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Hospital referral to skilled nursing facilities and readmission rates after heart failure or myocardial infarction

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Abstract

Background—Substantial hospital-level variation in the risk of readmission after hospitalization for heart failure (HF) or acute myocardial infarction (AMI) has been reported. Prior studies have documented considerable state-level variation in rates of discharge to skilled nursing facilities (SNFs) but evaluation of hospital-level variation in SNF rates and its relationship to hospital-level readmission rates is limited.

Methods—Hospital-level 30-day all-cause risk-standardized readmission rates (RSRRs) were calculated using claims data for fee-for-service Medicare patients hospitalized with a principal diagnosis of HF or AMI from 2006-2008. Medicare claims were used to calculate rates of discharge to SNF following HF-specific or AMI-specific admissions in hospitals with ≥25 HF or AMI patients, respectively. Weighted regression was used to quantify the relationship between RSRRs and SNF rates for each condition.

Results—Mean RSRR following HF admission among 4,101 hospitals was 24.7%, and mean RSRR after AMI admission among 2,453 hospitals was 19.9%. Hospital-level SNF rates ranged from 0% to 83.8% for HF and from 0% to 77.8% for AMI. No significant relationship between

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RSRR after HF and SNF rate was found in adjusted regression models (p=0.15). RSRR after AMI increased by 0.03 percentage point for each 1 absolute percentage point increase in SNF rate in adjusted regression models (p=0.001). Overall, HF and AMI SNF rates explained <1% and 4% of the variation for their respective RSRRs.

Conclusion—SNF rates after HF or AMI hospitalization vary considerably across hospitals, but explain little of the variation in 30-day all-cause readmission rates for these conditions.

Keywords

heart failure; acute myocardial infarction; skilled nursing facilities; readmission; hospitals; health services research

Background

Referral to skilled nursing facilities (SNFs) for recuperative care after hospitalization has risen dramatically.[1] Patients are thought to benefit from more intensive monitoring and treatments that SNFs provide relative to other post-acute care options. Because inadequate medical follow-up after hospital discharge is hypothesized to be a major reason for avoidable readmissions,[2] optimizing the use of SNFs may serve as a potential strategy for reducing rehospitalizations.[3, 4] Evaluating the relationship between SNF referral and readmission risk at the hospital level will become increasingly important as the Center for Medicare and Medicaid Services (CMS) and other health insurers are considering reducing reimbursements to hospitals with high readmission rates.[5]

However, it is unclear whether hospitals with high rates of patients discharged to SNFs have lower readmission rates compared with hospitals with low SNF rates. Furthermore, while state-wide variation in SNF use has been observed,[1] our understanding of hospital-level variation is limited. Accordingly, we conducted a study using Medicare data to address two specific aims: 1) to examine hospital-level variation in rates of patients discharged to SNFs across the United States, and 2) to examine the relationship between hospital-level SNF rates and 30-day readmission rates (RSRRs). We evaluated SNF rates and risk-standardized readmission rates for two key illnesses—heart failure (HF) and acute myocardial infarction (AMI)— two diagnoses targeted as priority conditions for readmission reductions by the 2010 Patient Protection and Affordable Care Act.[5]

Methods

Data Sources

We obtained a 100% sample of the Standard Analytical Files of Medicare Part A fee-for-service inpatient claims from January 1, 2006 to December 31, 2008 from the Centers for Medicare and Medicaid Services (CMS), which included patient-level data on demographics, and diagnosis codes using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) for hospitalizations billed under fee-for-service Medicare. We also obtained a 100% sample of Medicare SNF administrative claims for the corresponding time period which included patient-level data on demographics, dates of service, and ICD-9-CM diagnosis codes for each SNF encounter billed under fee-for-service Medicare.

Study Sample

The study population included Medicare fee-for-service patients aged 65 years or older hospitalized with a principal discharge diagnosis of HF (ICD-9-CM codes 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, or 428.xx) or AMI (ICD-9-CM

codes 410.xx, excluding codes with 410.x2 which indicate non-acute events). The study cohort consisted of patients with 1) complete Medicare fee-for-service claims history for 12 months prior to index HF or AMI hospitalization in order to fully ascertain comorbidities, and 2) at least 30 days of Medicare fee-for-service enrollment post HF or AMI discharge in order to fully ascertain readmission outcomes. Patients who were discharged alive within the first day of admission were excluded due to concerns about the accuracy of the diagnosis. To calculate stable estimates of hospital-level SNF rates, the study cohort was limited to patients admitted to hospitals with at least 25 HF or AMI patients, respectively, who were discharged alive from their index admission. Because we wanted to examine outcomes of typical HF patients, we excluded patients with a prior history of heart transplantation (ICD-9-CM procedure code 37.51) or mechanical circulatory support such as left ventricular assist devices (ICD-9-CM procedure codes 37.52-37.54, 37.62-37.68).

