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Hospitalist Care and Length-of-stay in Patients Requiring Complex Discharge Planning and Close Clinical Monitoring

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Abstract

Background—Academic medical centers are increasingly employing hospitalists to staff teaching wards. Although studies have demonstrated reduced length-of-stay associated with hospitalist care, it is unclear which patients are most likely to benefit.

Objective—To determine whether patients with specific diagnoses or discharge needs account for the association between hospitalist care and reduced length-of-stay.

Design—Hospital admissions were divided into two groups based on type of attending: teaching hospitalist (full-time faculty hospitalist with no outpatient responsibilities), and non-hospitalist (full-time or voluntary faculty contributing one or two months of teaching service per year).

Participants—All patients discharged from an academic teaching service over two years.

Measurements—Data were extracted from Montefiore Medical Center's clinical information system and the social security death registry.

Results—Mean length-of-stay was lower for teaching hospitalists than for non-hospitalists (5.01 days vs. 5.87 days, $p < 0.02$). The reduction in length-of-stay was greatest for patients requiring close clinical monitoring (patients with congestive heart failure, stroke, asthma, or pneumonia), and for those requiring complex discharge planning. There were no significant differences between the groups in readmission, in-hospital mortality, or 30-day mortality.

Conclusions—Teaching hospitalist care was associated with shorter length-of-stay in patients requiring close clinical monitoring and complex discharge planning, without adversely affecting readmission or mortality rates.

Introduction

Pressure to control costs of inpatient care has led many academic medical centers to employ hospitalists to provide care for medical inpatients and to staff medical teaching rounds.[1] Hospitalist care has been associated with shorter length-of-stay[2-16] and lower cost[3, 4, 7,

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[9-14, 16, 17] in a variety of settings, including after adjustment for physician experience.[18] This reduction in length-of-stay has been demonstrated among patients admitted with pneumonia[9, 17] and congestive heart failure.[19] However, whether there are other specific patient diagnoses or discharge dispositions that appear to derive particular benefit from hospitalist care has not been firmly established.

The available data on clinical outcomes associated with hospitalist care is less consistent than the data on length-of-stay. One study noted a 33% decrease in in-hospital mortality among patients on the hospitalist service, and this decrease remained significant at 60 days. However, these findings were confounded by non-random assignment to the hospitalist service, and major differences between the treatment groups.[11] Another study, in which assignment to the hospitalist service was without preference, found a statistically significant reduction in 30-day mortality in the hospitalist-treated group in the second year of the program,[14] but included only two hospitalists. Despite these promising results, randomized studies with long-term follow-up of hospitalist versus non-hospitalist care are lacking.

Our primary objective was to determine which patient groups appear more likely to benefit from hospitalist care by comparing length-of-stay and clinical outcomes (in-hospital mortality, 30-day mortality, and readmission) among hospitalists and non-hospitalists. Our secondary objective was to compare teaching quality between these groups. We compared two models of care: teaching hospitalist (full-time faculty with no outpatient responsibilities), and non-hospitalist (full or part-time faculty with no more than two months per year on the inpatient service). We hypothesized that hospitalist care would be associated with shorter length-of-stay among patients with specific diagnoses, levels of acuity, and discharge needs, without adversely affecting clinical outcomes.

Methods

Study Setting and Data Collection

Montefiore Medical Center's Weiler Hospital is a 381-bed teaching hospital affiliated with Albert Einstein College of Medicine. We extracted data on all discharges from the medical teaching service at Weiler Hospital for two years, from 7/1/02 through 6/30/04. Patients were assigned to a teaching hospitalist or non-hospitalist team, in rotation, at the time of admission by a senior admitting resident. Hospitalist and non-hospitalist teams are identical in every way other than type of attending conducting rounds. Patients assigned to the non-teaching service were not included in this analysis. Although team assignment appears random, we decided not to use this term as we acknowledge that concealed allocation did not occur. Rather, we used a quasi-randomized study design.[2] Data on patient age, race-ethnicity, sex, insurance status, history of prior admissions, laboratory values, ICD-9 and DRG codes, length-of-stay, readmission, and in-hospital mortality were extracted from a replicate of Montefiore's clinical information system (Emerging Health Information Technology, Yonkers, NY). The data replicate is merged monthly with the social security death registry, which allowed extraction of 30-day mortality rates after discharge. Montefiore's Institutional Review Board approved the study.

Outcome Variables

The main outcome variables were: length-of-stay, readmission, in-hospital and 30-day mortality, and resident and student teaching evaluations. Length-of-stay was analyzed as a continuous variable and, although not normally distributed, was reported as a mean (as has been done previously).[5, 14, 15] Readmission was defined as an admission for any reason, within 30 days of discharge, to Weiler hospital or to the other Montefiore hospital, Moses, and was analyzed as a dichotomous variable. In-hospital and 30-day mortality were analyzed as dichotomous variables.

