronic ACSC hospitalization rates compared with

patients who utilized non-safety-net providers (4.21 vs. 3.64 per 100 patients, respectively, Table 3). Once again, under both the age and gender risk adjustment model and the standard CMS-HCC risk adjustment model, safety-net providers' patients were predicted to have a significantly ( $p < .05$ ) lower rate of chronic ACSC hospitalization than non-safety-net

**Table 2** The Association of Patient Social, Cognitive, and Functional Health Risk Factors with Following-Year Incidence of Ambulatory Care-Sensitive Complication Hospitalizations

	Acute ACSC hospitalizations		Chronic ACSC hospitalizations	
	Incidence rate ratio	95% CI	Incidence rate ratio	95% CI
Total number of patient years, unweighted	<i>N</i> = 38,616		<i>N</i> = 38,616	
Total number of patient years, weighted*	<i>N</i> = 157,923,882		<i>N</i> = 157,923,882	
ACSC hospitalizations, mean rate per 100	2.19		3.70	
CMS HCC risk adjustment				
HCC risk score (1 point change)	3.03	(2.45, 3.75)	4.81	(4.04, 5.73)
HCC risk score squared	0.89	(0.86, 0.93)	0.84	(0.82, 0.87)
Social risk factors				
Annual income				
< \$25,000	1.20	(0.87, 1.65)	1.28	(1.03, 1.58)
≥ \$25,000	1.27	(0.92, 1.75)	1.15	(0.97, 1.38)
≥ \$50,000/unknown	Reference		Reference	
Education				
No high school or college education	1.23	(0.93, 1.63)	1.33	(1.04, 1.69)
High school/some college education	1.06	(0.80, 1.40)	1.00	(0.82, 1.22)
College/graduate school education	Reference		Reference	
Not married	1.09	(0.92, 1.31)	1.18	(1.01, 1.36)
Cognitive risk factors				
Depression	1.19	(0.99, 1.43)	1.03	(0.85, 1.25)
Alzheimer's/dementia	1.30	(1.02, 1.65)	1.16	(0.93, 1.44)
Functional risk factors				
ADLs with difficulty/cannot do				
0 ADLs	Reference		Reference	
1–2 ADLs	1.23	(0.97, 1.57)	1.12	(0.93, 1.34)
3–6 ADLs	1.43	(1.05, 1.94)	0.81	(0.62, 1.06)
IADLs with difficulty/cannot do				
0 IADLs	Reference		Reference	
1–2 IADLs	1.54	(1.26, 1.90)	1.30	(1.05, 1.60)
3–6 IADLs	1.90	(1.49, 2.43)	1.44	(1.16, 1.80)

*N*, number; ACSC, ambulatory care-sensitive complications; HCC, hierarchical condition categories; ADLs, activities of daily living; IADLs, instrumental ADLs; HSA, hospital service area

We estimate multivariable negative binomial regression models. We include year fixed effects to control for secular trend and also adjust our *p* values for the complex survey design of the MCBS and intra-person correlation over time

\*Weighted estimates from the 2006–2013 Medicare Current Beneficiary Survey (MCBS) for all Medicare patients with at least 2 years of enrollment in Medicare part A and part B and having completed the fall survey rounds of the MCBS (after applying exclusion criteria). Using the MCBS longitudinal (with 1-year lookback) survey weights accounting for the overall annual selection probability of each person sampled and including adjustments for the stratified sampling design, survey nonresponse, and coverage error

providers' patients. Adding patient social, cognitive, and functional risk factor variables to the standard CMS-HCC risk adjustment in the third modelling scenario increased the predicted chronic ACSC hospitalization rate for safety-net providers' patients from 3.45 to 3.83 (per 100), so that there was no longer a significant difference ( $p < .05$ ) between the predicted rates for safety-net versus non-safety-net providers. The observed-to-expected chronic ACSC ratio (Fig. 1) for safety-net providers was 1.20 under age/gender adjustment and 1.22 under HCC adjustment, but fell to 1.10 after adding the additional risk factors, suggesting again that half of these providers' poor performance was explained by differences in patient population related to these parameters.