Risk-Standardization Readmission Rate (RSRR)

The primary outcomes were hospital-level risk-standardized readmission rates (RSRRs) representing readmissions for any reason within 30 days of discharge for HF or AMI. RSRRs were calculated using statistical models currently employed by CMS and endorsed by the National Quality Forum. The CMS models are publicly available and perform comparably to models based on clinical data abstracted medical record.[6, 7] Briefly, the RSRR model after HF contains 2 demographic, 12 cardiovascular, and 29 comorbidity variables; the RSRR measure after AMI contains 2 demographic, 13 cardiovascular, and 16 comorbidity variables. Concurrent cardiovascular and comorbid conditions were ascertained from Medicare Part A (i.e., inpatient and hospital outpatient data) and Medicare Part B (i.e., physician office outpatient data).

Skilled Nursing Facility (SNF) Rate

Patients discharged to SNF were identified by linking to Medicare SNF administrative claims through unique patient identifiers. Patients were considered as discharged to SNF if they entered a SNF on the same day or the subsequent day after discharge from hospitalization for HF or AMI. Hospital-level SNF rates were calculated by dividing the number of patients discharged to SNF in a given hospital by the overall denominator of HF or AMI admissions of patients who survived the hospitalization.

Hospital characteristics

Hospital characteristics were ascertained by linking the Medicare hospital provider number in the claims to the 2008 American Hospital Association Survey of Hospitals database. There were 153 and 83 hospitals not matched with AHA data which were excluded from the HF and AMI analyses, respectively; the relationship between RSRR and SNF rates in excluded hospitals were consistent with the primary analysis for both HF and AMI.

Statistical Analysis

Patient characteristics, hospital characteristics, and RSRRs were compared across quintiles of hospital SNF discharge rates using chi-squared tests for categorical variables and analysis of variance for continuous variables. We developed regression models of the relationship between hospital-level RSRRs (represented as percentage points, e.g. 15.0%) and SNF rates (represented as percentage points, e.g. 30%) weighted by hospital volume of HF or AMI patients. Linear and linear-log models were examined with comparable results; we present findings from the linear models. The explained variation between SNF rate and RSRR was represented by R^2. Additional models were evaluated to assess whether the relationship the relationship between SNF rate and RSRR would change after adjusting for hospital

characteristics described above. All analyses were conducted using SAS statistical software (version 9.1.3; SAS Institute Inc, Cary, North Carolina).

Results

Heart failure

1,347,425 patients were discharged alive after HF hospitalization in 4,101 hospitals with ≥25 patients over the study period. The cohort had mean age of 80.5 years, was 56.7% female, and 15.8% of non-white race. Common comorbidities included coronary artery disease (CAD), arrhythmias, diabetes, and valvular disease. (Table 1) 273,903 (20.3%) HF patients were discharged to SNF. HF patients entering SNFs were more likely to be readmitted within 30 days compared with patients not referred to SNF (28.2% v 23.7%, $p<0.001$)

The HF cohort was predominately treated in non-profit non-teaching medical centers located in non-rural settings. (Table 2) The mean hospital SNF rate was 22.5% (SD 10.9) with variation in SNF rates ranging from 0 to 83.8%. (Table 3) Hospitals in the highest quintile of SNF rate after HF were most likely to be non-teaching facilities, without on-site facilities for cardiac procedures, with smaller bed size. (Table 2)

Patients admitted to hospitals in the highest quintile of SNF rates were likely to be older, female, and of white race compared with the lowest quintile ($p<0.0001$). (Table 1) There were significantly fewer patients of black or other race in the highest quintile of SNF rates compared with the lowest quintile ($p<0.0001$) Patients in hospitals in the highest quintile of SNF rates were more likely to suffer from certain non-cardiac comorbidities (e.g. depression, dementia, decubitus ulcers), but in general, differences across SNF quintiles was 5 percentage points or less. (Table 1)

The mean 30-day RSRR after discharge for HF was 24.7 (SD 2.0) and ranged from 17.0 to 33.2. (Table 3) The R^2, representing explained variation between SNF rate and RSRR, was very low at 0.009. In a regression model adjusting for hospital characteristics, we observed no significant relationship between SNF rate and RSRR ($p=0.15$). (Figure 2)

