

Impact of Care Coordination Based on Insurance and Zip Code

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Since 2012, CMS has incentivized hospital systems to reduce 30-day rehospitalizations for patients with a history of acute myocardial infarction (AMI).¹ Patients experiencing an AMI are medically complex,² and their high level of medical acuteness is an important driver of high readmission rates. Furthermore, given the additional barriers that patients of low socioeconomic status (SES) face, they are at even greater risk for readmission^{3,4} and other adverse outcomes.⁵⁻⁸ In an effort to reduce unnecessary rehospitalizations, many health systems have implemented programs to help patients overcome barriers to care, including interventions to improve care transitions from hospital to home.⁹⁻¹² However, a systematic review of care transitions interventions for patients with AMI found that readmission rates did not differ between those who were enrolled in care transitions programs and those who were not.¹³ Although patients are often selected for care transitions programs based on variables related to high risk of readmission, variation in the effects of these interventions due to these characteristics is often not examined.¹⁴ For example, although patients with a history of AMI are at higher risk of readmission and mortality if they live in high-poverty areas or have Medicaid insurance,^{4,7} few studies, if any, have examined whether implementation of a care transitions intervention can attenuate these risks. The objective of this study was to examine whether an intensive care transitions program was associated with a reduction in 30-day rehospitalization rates among patients who received percutaneous coronary intervention (PCI) based on individual and combined indicators of low SES.

METHODS

These data were collected as part of a quality improvement program that implemented an intensive care transitions intervention for patients who received PCI at a single regional health system in Delaware from 2012 to 2015. The intervention was called “Bridging the Divides” (“Bridges”) and was developed with a grant from the Center for Medicare and Medicaid Innovation. Details of the intervention have been described previously in the literature.¹⁵ Briefly, the intervention consisted of medication education for the patient from a clinical

ABSTRACT

OBJECTIVES: To examine whether a care transitions program, Bridges, differentially reduced rehospitalizations among patients who underwent percutaneous coronary intervention (PCI) based on insurance status and zip code poverty level.

STUDY DESIGN: Retrospective observational cohort.

METHODS: We examined data from a single health system in Delaware, collected as part of a care transitions program for patients who underwent PCI from 2012 to 2015 compared with an unmatched historical control cohort from 2010 to 2011. Socioeconomic status was assessed by insurance status and zip code-level poverty data. Patients were divided into tertiles based on the proportion of their zip code of residence living under 100% of the federal poverty level. Rehospitalization rates were analyzed by negative binomial regression and included interaction terms to examine differential effects of Bridges by insurance and poverty level.

RESULTS: There were 4638 patients representing 5710 hospitalizations: 3212 in the historical control and 2498 in the Bridges cohort. Among patients with Medicaid who received the Bridges intervention, those living in the wealthiest zip codes were 15.5% less likely to be rehospitalized than patients with Medicare and 9.4% less likely than patients with commercial insurance ($P = .04$). However, patients with Medicaid who lived in the poorest zip codes and those with dual Medicare/Medicaid status had higher rates of rehospitalization post intervention.

CONCLUSIONS: The Bridges intervention was associated with improved rehospitalization rates for Medicaid patients compared with those with Medicare or commercial insurance within Delaware’s wealthier communities. Care transitions programs may differentially affect Medicaid patients based on the wealth of the communities in which they reside.

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TAKEAWAY POINTS

Among patients who underwent percutaneous coronary intervention who received a care transitions intervention, patients with Medicaid who lived in the wealthiest zip codes were 15.5% less likely to be rehospitalized than their peers with Medicare and 9.4% less likely than their peers with commercial insurance ($P = .04$). Those who lived in the poorest areas had the highest rates of rehospitalization.

- ▶ Care transitions interventions may be more effective in reducing rehospitalizations if targeted toward patients with Medicaid who live in areas with greater resources.
- ▶ Alternately, rehospitalization rates may increase among patients with Medicaid who live in poorly resourced areas.

pharmacist and bedside nurse prior to discharge, biweekly phone calls during the first 2 weeks post discharge, and regularly scheduled calls from a care management nurse for up to 1 year if needed. As part of the program, called CareLink, the care management team helped to coordinate many aspects of postdischarge care, including making follow-up appointments, ensuring access to medications, and arranging transportation. During the postdischarge phone calls, the CareLink team assessed clinical issues (eg, clinical symptoms, medication adherence) and nonclinical issues (eg, barriers to obtaining follow-up care or medications). CareLink placed heavy emphasis on directing patients to appropriate sites for regular follow-up or urgent care and proactively identified issues that could lead to the need for emergency care.¹⁵ The program and approval to publish results of the study were obtained from the Christiana Care Institutional Review Board.