### Sensitivity Analyses

We conducted sensitivity analyses around our definition of safety-net patients whereby we defined beneficiaries with annual income less than \$25,000 as probable safety-net users. We then compared observed and predicted rates of acute and chronic ACSC hospitalization for low-income versus non-low-income beneficiaries (online Appendix Table 2). We found that adding patient social, cognitive, and functional risk

factor variables to the standard CMS-HCC risk adjustment increased the predicted ACSC hospitalization rates for low-income beneficiaries to be more in line with their observed rates and decreased the predicted rates for non-low-income beneficiaries to be more in line with their observed rates. This finding confirmed our main results.

### DISCUSSION

In this nationally representative study of community-dwelling Medicare beneficiaries, we found that patient-reported social, cognitive, and functional risk factors were common, and associated with higher incidence of acute and chronic ACSC hospitalization. Furthermore, these risk factors were more common among safety-net-providers' patients; adding them to the standard CMS-HCC risk adjustment model reduced safety-net providers' underperformance on the acute and chronic ACSCs relative to non-safety-net providers.

The acute and chronic composite ACSC hospitalization measures were designed by AHRQ to measure hospitalizations that can be prevented if patients receive timely and effective outpatient care in the community.<sup>3</sup> For instance, if

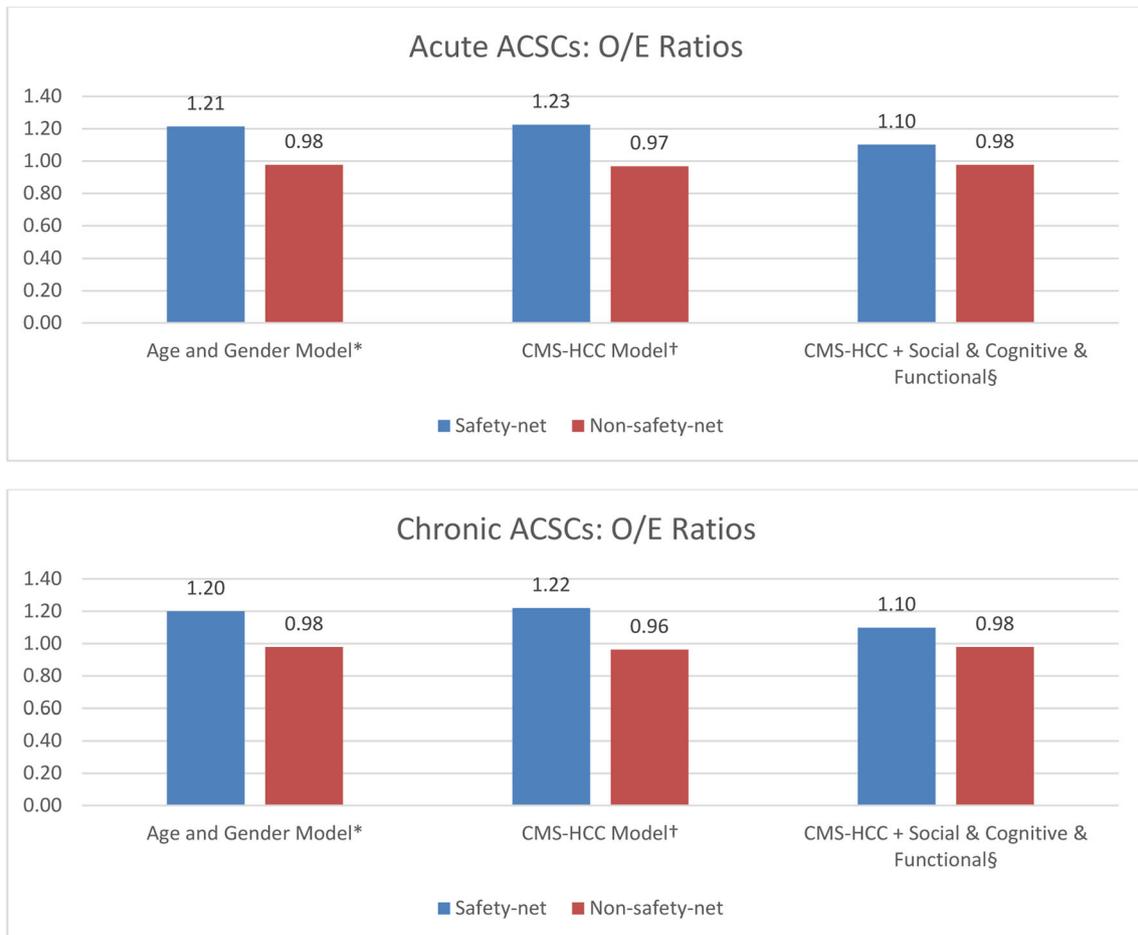
**Table 3 Does Adjusting for Previously Unobserved Medicare Patient Characteristics in Addition to Age and Gender and the Standard CMS-HCC Model Affect Safety-Net Provider Performance on the Acute and Chronic ACSC Hospitalization Composite Measures?**