Acute Myocardial Infarction

539,869 patients were discharged alive after AMI hospitalization in 2,453 hospitals with ≥25 patients over the study period. The cohort had mean age of 78.8 years, was 50.4% female and 11.1% of non-white race. Common comorbidities for these AMI patients included CAD, history of HF, prior AMI, and vascular disease. (Table 4) 103,961 (19.3%) AMI patients were discharged to SNF. AMI patients entering SNFs were more likely to be readmitted within 30 days compared with patients not referred to SNF (27.8% v 17.9%, $p<0.001$)

Similar to HF, the AMI cohort was predominately treated in non-profit non-teaching medical centers located in non-rural settings. (Table 5) The mean hospital SNF rate was 24.1% (SD 13.0) with variation in SNF rates ranging from 0 to 77.8%. (Table 6) Hospitals in the highest quintile of SNF rate after AMI were most likely to be smaller bed-size non-teaching facilities, without on-site facilities for cardiac procedures. (Table 4)

Patients admitted to hospitals in the highest quintile of SNF rates were likely to be older, female, and of white race compared with the lowest quintile ($p<0.0001$). (Table 4) There were significantly fewer patients of black or other race in the highest quintile of SNF rates compared with the lowest quintile ($p<0.0001$) Patients in hospitals in the highest quintile of

SNF rates were significantly more likely to have comorbidities such as HF, anemia, history of infection, pneumonia, or dementia. (Table 4)

Overall, the mean 30-day RSRR after AMI was 19.9, (SD 1.3) and ranged from 15.3 to 25.2. The weighted correlation between SNF rate and RSRR after AMI was low, with an R^2 of 0.04. In adjusted regression models, a very small relationship was observed with 0.03 percentage point higher RSRR after AMI with each percentage point increase in SNF rate ($p < 0.001$), (e.g. a difference in SNF rate from 24.1% to 25.1% was associated with a difference in RSRR from 19.90% to 19.93%) (Figure 4).

Discussion

Our analysis demonstrated substantial hospital-level variation in rates of patients discharged to SNFs for Medicare patients hospitalized for AMI and HF. However, this variation was not, in turn, associated with clinically important differences in RSRRs.

Prior studies have demonstrated an unclear relationship between SNF care and readmission risk. Some patient-level studies[3, 4] reported that SNF care was associated with lower risk of readmission after HF, while a recent analysis of Medicare patients [8] found HF patients discharged to SNF had higher readmission rates. Our study found that higher hospital-level SNF rates were not correlated with lower RSRRs after HF admission, while for AMI hospitals with higher SNF rates were statistically associated with higher readmission rates; however, this relationship was small as SNF rates explained little (<4%) of the variation in RSRR after AMI.

Our use of hospital-level rather than patient-level analysis is unique in that it provides insight as whether a higher intensity of SNF referral can severe as a viable strategy for globally reducing readmission for HF and AMI. A hospital-level approach also answers the question of whether hospitals with limited access to SNF care are systematically disadvantaged in the CMS readmission measures for HF and AMI. The policy implication is that many hospitals appear to achieve low RSRRs regardless of high or low SNF rates, a finding of importance to hospitals, given that recent legislation will eventually reduce reimbursement to hospitals with excess readmission rates.[9] While we acknowledge that our study design is not able to prove causality (or lack of causality) between SNF rates and RSRR, our findings illustrate that low RSRRs after either HF or AMI can be attained by hospitals across a range of SNF rates, implying that the CMS readmission measures for HF and AMI are not systematically biased in favor of high or low SNF referring hospitals.

Several reasons may explain the lack of relationship between hospital SNF rates and RSRR for HF patients. First, SNFs likely vary in their readmission policies and on-site capabilities; some SNFs may prioritize for keeping patients out of the hospital while others have may favor readmitting patients with the slightest clinical complications. Second, SNF referral may not be closely related to RSRR if there were substantial variation in SNF quality. SNFs vary in quality in terms of mortality, development of pressure ulcers, and use of physical restraints.[10] If lower quality SNFs resulted in more post-hospitalization complications, this would mute the relationship between SNF rate and RSRR. Third, SNF referral may based on non-clinical factors such as hospital ownership of a SNF facility or distance to SNF, [11-14] obscuring the relationship between SNF care and readmission risk. Lastly, hospitals with low use of SNFs may employ other mechanisms to ensure that patients received adequate follow-up after discharge, such as home-health aides or visiting nurses, allowing these hospitals to achieve low RSRRs.