We collected data for consecutive patients who underwent PCI from 2012 to 2015 who were enrolled in the Bridges program (Bridges cohort); we compared this cohort with historical controls for patients who underwent PCI at the same institution from 2010 to 2011 (control cohort). Low SES was determined by insurance status and zip code–level poverty data obtained from the 2011 to 2015 estimates from the US Census Bureau.^{4,8,16} Patients were divided into tertiles based on the proportion of individuals within their zip code of residence who live under 100% of the federal poverty level (FPL). The 3 tertiles included the “wealthy” zip code (defined as those living in zip codes where <9.1% of individuals live under the FPL), the “moderate wealth” zip code (where 9.2%–13.1% of individuals live under the FPL), and the “poor” zip code (where >13.1% of individuals live under the FPL) tertiles.¹⁷ Insurance status was defined as Medicare, Medicaid, dual eligible (Medicare/Medicaid), commercial, or uninsured/other. Thirty-day rehospitalization was defined as a composite of inpatient, observation, and emergency department (ED) visits to the index site of service. We used a combined metric of rehospitalization because the Bridges intervention sought to reduce the need for all types of emergency care.

We then examined the unadjusted association between poverty level, insurance status, and the Bridges intervention with our outcome of 30-day rehospitalization using Poisson regression or negative binomial regression if the distribution of counts was overdispersed. For Poisson distributions, the mean and variance are

equal; overdispersion occurs when the variance is greater than the mean. Analogous to an odds ratio in logistic regression, Poisson regression gives an incident rate ratio (IRR)—that is, a ratio of incident rates between categorical variables or increase (or decrease) for units of a continuous variable. Counts were analyzed because patients could have more than 1 rehospitalization.

We constructed a multivariable count model with poverty tertile as the primary independent variable and 30-day rehospitalization as the dependent variable. We controlled for

insurance status, Bridges intervention, age, and all variables that were significantly different ($P < .05$) between the historical control and Bridges cohorts.^{3,18,19} To determine if there was a differential improvement in 30-day rehospitalization rates after the Bridges intervention among patients with combined indicators of low SES (Medicaid insurance/poor zip code), we tested the 3-way interaction (control vs Bridges, insurance status, poverty tertile) in the models. We then compared differences in predicted proportions of 30-day rehospitalization rates in the control and Bridges cohorts, stratified by poverty tertile and insurance status. All analyses were conducted in Stata version 14 (StataCorp; College Station, Texas).

RESULTS

Study Population

There were 4638 patients, with 5710 hospitalizations, who had valid zip code–level poverty data and who underwent PCI from 2010 to 2015. Patients in the “poor” zip code tertile were significantly different from those in the “wealthy” zip code tertile in that they were younger (mean age, 63.3 vs 65.2 years, respectively; $P < .001$); were more likely to be female (594/1593 [37.2%] vs 423/1470 [28.8%]; $P < .001$), be African American (432/1593 [27.1%] vs 131/1470 [8.9%]; $P < .001$), and have Medicaid (213/1944 [11.0%] vs 84/1817 [4.6%]; $P < .001$) or dual-eligible status (149/1944 [7.7%] vs 59/1817 [3.2%]; $P < .001$); and had a greater number of comorbidities (2.11 vs 1.72; $P < .001$), higher rates of multiple prior hospitalizations (14.5% vs 11.0%; $P < .004$), and longer length of stay (3.05 vs 2.64 days; $P = .006$) (Table 1).

Demographic differences were also examined in the control and Bridges cohorts. Overall, there were no statistically significant differences between the control and Bridges groups, except that in the Bridges cohort, there were more patients with Medicaid as their primary form of insurance compared with the control cohort (235/2498 [9.4%] vs 211/3212 [6.5%]; $P = .038$; data not shown).