	Unadjusted	Age and gender model*	CMS-HCC model†	CMS-HCC + social, cognitive, & functional‡
	Observed ACSCs (per 100)	Predicted ACSCs (per 100)	Predicted ACSCs (per 100)	Predicted ACSCs (per 100)
<b>Panel A—acute ACSC hospitalization composite measure</b>				
Safety-net provider utilizers (N=16,141,417)	2.50	2.06	2.04	2.27
(95% confidence interval)	(1.89, 3.11)	(2.02, 2.11)	(1.95, 2.13)	(2.14, 2.40)
Non-safety-net provider utilizers (N=141,782,465)	2.15	2.20	2.22	2.20
(95% confidence interval)	(1.96, 2.34)	(2.18, 2.22)	(2.17, 2.27)	(2.13, 2.26)
<b>Panel B—chronic ACSC hospitalization composite measure</b>				
Safety-net provider utilizers (N=16,141,417)	4.21	3.51	3.45	3.83
(95% confidence interval)	(2.93, 5.50)	(3.44, 3.58)	(3.23, 3.67)	(3.58, 4.08)
Non-safety-net provider utilizers (N=141,782,465)	3.64	3.72	3.78	3.72
(95% confidence interval)	(3.30, 3.98)	(3.70, 3.74)	(3.68, 3.89)	(3.61, 3.84)

N, number; CMS, Centers for Medicare and Medicaid Services; HCC, hierarchical condition categories; ADLs, activities of daily living; IADLs, instrumental ADLs  
 \*We estimate a multivariable negative binomial model with age, age squared, and gender covariates. We further include year fixed effects to control for secular trend. We also adjust our p values for the complex survey design of the MCBS and intra-person correlation over time

†We estimate a multivariable negative binomial model with the CMS-HCC risk adjustment covariates (HCC score, HCC score squared, ESRD status, institutionalization in long-term care). We further include year fixed effects to control for secular trend. We also adjust our p values for the complex survey design of the MCBS and intra-person correlation over time

‡We estimate a multivariable OLS model with the CMS-HCC risk adjustment covariates plus the social risk (annual income, educational attainment, marital status) and cognitive risk (depression, Alzheimer's/dementia) and functional status risk (1–2 ADLs, 3–6 ADLs, 1–2 IADLs, 3–6 IADLs with difficulty/cannot do) covariates. We further include year fixed effects to control for secular trend. We also adjust our p values for the complex survey design of the MCBS and intra-person correlation over time



**Figure 1 Observed-to-expected ratios for ambulatory care-sensitive conditions.**

patients with heart failure are assessed and treated with diuretics as soon as they begin to retain fluid, they are less likely to be hospitalized. However, our findings indicate that patient risk factors, including income, education, marital status, dementia, and difficulty with ADLs and IADLs, contribute to these outcomes, perhaps even more than a medical risk score, which added little to risk prediction above and beyond a model that only included age and gender. Interestingly, we found that social factors were more powerfully related to chronic than acute ACSCs; this may indicate that chronic conditions, which often require complex medication regimens and lifestyle changes, may be more sensitive to the effects of social, cognitive, and functional risk factors than more acute events.

Our findings have implications for use of the ACSCs as performance measures for outpatient providers under Medicare VBP, such as in the ACO and MIPS programs. Because the particular patient social, cognitive, and functional risk factors that are associated with these measures are more common in patients that tend to be cared for by safety-net providers, such performance measures disproportionately and unfairly penalize providers who care for the most vulnerable patients in our society. This would suggest that CMS should consider adjusting for these social, cognitive, and functional risk factors when using ACSCs as performance measures. Although opponents of social risk factor adjustment argue that it amounts to accepting lower quality for vulnerable groups,<sup>29</sup> we believe our results indicate a failure to adjust for these factors could lead to more harm than good. However, there are logistic barriers; CMS would need to consider collecting such data from all Medicare beneficiaries or, more realistically, developing reliable proxy measures using administrative data. For instance, some high-profile health policy studies have used dual enrollment in Medicare and Medicaid as a proxy measure for social risk factor variables in risk adjustment of VBP outcomes. In the absence of such risk adjustment, our results suggest these measures are not adequately constructed to fairly assess the performance of outpatient providers under VBP.<sup>30–34</sup>