That higher SNF rates were associated with slightly higher RSRRs after AMI merits further discussion. AMI patients discharged from hospitals in the highest SNF quintile appeared to

have more comorbidities, and may have been more medically complex, leading to a positive association between SNF rates and RSRR from residual confounding. Nevertheless, the relationship between increasing SNF rates and higher RSRR after AMI had limited explanatory power, implying that the impact of patient complexity was likely small. In contrast, for HF patients the differences in comorbidity between hospitals in the highest and lowest quintiles of SNF use was ≤5 percentage points; as such, one would not expect that higher SNF rates would be associated more medically complex patients that lead to higher RSRRs.

In our study, black and other non-white patients were more likely to be admitted to hospitals with lower SNF rates. This is consistent with a recent study examining racial differences in 30-day readmission after HF and AMI hospitalization in Medicare patients[15] where part of the higher risk of readmission for blacks was related to whether a hospital was predominately minority-serving, even after adjusting for discharge to SNF. These findings are consistent with our study suggesting that factors other than SNF use explain the differences in readmission rates between white and minority patients.

Our hospital-level analysis found almost no correlation between higher SNF rates and lower RSRR, suggesting there may be inefficiencies in the current use of SNF. However, one should not conclude from our findings that individual patients would not benefit from SNF care after HF or AMI hospitalization. Future studies using patient-level analysis of medical chart data would be better suited towards identifying particular patients would benefit from SNF care to reduce readmission risk. While we speculate that differences in quality of SNF care may explain the lack of relationship with readmission, additional work is needed to evaluate specific interventions for improving care surrounding the transition between hospitals and SNF.[16]

Our study was limited by its use of administrative data for case-mix adjustment. However, studies have shown that hospital-level estimates of risk-standardized readmission rates after HF or AMI hospitalization are similar whether derived from administrative claims or clinical data. [6, 7] Second, generalizing our findings to medical conditions other than HF and AMI may be limited. Third, we examined a cohort of elderly patients covered under fee-for-service Medicare; results from younger populations or different health insurances may differ. Lastly, data on the SNF characteristics regarding on-site facilities and staffing were not available.

A strength of our study is that we determined SNF use using Medicare SNF billing claims rather than hospital discharge disposition codes as in previous studies. [3, 4] The accuracy of discharge disposition recorded in hospital billing data has been estimated to be as low as 80%,[17] and as such SNF billing data provides a more accurate representation of a SNF episode given financial implications for reimbursement.

Conclusion

In conclusion, our study found considerable variation in hospital use of SNF referral for Medicare patients discharged for HF and AMI in contemporary medical practice. No significant relationship between hospital-level readmission rates and SNF rates was detected for HF patients after adjustment for hospital characteristics. There was a weak positive relationship between SNF rates and readmission rates for AMI patients; however, SNF rates explained less than 4% of the variation in readmission rates after AMI. Hospitals achieving low readmission rates for their HF and AMI patients had both high and low use of SNF.

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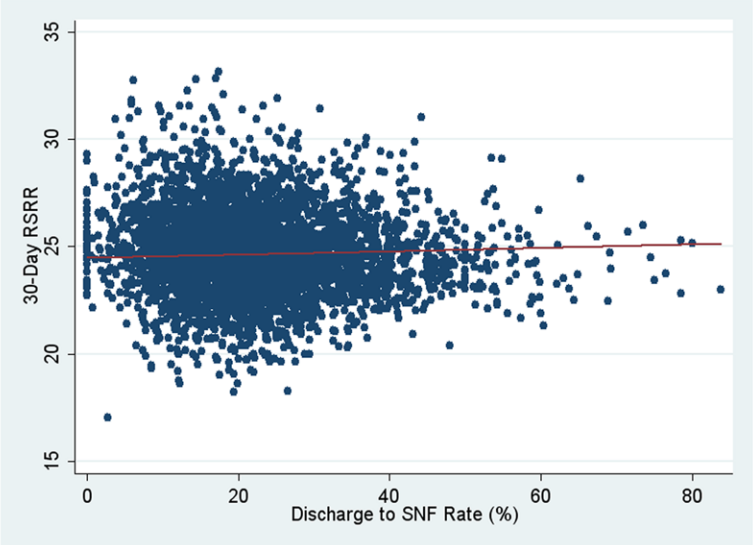

Figure 1.
30-day heart failure risk-standardized readmission rate by skilled nursing facility rate