In our unadjusted analysis, we found no significant association between zip code poverty tertile and 30-day rehospitalization rate. Similarly, the Bridges intervention was not associated with 30-day rehospitalization rate. However, insurance status was; patients with dual Medicare/Medicaid eligibility had the highest rates of rehospitalization (35.5%) whereas those with commercial insurance had the lowest rates (13.6%) (Table 2).

Poverty, Insurance, Bridges, and 30-Day Rehospitalization

In our first multivariable model, we found that poverty level was not independently associated with higher rates of rehospitalization after adjustment for insurance status, Bridges intervention, and age, but that insurance status was. Study participants with dual Medicare/Medicaid eligibility had higher rates of rehospitalization (IRR, 1.57; 95% CI, 1.18-2.09) and commercially insured participants had lower rehospitalization rates (IRR, 0.54; 95% CI, 0.42-0.70) compared with other insurance types (eAppendix [available at ajmc.com]). Participation in the Bridges intervention was not associated with lower rates of rehospitalization compared with historical controls.

In our subsequent models (models 2-4), we examined all 2-way interactions between zip code poverty tertile, insurance status, and Bridges intervention and found that only the effect of Medicaid status on rehospitalization significantly varied based on zip code poverty level (model 4; $P = .034$). Our final model (model 5) included all 2-way and 3-way interaction terms and found that there was a significant 3-way interaction among insurance status, zip code poverty tertile, and Bridges intervention ($P = .04$) (eAppendix Tables 1 and 2).

As shown in eAppendix Table 2, using predicted proportions of readmissions based on model 5 (all interaction terms), we examined whether, within zip code poverty tertiles, changes in rehospitalization rates were greater among Bridges versus historical control patients based on insurance status. This model represented 3212 hospital revisits in the historical control group, 6.5% ($n = 211$) of which were from Medicaid patients. Of these, 30.2% ($n = 110$) of revisits were from patients from poor zip codes, 26.5% ($n = 55$) were from moderate-wealth zip codes, and 17.6% ($n = 46$) were from wealthy zip codes. For the Bridges cohort, the model represented 2498 revisits, 9.4% ($n = 235$) of which were from Medicaid patients. Of these, 45.8% ($n = 103$) of revisits were from poor zip codes, 16.5% ($n = 94$) were from moderate-wealth zip codes, and 4.5% ($n = 38$) were from wealthy zip codes (eAppendix Table 2). Among patients with Medicaid who received the Bridges intervention, those who lived in the wealthiest and moderately wealthy zip codes had lower rehospitalization rates than historical controls (-12.5% and -10.6%, respectively), whereas those who lived in the poorest zip codes had a higher postintervention rehospitalization rate (16%) (Table 3). Patients dually insured with Medicare and Medicaid had higher rehospitalization rates post intervention regardless of zip code poverty level (Table 3).

TABLE 1. Characteristics of Study Population

Variable	Zip Code Poverty Level ^a				P ^b
	Overall N = 5710 (%)	Wealthy n = 1817 (%)	Moderate Wealth n = 1945 (%)	Poor n = 1944 (%)	
Intervention, n (%)					
Control	3212 (56.2)	1025 (56.4)	1076 (55.3)	1111 (57.1)	.531
Bridges	2498 (43.7)	792 (43.5)	870 (44.7)	836 (43.0)	
Age in years, mean (SD)	64.2 (12.2)	65.2 (11.9)	64.0 (12.0)	63.3 (12.3)	<.001
Female, ^c n (%)	1526 (32.9)	423 (28.8)	509 (32.3)	594 (37.2)	<.001
Race, ^c n (%)					
Caucasian	3649 (78.7)	1268 (86.3)	1317 (83.6)	1064 (66.8)	<.001
African American	733 (15.8)	131 (8.9)	170 (10.8)	432 (27.1)	
Other	256 (5.5)	71 (4.8)	88 (5.6)	97 (6.1)	
Insurance, n (%)					
Medicare	2624 (45.9)	896 (49.3)	857 (4.0)	871 (44.8)	<.001
Medicaid	446 (7.8)	84 (4.6)	149 (7.7)	213 (11.0)	
Dual eligible	308 (5.4)	59 (3.2)	100 (5.1)	149 (7.7)	
Commercial	2092 (36.6)	718 (39.5)	745 (38.3)	629 (32.3)	
Uninsured/other	240 (4.2)	60 (3.3)	95 (4.9)	85 (4.4)	
Comorbidity count, mean (SD)	1.95 (1.50)	1.72 (1.39)	2.02 (1.50)	2.11 (1.55)	<.001
Previous hospitalization, n (%)					
None	3774 (66.1)	1251 (68.8)	1291 (66.3)	1232 (63.4)	.004
1	1204 (21.1)	366 (20.1)	405 (20.8)	433 (22.2)	
More than 1	732 (12.8)	200 (11.0)	250 (12.9)	282 (14.5)	
Length of stay in days, mean (SD)	2.85 (3.94)	2.64 (3.21)	2.86 (4.23)	3.05 (4.22)	.006

^aColumns may not sum to 100% because of rounding error.