Our findings are consistent with an increasing movement in health care to recognize—and ultimately begin to address—social and functional determinants of health outcomes. For example, the National Academies of Medicine recently released reports on addressing the needs of high-cost, high-need individuals and included cataloguing and addressing social and functional characteristics as critical components of care delivery.<sup>35</sup> Similarly, CMS' Accountable Health Communities program encourages participants to screen for social needs as part of their overall risk assessment and includes a specific tool for doing so.<sup>36</sup> Recognizing the importance of these factors and accounting for them are necessary to ensure that value-based payment can be a tool to improve care for vulnerable populations while reducing disincentives to caring for them.

This study has several limitations. First, we were unable to identify safety-net providers who were not FQHCs or RHCs. As a result, these unidentified providers' patients were counted as non-safety-net utilizers; this would likely bias our results

toward the null. Second, we were only able to identify patients who participated in the MCBS; while survey and nonresponse weighting can significantly reduce bias related to this issue, our results may not generalize more broadly. Third, we measured acute and chronic ACSC hospitalizations at a period in time prior to full implementation of the Medicare ACO or Value-Based Payment Modifier programs using those measures and it is possible that safety-net and non-safety-net patients or practices have changed since then. Repeating these analyses as the programs mature will be important. Fourth, the safety-net patients in our analysis had lower rates of medical comorbidities than their non-safety-net counterparts; we do not know whether this represents a true lower medical burden, or differences in coding practices between providers. This may warrant future research.

## CONCLUSIONS

Social, cognitive, and functional risk factors are common in Medicare beneficiaries, especially among those cared for by safety-net providers. These risk factors are independently associated with ACSC hospitalizations, are largely beyond the control of providers, and are not accounted for by current Medicare risk adjustment methods. Consequently, Medicare's VBP scoring formula may inappropriately penalize safety-net providers if it does not account for these common patient risk factors. In the future, Medicare may want to consider accounting for patient social, cognitive, and functional status in risk adjustment.

---

### Acknowledgments:

We thank Julia Clarke of Saint Louis University for providing assistance on the literature review.

**Funding/Support:** Saint Louis University purchased and provided access to the data used in this study. Dr. Joynt Maddox is supported by K23-HL109177-03 from the National Heart, Lung, and Blood Institute (NHLBI).

**Corresponding Author:** Kenton J. Johnston, PhD; Department of Health Management and Policy and Center for Outcomes Research-College for Public Health and Social Justice, Saint Louis University, St. Louis, MO, USA (e-mail: johnstonkj@slu.edu).

**Author Contributions** Dr. Johnston had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: all authors.

Acquisition, analysis, or interpretation of data: all authors.

Drafting of the manuscript: all authors.

Critical revision of the manuscript for important intellectual content: all authors.

Statistical analysis: Johnston.

Obtained funding: Johnston.

Administrative, technical, or material support: Johnston.

Study supervision: all authors.

### Compliance with Ethical Standards:

This study was approved by the Saint Louis University Institutional Review Board.

**Conflict of Interest:** Dr. Joynt Maddox does work under contract with the US Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation. All remaining authors declare that they do not have a conflict of interest.

**Role of the Sponsor:** Neither Saint Louis University nor the NHLBI had any role in the design and conduct of the study; analysis or interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