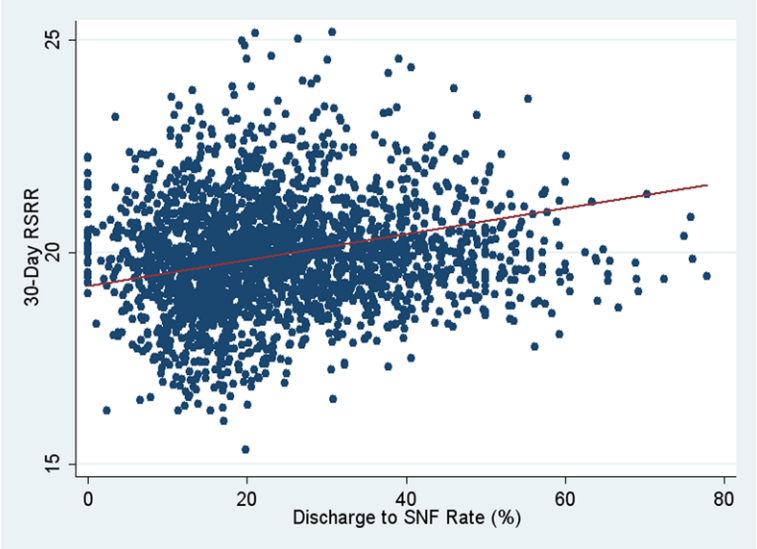

Figure 2.
30-day acute myocardial infarction risk-standardized readmission rate by skilled nursing facility referral rate

Table 1

Patient characteristics, according to quintiles of hospital-level SNF rates following HF hospitalization

Characteristics	**Overall**	**Lowest**	**2**	**3**	**4**	**Highest**
SNF rates	**0-83.8**	**0-13.7**	**13.8-18.7**	**18.8-23.5**	**23.6-30.0**	**30.1-83.8**
No. of patients	1347425	275960	337689	327166	261948	144662
No. of hospitals	4101	820	822	819	820	820
Mean age (standard deviation)	80.5 (7.9)	79 (7.9)	80 (7.9)	80.7 (7.9)	81.4 (7.9)	82.3 (7.8)
Male sex	43.3	45.1	44.1	43.0	41.8	40.5
White race	84.2	73.6	82.2	87.4	89.4	92.3
Black race	11.7	19.6	13.3	9.2	7.8	5.5
Other race	4.1	6.7	4.4	3.4	2.7	2.1
Cardiovascular and Comorbidity Conditions						
Congestive heart failure	75.0	77.1	76.0	75.4	75.4	75.0
Chronic atherosclerosis	73.0	74.4	74.0	73.3	72.0	71.0
Arrhythmias	63.2	61.5	63.3	64.2	62.8	62.0
Other gastrointestinal disorders	53.1	52.0	53.2	52.8	53.2	53.9
Iron deficiency and other anemias	52.1	51.2	52.0	52.2	52.5	53.3
Diabetes mellitus and complications	50.9	53.1	51.4	50.4	49.6	48.8
Valvular and rheumatic heart disease	49.2	48.0	49.1	50.5	49.8	46.4
Vascular or circulatory disease	48.2	47.0	48.2	48.3	48.9	48.6
Chronic obstructive pulmonary disease	47.5	47.4	47.2	48.0	46.9	48.3
Pneumonia	42.1	40.7	41.0	41.7	43.0	44.4
Disorders of fluid/electrolyte/acid-base	41.7	41.9	41.9	41.5	41.4	41.9
Renal failure	38.0	39.5	38.8	38.1	36.9	35.5
Other urinary tract disorders	33.5	33.8	33.3	33.6	33.5	32.8
Other and unspecified heart disease	33.2	34.3	32.5	33.1	32.8	34.1
Cardio-respiratory failure and shock	20.7	21.0	21.3	20.6	20.5	18.6
Dementia and senility	20.5	18.7	19.6	20.2	21.8	23.9
Cancer	20.3	20.0	20.4	20.7	20.4	20.0
Acute coronary syndrome	18.7	19.8	19.4	18.4	17.9	17.2
Peptic ulcer, gastrointestinal hemorrhage	15.5	15.0	15.4	15.5	15.9	16.1
Depression	13.1	11.3	12.5	13.1	14.0	15.8