^bP value obtained by χ^2 and 1-way analysis of variance.

^cSex and race statistics are based on number of patients (N = 4638; wealthy, n = 1470; moderate wealth, n = 1575; poor, n = 1593); all others on number of hospitalizations.

TABLE 2. Unadjusted Rehospitalization Rates by Zip Code Poverty Level, Insurance, and Bridges Intervention, Predicted Proportions

	Unadjusted 30-Day Rehospitalization Rate Mean (SD)	P ^a
Zip code poverty level		
Wealthy	17.6% (0.46)	.215
Moderate wealth	20.2% (0.52)	
Poor	20.4% (0.62)	
Insurance status		
Medicare	21.2% (0.51)	<.001
Medicaid	26.9% (0.96)	
Dual eligible	35.5% (0.69)	
Commercial	13.6% (0.41)	
Uninsured/other	17.1% (0.50)	
Intervention		
Control	18.9% (0.49)	.392
Bridges	20.2% (0.61)	

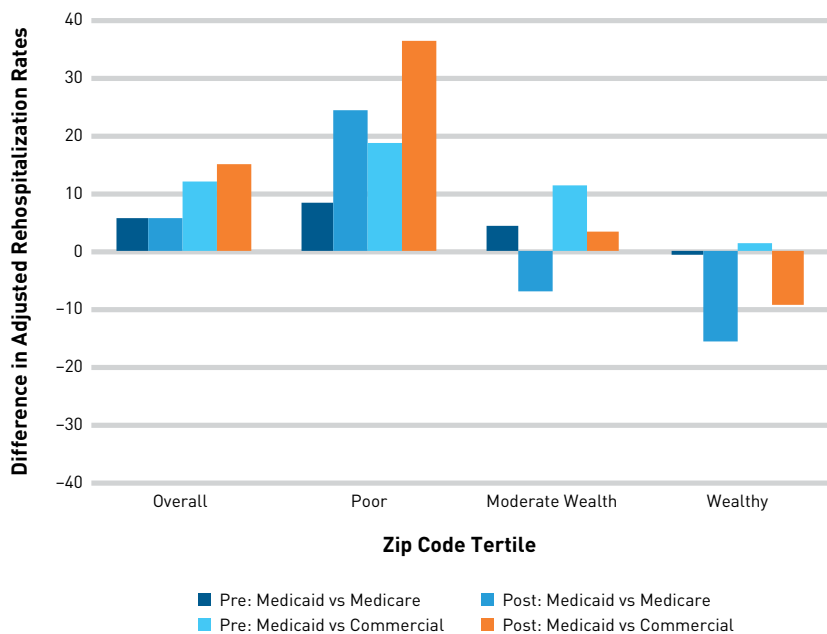
^aP values obtained by negative binomial regression.

TABLE 3. Differences in Predicted Proportions of 30-Day Rehospitalization Rates by Zip Code Poverty Level, Insurance Status, and Bridges Intervention^a

	Zip Code Poverty Level								
	Wealthy			Moderate Wealth			Poor		
	Control (%)	Bridges (%)	Δ (%)	Control (%)	Bridges (%)	Δ (%)	Control (%)	Bridges (%)	Δ (%)
Medicare	17.7	20.2	2.5	22.7	23.5	0.8	21.9	21.5	-0.4
Medicaid	17.2	4.7	-12.5	27.1	16.5	-10.6	30.0	46.0	16.0
Dual eligible	29.6	45.9	16.3	33.5	46.9	13.4	26.7	38.3	11.6
Commercial	16.0	14.1	-1.9	15.6	13.2	-2.4	11.3	9.5	-1.8
Uninsured/other	18.2	14.2	-4.0	15.8	21.6	5.8	10.9	26.8	15.9

^aRehospitalization rates obtained by negative binomial regression.