## REFERENCES

- Buntin MB, Ayanian JZ. Social Risk Factors and Equity in Medicare Payment. *N Engl J Med*. 2017;376(6):507–510. doi:<https://doi.org/10.1056/NEJMp1700081>.
- Joynt KE, De Lew N, Sheingold SH, Conway PH, Goodrich K, Epstein AM. Should Medicare Value-Based Purchasing Take Social Risk into Account? *N Engl J Med*. 2017;376(6):510–513. doi:<https://doi.org/10.1056/NEJMp1616278>.
- Agency for Healthcare Research and Quality. Guide to prevention quality indicators: hospital admission for ambulatory care sensitive conditions. In: *AHRQ Quality Indicators*. Vol Version 3. Department of Health and Human Services; 2007:1–59.
- Figueroa JF, Joynt Maddox KE, Beaulieu N, Wild RC, Jha AK. Concentration of Potentially Preventable Spending Among High-Cost Medicare Subpopulations. *Ann Intern Med*. 2017;167(10):706. doi:<https://doi.org/10.7326/M17-0767>.
- Centers for Medicare and Medicaid Services. Quality and Cost Measures Used in the Value Modifier. *Value-Based Paym Modif*. 2018. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/ValueBasedPaymentModifier.html>. Accessed January 16, 2019.
- Centers for Medicare and Medicaid Services. Accountable Care Organization 2018 Quality Measures. Medicare Shar Savings Progr. 2018. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/sharesavingsprogram/Downloads/2018-reporting-year-narrative-specifications.pdf>. Accessed January 16, 2019.
- Centers for Medicare and Medicaid Services. The Merit-Based Incentive Payment System: MIPS Scoring Methodology Overview. 2018.
- Centers for Medicare and Medicaid Services. 2016 Measure Information About the Per Capita Costs for All Attributed Beneficiaries Measure, Calculated for the 2018 Value-Based Payment Modifier Program. 2017:1–8. <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/2016-TPCC-MIF.pdf>. Accessed January 16, 2019.
- Franks P, Tancredi DJ, Winters P, Fiscella K. Including socioeconomic status in coronary heart disease risk estimation. *Ann Fam Med*. 2010;8:447–453. doi:<https://doi.org/10.1370/afm.1167>.
- Braveman PA, Cubbin C, Egerter S, Williams DR, Pamuk E. Socioeconomic disparities in health in the United States: What the patterns tell us. *Am J Public Health*. 2010;100(SUPPL. 1). doi:<https://doi.org/10.2105/AJPH.2009.166082>.
- Galea S, Tracy M, Hoggatt KJ, DiMaggio C, Karpati A. Estimated deaths attributable to social factors in the United States. *Am J Public Health*. 2011;101(8):1456–1465. doi:<https://doi.org/10.2105/AJPH.2010.300086>.
- Muennig P, Fiscella K, Tancredi D, Franks P. The relative health burden of selected social and behavioral risk factors in the United States: implications for policy. *Am J Public Health*. 2010;100(9):1758–1764. doi:<https://doi.org/10.2105/AJPH.2009.165019>.
- Bernheim SM, Spertus JA, Reid KJ, et al. Socioeconomic disparities in outcomes after acute myocardial infarction. *Am Heart J*. 2007;153(2):313–319. doi:<https://doi.org/10.1016/j.ahj.2006.10.037>.
- Fong TG, Jones RN, Marcantonio ER, et al. Adverse Outcomes After Hospitalization and Delirium in Persons With Alzheimer Disease. *Ann Intern Med*. 2012;156(12):848. doi:<https://doi.org/10.7326/0003-4819-156-12-201206190-00005>.
- Linden M, Horgas AL, Gilberg R, Steinhagen-Thiessen E. Predicting Health Care Utilization in the Very Old. *J Aging Health*. 1997;9(1):3–27. doi:<https://doi.org/10.1177/089826439700900101>.
- McGinty EE, Sridhara S. Potentially Preventable Medical Hospitalizations Among Maryland Residents With Mental Illness, 2005–2010. *Psychiatr Serv*. 2014;65(7):951–953. doi:<https://doi.org/10.1176/appi.ps.201300323>.
- Nguyen OK, Makam AN, Halm EA. National use of safety-net clinics for primary care among adults with non-medicare insurance in the United States. *PLoS One*. 2016;11(3):1–14. doi:<https://doi.org/10.1371/journal.pone.0151610>.
- Gilman M, Adams EK, Hockenberry JM, Milstein AS, Wilson IB, Becker ER. Safety-net hospitals more likely than other hospitals to fare poorly under medicare's value-based purchasing. *Health Aff*. 2015;34(3):398–405. doi:<https://doi.org/10.1377/hlthaff.2014.1059>.