Characteristics	Overall	Lowest	2	3	4	Highest
SNF rates	**0-83.8**	**0-13.7**	**13.8-18.7**	**18.8-23.5**	**23.6-30.0**	**30.1-83.8**
Decubitus ulcer or chronic skin ulcer	12.8	11.5	12.0	13.2	13.7	13.9
Fibrosis of lung and other chronic lung disorders	12.4	11.9	12.1	12.8	12.4	12.7
History of CABG	11.2	11.9	11.3	11.5	10.8	10.0
Stroke	10.4	10.1	10.5	10.3	10.0	10.3
Other psychiatric disorders	10.0	9.0	9.5	9.9	10.6	12.1
Drug/alcohol abuse / dependence / psychosis	9.1	10.4	9.6	8.8	8.3	7.3
Asthma	8.8	9.6	9.0	8.5	8.4	8.0
Major psychiatric disorders	8.7	7.5	8.5	8.6	9.4	10.5
Liver and biliary disease	8.4	8.9	8.0	8.3	8.0	7.7
Paralysis	6.8	6.9	7.0	6.9	6.8	6.8
Protein-calorie malnutrition	5.9	6.4	6.2	5.7	5.7	4.7
End-stage renal disease or dialysis	3.8	4.7	4.2	3.8	3.1	2.3
Severe hematological disorders	3.7	3.5	3.8	3.8	3.7	3.7
Nephritis	3.0	3.1	3.1	3.0	2.8	2.6
Metastatic cancer and acute leukemia	2.2	2.1	2.2	2.3	2.2	2.2

Abbreviations: CABG, coronary artery bypass graft surgery

$p<0.0001$ for all comparisons across quintiles using ANOVA for continuous variables and chi-square test for categorical variables

Table 2

Hospital characteristics, according to quintiles of hospital-level SNF rates following HF hospitalization

	Overall	Lowest	2	3	4	Highest
SNF rates	**0-83.8**	**0-13.7**	**13.8-18.7**	**18.8-23.5**	**23.6-30.0**	**30.1-83.8**
No. of hospitals	4101	820	822	819	820	820
Teaching						
COTH	270 (6.6)	104 (12.6)	76 (9.2)	47 (5.7)	34 (4.1)	9 (1.1)
Teaching	486 (11.8)	112 (13.6)	111 (13.5)	121 (14.7)	106 (12.9)	36 (4.4)
Non-teaching	3345 (81.5)	604 (73.6)	635 (77.2)	651 (79.4)	680 (82.9)	775 (94.5)
Rural	927 (22.6)	125 (15.2)	142 (17.2)	121 (14.7)	187 (22.8)	352 (42.9)
Heart transplant hospital	111 (2.7)	51 (6.2)	36 (4.4)	15 (1.8)	6 (0.7)	3 (0.4)
PCI hospital	1731 (42.2)	403 (49.1)	437 (53.1)	435 (53.1)	328(40.0)	128 (15.6)
CABG hospital	1714 (41.7)	400 (48.7)	435 (52.9)	429 (52.3)	322 (39.2)	128 (15.6)
Bedsize, mean (SD)	180.3 (192.0)	221.8 (207.0)	234.0 (239.0)	201.3 (192.0)	158.5 (153.0)	85.4 (94.7)
Ownership						
non-profit	2536 (61.8)	409 (49.0)	506 (61.5)	575 (70.2)	536 (65.3)	510 (62.1)
private, for-profit	652 (15.8)	204 (24.0)	152 (18.4)	114 (13.9)	107 (13.0)	75 (9.1)
public	913 (22.2)	207 (25.2)	164 (19.0)	130 (15.8)	177 (21.5)	235 (28.6)
Census division						
New England	174 (4.2)	2 (0.2)	12 (1.45)	29 (3.5)	51 (6.2)	80 (9.7)
Middle Atlantic	395 (9.6)	42 (5.1)	55 (6.7)	105 (12.8)	118 (14.3)	75 (9.1)
South Atlantic	382 (9.3)	100 (12.1)	103 (12.5)	51 (6.2)	69 (8.4)	59 (7.2)
East North Central	643 (15.6)	165 (20.0)	199 (24.2)	144 (17.5)	96 (11.7)	39 (4.7)
East South Central	536 (13.0)	25 (3.0)	61 (7.42)	86 (10.5)	117 (14.2)	247 (30.0)
West North Central	674 (16.0)	73 (8.9)	106 (12.8)	154 (18.8)	171 (20.8)	170 (20.7)
West South Central	562 (13.0)	174 (21.2)	114 (13.8)	95 (11.0)	84 (10.2)	95 (11.5)
Mountain	277 (6.8)	82 (10.0)	68 (8.3)	49 (6.0)	45 (5.4)	33 (4.0)
Pacific	423 (10.3)	122 (14.0)	104 (12.6)	106 (12.9)	69 (8.4)	22 (2.7)

Abbreviations: CABG, coronary artery bypass graft surgery; COTH, Council of Teaching Hospitals; HF, heart failure; PCI, percutaneous coronary intervention, SD, standard deviation