FIGURE. Pre- and Postintervention Differences in Adjusted 30-Day Rehospitalization Rates for Medicaid Patients Compared With Medicare and Commercially Insured Patients by Wealth of Zip Code



Medicare (4.7% vs 20.2%) and 9.4% less likely than patients with commercial insurance (4.7% vs 14.1%; $P = .04$) (Table 3; Figure).

DISCUSSION

In this secondary analysis of data of patients who underwent PCI, we found that after implementation of a care transitions program, 30-day rehospitalization rates decreased among patients with Medicaid who lived in relatively wealthier zip codes compared with other patients.

Similar to findings of prior studies that have examined the impact of care transitions programs on rehospitalization rates,²⁰⁻²⁴ the 2017 overall analysis of the Bridges program found that the intervention did not reduce rehospitalization or 30-day ED utilization rates.¹⁵ However, the findings of our current study suggest that there may be merit in examining the impact of such longitudinal care management interventions based on patient- and community-level socioeconomic factors. Prior work has demonstrated that among patients with a history of myocardial ischemia, residence in a high-poverty area⁵⁻⁷ and low income

We then compared adjusted 30-day rehospitalization rates for Medicaid patients with those for patients with Medicare and commercial insurance according to zip code poverty level. Among patients who received the Bridges intervention, patients with Medicaid who lived in the poorest zip codes were 24.5% more likely to be rehospitalized than patients with Medicare (46% vs 21.5%) and 36.5% more likely than those with commercial insurance (46% vs 9.5%) (Table 3). These rates were higher than those of historical controls. However, patients with Medicaid who received the Bridges intervention who lived in moderate wealth zip codes were 7% less likely to be rehospitalized than patients with Medicare (16.5% vs 23.5%) (Figure). Those with Medicaid living in the wealthiest zip codes were 15.5% less likely to be rehospitalized than patients with

status²⁵ are associated with worse outcomes, whereas residence in wealthier neighborhood environments has a positive impact on outcomes.²⁴ In the general population, even as hospitalization rates decline, patients with Medicaid are hospitalized at higher rates and those from wealthier communities are hospitalized at lower rates.²⁶ Additionally, prior work has demonstrated that the positive health effects of wealthy communities can modify the negative health effects associated with low-income status.²⁵ Our study builds on this work in that it examines the interaction between individual- and community-level indicators of poverty and suggests that, among low-income patients, the wealth of their area of residence could potentially influence the effectiveness of a care management intervention.

In the general medicine literature, there are several examples of effective care transition programs that were created specifically for patients of low SES. The IMPaCT program, which targets patients with Medicaid or no insurance who live in low-income zip codes, has demonstrated a reduction in the rate of multiple rehospitalizations.¹⁶ The C-TraIn program also targets low-income patients and has demonstrated improvement in the quality of care transitions.¹² However, neither intervention demonstrated a reduction in 30-day rehospitalization rate, and neither stratified their results by neighborhood or zip code characteristics. This may be because most studies of this nature, including ours, are not powered for such subgroup analyses a priori. Nevertheless, it may be important to consider this for future studies.

Many health systems have invested millions of public and private dollars into care transitions programs with variable results.²⁷ To our knowledge, this is the first study that suggests a differential impact of such programs based on the interaction of insurance status and the community in which patients live. Our findings suggest that the effectiveness of such programs may be further accentuated among traditionally underserved groups who live in wealthier, presumably better-resourced environments. A deeper understanding of where these programs may have the greatest impact could allow us to continue to innovate new approaches to care and also could help to direct precious resources to communities and patients who may benefit the most.²⁸ It could also help to demonstrate the long-term value of community investment to policy makers and health systems.