- Chokshi DA, Chang JE, Wilson RM. Health Reform and the Changing Safety Net in the United States. *N Engl J Med*. 2016;375(18):1790–1796. doi:<https://doi.org/10.1056/NEJMp1608578>.
- Andrulis DP, Siddiqui NJ. Health Reform Holds Both Risks And Rewards For Safety-Net Providers And Racially And Ethnically Diverse Patients. 2011;10(10):1830–1836. doi:<https://doi.org/10.1377/hlthaff.2011.0661>.
- Center for Medicare and Medicaid Services. Technical Documentation for the Medicare Current Beneficiary Survey. In: *Medicare Current Beneficiary Survey Data Tables*. Vol ; 2009:1–12.
- CMS Chronic Condition Warehouse. 27 Chronic Condition Algorithms. 2016. <https://www.cwdata.org/web/guest/condition-categories>. Accessed January 16, 2019.
- Pope GC, Kautter J, Ellis RP, et al. Risk adjustment of Medicare capitation payments using the CMS-HCC model. *Health Care Financ Rev*. 2004;25(4):119–141. <http://www.ncbi.nlm.nih.gov/pubmed/15493448>.
- Meddings J, Reichert H, Smith SN, et al. The Impact of Disability and Social Determinants of Health on Condition-Specific Readmissions beyond Medicare Risk Adjustments: A Cohort Study. *J Gen Intern Med*. 2017;32(1):71–80. doi:<https://doi.org/10.1007/s11606-016-3869-x>.
- Ivanova JI, Mytelka DS, Duh MS, et al. Evaluating the utility of existing patient-reported outcome scales in novel patient populations with pancreatic cancer, lung cancer, and myeloproliferative neoplasms using medicare current beneficiary survey data. *Patient*. 2013;6(3):189–200. doi:<https://doi.org/10.1007/s40271-013-0018-z>.
- Agency for Healthcare Research and Quality. Prevention Quality Indicators (PQI) Composite Measure Workgroup Final Report. Agency Healthc Res Qual Qual Indic (AHRQ QI). 2006:1–29. [http://www.qualityindicators.ahrq.gov/Downloads/Modules/PQI/PQI\\_Composite\\_Development.pdf](http://www.qualityindicators.ahrq.gov/Downloads/Modules/PQI/PQI_Composite_Development.pdf). Accessed January 16, 2019.
- Agency for Healthcare Research and Quality. Prevention Quality Indicators (PQI) Composite Measure Workgroup Final Report. Agency Healthc Res Qual Qual Indic (AHRQ QI). 2006:1–29.
- Ash AS, Ellis RP, Pope GC, et al. Using diagnoses to describe populations and predict costs. *Health Care Financ Rev*. 2000;21(3):7–28. doi:Article.
- Krumholz HM, Bernheim SM. Considering the Role of Socioeconomic Status in Hospital Outcomes Measures. *Ann Intern Med*. 2014;161(11):833. doi:<https://doi.org/10.7326/M14-2308>.
- Department of Health and Human Services Office of the Assistant Secretary for Planning and Evaluation. Report to Congress: Social Risk Factors and Performance Under Medicare's Value-Based Payment Programs. 2016. <https://aspe.hhs.gov/pdf-report/report-congress-social-risk-factors-and-performance-under-medicare-value-based-purchasing-programs>. Accessed January 16, 2019.
- Roberts ET, Zaslavsky AM, McWilliams JM. The Value-Based Payment Modifier: Program Outcomes and Implications for Disparities. *Ann Intern Med*. 2018;168(4):255. doi:<https://doi.org/10.7326/M17-1740>.
- Chen LM, Epstein AM, Orav EJ, Filice CE, Samson LW, Joynt Maddox KE. Association of Practice-Level Social and Medical Risk With Performance in the Medicare Physician Value-Based Payment Modifier Program. *JAMA*. 2017;318(5):453. doi:<https://doi.org/10.1001/jama.2017.9643>.
- Markovitz AA, Ellimoottil C, Sukul D, et al. Risk Adjustment May Lessen Penalties On Hospitals Treating Complex Cardiac Patients Under Medicare's Bundled Payments. *Health Aff*. 2017;36(12):2165–2174. doi:<https://doi.org/10.1377/hlthaff.2017.0940>.
- Durfey SNM, Kind AJH, Gutman R, et al. Impact Of Risk Adjustment For Socioeconomic Status On Medicare Advantage Plan Quality Rankings. *Health Aff*. 2018;37(7):1065–1072. doi:<https://doi.org/10.1377/hlthaff.2017.1509>.
- National Academy of Medicine. Effective Care for High-Need Patients. A Spec Publ from Natl Acad Med. 2017:1–213. <https://nam.edu/wp-content/uploads/2017/06/Effective-Care-for-High-Need-Patients.pdf>. Accessed January 16, 2019.
- Billieux A, Conway PH, Alley DE. Addressing Population Health. *JAMA*. 2017;318(19):1865. doi:<https://doi.org/10.1001/jama.2017.15063>.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.