$p<0.0001$ for all comparisons across quintiles using ANOVA for continuous variables and chi-square test for categorical variables

Table 3

30-day risk-standardized readmission rate following HF hospitalization, by quintile of SNF rate

	Overall	Lowest	2	3	4	Highest
SNF rates	**0-83.8**	**0-13.7**	**13.8-18.7**	**18.8-23.5**	**23.6-30.0**	**30.1-83.8**
No. of hospitals	4101	820	822	819	820	820
Risk-standardized readmission rate						
mean	24.7	25.0	24.7	24.4	24.6	24.5
standard deviation	2.0	2.2	2.1	1.9	2.0	1.7
median	24.5	24.8	24.6	24.5	24.4	24.4
minimum	17.0	17.0	19.0	18.2	18.3	20.3
maximum	33.2	32.8	33.2	31.5	31.9	31.4

Table 4

Patient characteristics, according to quintiles of hospital-level SNF rates following AMI hospitalization

Characteristics	**Overall**	**Lowest**	**2**	**3**	**4**	**Highest**
SNF rates	**0-77.8**	**0-13.1**	**13.2-18.4**	**18.5-25.0**	**25.1-34.8**	**34.9-77.8**
No. of patients	539869	143715	156232	130153	70910	38859
No. of hospitals	2453	490	491	498	484	490
Mean age (standard deviation)	78.8 (8.0)	77.1 (7.6)	78.1 (7.8)	79.0 (7.9)	80.0 (8.1)	83.3 (7.9)
Male	49.6	53.2	51.2	49.3	44.9	39.5
White	88.0	86.8	89.2	89.4	89.4	91.6
Black	7.2	8.5	6.5	7.1	7.1	5.6
Other	3.9	4.7	4.2	3.4	3.3	2.7
Cardiovascular and Comorbidity Conditions						
Coronary artery disease	80.9	84.4	83.2	81.0	75.7	67.2
Diabetes mellitus and complications	42.0	41.3	41.4	42.4	42.7	44.0
Iron deficiency and other anemias	37.6	33.4	35.8	38.8	42.1	48.0
Vascular or circulatory disease	33.8	30.1	32.1	35.1	37.9	42.1
Arrhythmias	33.0	29.1	31.8	34.0	36.5	40.5
Congestive heart failure	32.9	28.8	31.0	33.2	38.0	45.5
Valvular and rheumatic heart disease	31.0	27.7	29.7	32.7	34.5	36.1
Chronic obstructive pulmonary disease	30.2	29.0	29.4	29.8	32.2	35.8
History of infection	25.0	19.2	22.9	26.9	30.9	37.0
Disorders of fluid/electrolyte/acid-base	24.1	21.5	22.9	24.6	26.9	31.8
Angina pectoris / old myocardial infarction	23.7	23.1	23.6	23.9	24.3	24.3
Pneumonia	23.1	19.5	21.5	23.0	27.3	35.1
Acute coronary syndrome	23.0	22.5	22.9	22.7	23.3	25.6
Other urinary tract disorders	21.8	20.2	21.2	22.3	23.6	25.7
Renal failure	19.4	17.1	18.6	20.2	21.6	25.0
Cerebrovascular disease	19.4	17.8	18.6	20.2	21.1	22.9
Cancer	18.7	17.7	18.6	19.8	19.2	18.9
Dementia and senility	16.5	12.7	14.3	16.5	21.6	30.0
Myocardial infarction, other than anterior	13.3	16.0	14.7	12.7	10.0	6.3
Myocardial infarction, anterior	9.6	10.9	10.2	9.3	7.9	6.2

Characteristics	Overall	Lowest	2	3	4	Highest
SNF rates	**0-77.8**	**0-13.1**	**13.2-18.4**	**18.5-25.0**	**25.1-34.8**	**34.9-77.8**
History of PCI	8.8	9.9	9.3	8.9	7.1	4.7
Stroke	8.1	7.0	7.2	8.2	9.7	11.7
Decubitus ulcer or chronic skin ulcer	7.4	5.4	6.6	8.0	9.7	12.4
History of CABG	6.3	6.4	5.8	6.3	6.7	6.6
Asthma	5.8	5.9	6.1	6.0	5.9	5.6
Hemiplegia, paraplegia, paralysis	5.4	4.7	5.1	5.5	6.4	7.5
Protein-calorie malnutrition	3.9	3.4	3.7	3.6	4.7	5.5
End-stage renal disease or dialysis	2.2	2.1	2.3	2.4	2.1	2.0
Metastatic cancer and acute leukemia	2.1	1.7	2.0	2.2	2.4	2.8