We found that among certain subgroups, such as those with Medicaid who lived in poorer areas and those with dual-eligible status, revisit rates increased with the Bridges intervention. Among the Medicaid patients, this may reflect greater barriers to accessing ambulatory care that exist within poorer communities that could have resulted in higher rates of hospital use.¹¹ The high revisit rates seen among patients with dual Medicare/Medicaid status likely reflect their greater complexity as patients, including higher level of comorbidity and disability.²⁹ However, because a key element of the Bridges intervention was regular assessment for concerning symptoms such as chest pain, these increases in utilization may reflect appropriate, potentially life-saving interventions within populations of high risk and great need. Indeed, efforts to reduce 30-day readmissions among patients with heart failure have been associated with increases in 1-year mortality.³⁰

Limitations

It is important to interpret the findings of this study within the context of its limitations. This was a secondary, post hoc analysis of a single-center study using noncontemporaneous unmatched controls, which was not powered to examine differences in outcomes based on zip code of residence. Therefore, our findings should be interpreted with caution, and causality cannot be inferred from our results. The variables used to examine poverty status were not based on personal income. Rather, we used Medicaid status, which is a common surrogate in the health services literature, and

US Census poverty data for zip code of residence, which has been used previously.^{4,8} The demographic characteristics of our poor zip code tertile were similar to those in prior studies of patients with a history of myocardial ischemia that had used more granular Census block poverty data,⁶ which adds credibility to our findings. The Bridges cohort had a greater proportion of patients with Medicaid insurance than the historical control cohort, which may reflect changes related to Medicaid expansion under the Affordable Care Act. We could not account for unmeasured confounders, such as self-efficacy and social cohesion, that could potentially differentiate patients with Medicaid who live in areas of relative wealth versus those who do not and could potentially affect health behaviors. We also could not account for community characteristics that may have influenced the effect of the intervention.

CONCLUSIONS

In this large, single-center study of patients who have undergone PCI, a care transitions intervention appeared to reduce 30-day rehospitalization rates more effectively among patients with Medicaid who lived in areas of relative wealth. In contrast, those who lived in areas of relative poverty and those with dual Medicaid/Medicare eligibility status experienced a higher rate of rehospitalization. Transitions of care interventions may be more effective if targeted toward patients of high need who live in areas with greater resources. Alternately, for patients of lower SES living in poorer areas, alternate or more intensive interventions may be needed. As our findings were post hoc in nature with a relatively small sample size, we caution that further research is needed. Nonetheless, SES should be considered when conducting studies of transition of care programs. ■

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Medicaid				0.98	0.97	0.49-1.98									
Dual Eligible				1.37	0.26	0.79-2.63									
Commercial				0.83	0.31	0.57-1.19									
Self-Pay/other				1.46	0.34	0.67-3.14									
Bridges*Poverty							1.06	0.57	0.87-1.29						
Insurance*Poverty															
Medicare										1.09	0.69	0.70-1.70			
Medicaid										1.94	0.034	1.05-3.56			
Dual Eligible										0.93	0.82	0.52-1.65			
Private										0.853	0.5	0.53-1.35			
Self-Pay/other ^d										NA					
Insurance*Poverty*Bridges															
Medicare ^c													NA		
Medicaid													2.59	0.04	1.04-6.45
Dual Eligible													1.04	0.9	0.51-2.16
Commercial													1.04	0.84	0.66-1.66
Self-Pay/other													1.91	0.157	0.77-4.69

a: Baseline model: negative binomial regression of 30-day hospitalization by poverty adjusted for insurance status, age and bridges intervention

b: Model 2,3,4,&5 are baseline models plus interaction terms listed

c: IRR= Incidence rate ratio

d: Self-pay omitted because of collinearity

e: Medicare omitted because of collinearity

eAppendix Table 2. Model-5 Predicted 30-day rehospitalization rates % (n)^{a,b}

Insurance	Intervention	Poor	Moderate	Wealthy
Medicare	Control	21.9 (494)	22.6 (476)	17.7 (497)
Medicaid		30.2 (110)	26.5 (55)	17.6 (46)
Dual eligible		26.9 (82)	33.1 (55)	30.8 (32)
Commercial		11.4 (367)	15.5 (437)	16.1 (421)
Uninsured/ Other		10.9 (58)	16.1 (53)	18.0 (29)
Medicare	Bridges	21.4 (377)	23.9 (381)	20.2 (399)
Medicaid		45.8 (103)	16.5 (94)	4.5 (38)
Dual eligible		39.1 (67)	47.7 (45)	44.2 (27)
Commercial		9.5 (262)	13.2 (308)	14.0 (297)
Uninsured / Other		27.2 (27)	22.3 (42)	13.8 (31)

a. Data are rehospitalization rates expressed as a percent (n). Sample size(n) included to demonstrate observations per cell.

b. Model includes all 2-way and 3-way interaction terms