Abbreviations: CABG, coronary artery bypass graft surgery; PCI, percutaneous coronary intervention

$p<0.0001$ for all comparisons across quintiles using ANOVA for continuous variables and chi-square test for categorical variables

Table 5

Hospital characteristics, according to quintiles of hospital-level SNF rates following AMI hospitalization

	Overall	Lowest	2	3	4	Highest
SNF rates	**0-77.8**	**0-13.1**	**13.2-18.4**	**18.5-25.0**	**25.1-34.8**	**34.9-77.8**
No. of hospitals	2453	490	491	498	484	490
Teaching						
COTH	258 (10.5)	64 (13.0)	82 (16.7)	72 (14.4)	33 (6.8)	7 (1.4)
Teaching	437 (17.8)	113 (23.0)	117 (23.0)	87 (17.4)	67 (13.8)	53 (10.8)
Non-teaching	1758 (71.6)	313 (63.0)	292 (59.4)	339 (68.0)	384 (79.3)	430 (87.7)
Rural	130 (5.3)	10 (2.0)	10 (2.0)	18 (3.6)	27 (5.6)	65 (13.2)
Heart transplant hospital	110 (4.5)	39 (8.0)	41 (8.3)	21 (4.2)	9 (1.9)	0 (0.0)
Cath hospital	1651 (67.0)	392 (80.0)	404 (82.2)	382 (76.7)	308 (63.6)	165 (33.6)
PCI hospital	1651 (67.0)	392 (80.0)	404 (82.2)	382 (76.7)	308 (63.6)	165 (33.6)
CABG hospital	1637 (66.7)	391 (79.7)	401 (81.0)	378 (75.9)	303 (62.6)	164 (33.4)
Bedsize (mean, SD)	259.5 (208)	305.6 (212)	335.7 (225)	294.8 (242)	211.1 (168)	149.1 (107)
Ownership						
non-profit	1708 (69.6)	271 (55.3)	349 (71.0)	356 (71.4)	370 (76.4)	362 (73.0)
private, for-profit	429 (17.4)	142 (28.9)	80 (16.2)	90 (18.0)	58 (11.9)	59 (12.0)
public	316 (12.8)	77 (15.7)	62 (12.6)	52 (10.4)	56 (11.5)	69 (14.0)
Census division						
New England	148 (6.0)	2 (0.40)	13 (2.6)	20 (4.0)	31 (6.4)	82 (16.7)
Middle Atlantic	345 (14.0)	13 (2.7)	35 (7.1)	68 (13.6)	96 (19.8)	133 (27.1)
South Atlantic	180 (7.3)	53 (10.8)	36 (7.3)	33 (6.6)	30 (6.2)	28 (5.7)
East North Central	456 (18.5)	80 (16.3)	91 (18.5)	121 (24.2)	106 (21.9)	58 (11.8)
East South Central	174 (7.1)	19 (3.9)	56 (11.4)	35 (7.0)	26 (5.4)	38 (7.8)
West North Central	422 (17.2)	36 (7.3)	74 (15.0)	107 (21.4)	104 (21.4)	101 (20.6)
West South Central	286 (11.6)	134 (27.3)	61 (12.4)	31 (6.2)	35 (7.2)	25 (5.1)
Mountain	132 (5.4)	70 (14.2)	36 (7.3)	15 (3.0)	10 (2.1)	1 (0.20)
Pacific	282 (11.4)	55 (11.2)	89 (18.1)	68 (13.6)	46 (9.5)	24 (4.9)

Abbreviations: AMI, acute myocardial infarction; CABG, coronary artery bypass graft surgery; COTH, Council of Teaching Hospitals; PCI, percutaneous coronary intervention, SD, standard deviation

$p<0.0001$ for all comparisons across quintiles using ANOVA for continuous variables and chi-square test for categorical variables

Table 6

30-day risk-standardized readmission rate following AMI hospitalization, by quintile of SNF rate

	Overall	Lowest	2	3	4	Highest
SNF rates	**0-77.8**	**0-13.1**	**13.2-18.4**	**18.5-25.0**	**25.1-34.8**	**34.9-77.8**
No. of hospitals	2453	490	491	498	484	490
Risk-standardized readmission rate						
mean	19.9	19.7	19.6	20.0	20.1	20.1
standard deviation	1.3	1.4	1.3	1.4	1.2	1.1
median	19.9	19.8	19.6	20.0	20.0	19.9
minimum	15.3	16.3	16.0	15.3	16.5	17.3
maximum	25.2	23.8	23.9	25.2	25.2	24.6