Independent variables

The major independent variable was the team assignment of each admission (teaching hospitalist vs. non-hospitalist). In addition, we examined patient-level and physician-level covariates for each admission. Patient-level covariates included: demographic characteristics (age, sex, race-ethnicity), insurance status, number of prior admissions within the previous 90 days, albumin value at the time of admission, diagnosis of diabetes (defined as ICD-9 of 250 at discharge), DRG-weight, primary discharge diagnosis (ICD-9 code), and discharge disposition (home with self-care, home with services, or nursing home). Because the source of data was a clinical information system, independent variables used for adjusted analyses could only be those available on a majority of patients. DRG-weight was used as a surrogate for the overall severity of illness, as has been done previously,[14] because it was readily available on all patients. For length-of-stay analyses, DRG-weight was categorized into quartiles, which represent levels of patient acuity. Albumin level at the time of admission was also used as a marker for overall disease severity, as has been done in earlier studies,[20-22] because it is available on most patients and is thought to be useful in the quantification of risk in research settings.[23] ICD-9 codes were grouped into diagnosis clusters using the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality system.[24] Some of these diagnoses were further collapsed into clinical categories to make data reporting manageable (e.g. “Neoplasm” contains several AHRQ diagnosis classifications). For length-of-stay analyses, only those diagnoses that were among the top 30 causes for hospitalization in the U.S.A.[25] were included, to ensure adequate numbers of patients in each category. The major physician-level covariate of interest was the annual number of months on service. There was no crossover of attendings between groups (i.e. non-hospitalists never became hospitalists, nor vice versa).

Statistical Analysis

First, the two groups (teaching hospitalist vs. non-hospitalist) were compared with respect to demographic and clinical characteristics using t-tests, Mann-Whitney, or chi-square tests. Because DRG-weight is not normally distributed, it is reported both as a mean (using a t-test with unequal variances for comparison between the groups), and as a median (using the Mann-Whitney test for comparison between the groups). Categorical variables are compared using chi-square tests. Second, Somers' D was calculated and used as a rank-based test[26] to compare length-of-stay between the groups, with and without standard errors robust to clustering of patients within each physician. The analysis was repeated with and without truncation of length-of-stay to the mean plus three standard deviations to assess the influence of outliers. Then, multivariate linear regression was used to compare length-of-stay between the groups after adjusting for differences in demographic and clinical characteristics. For multivariate analyses the variables for insurance and race-ethnicity were recoded into multiple dummy variables.

For the dichotomous outcomes of readmission and in-hospital and 30-day mortality, rates were initially compared using chi-square tests, and then multivariate logistic regression models were used to assess the impact of hospitalist care after adjusting for differences between the three groups. Variables chosen for multivariate analyses included those that measured a significant difference between the groups (albumin, DRG-weight, insurance); other variables were added, one by one, keeping those with a Wald-statistic $p < 0.20$. 95% confidence intervals were calculated using standard errors, which are robust to the clustering of patients by physician.

STATA software, version 9.0, (StataCorp, College Station, TX) was used for all statistical analysis and data manipulation.

Results

Patient Population

From 7/1/02 through 6/30/04 there were 9047 discharges from the teaching service at Weiler Hospital. Significant data were missing for ten hospital stays; thus the study sample included 9037. This included 2913 discharges from teaching hospitalist teams (32.2%) and 6124 discharges from non-hospitalist teams (67.8%). The patient populations were similar with respect to age, sex, race-ethnicity, presence of prior admission, and mix of acute diagnoses. The teaching hospitalist group included more patients with Medicaid, a lower mean Albumin, and a lower mean DRG-weight. (Table 1)

Length-of-stay

The mean length-of-stay was 5.01 ± 6.12 days in the teaching hospitalist group vs. 5.87 ± 7.51 days in the non-hospitalist group ($p = 0.02$; Table 2). The reduction in length-of-stay was still large and significant after adjustment for potential confounders, (unadjusted reduction = 0.86 days, $p = 0.004$; adjusted reduction = 0.78 days, $p < 0.001$, adjusted for race-ethnicity, insurance, DRG-weight, albumin, and prior admissions). There was a statistically significant negative linear association between length-of-stay (in days) and number of months the attending was on service per year, with each extra month on service associated with a 0.19 day reduction in length-of-stay ($\beta = -0.19$ days per month on service, $p < 0.002$).

To assess the influence of outliers on length-of-stay, the analysis was repeated using the variable length-of-stay truncated at the mean plus three standard deviations. In truncated analysis, teaching hospitalist care was associated with reduced length-of-stay when compared with non-hospitalist care (4.82 days vs. 5.54 days, $p = 0.02$).

To assess the influence of patients returning with multiple admissions, the analysis was performed using only the first admission for each patient during the time period ($n = 6883$). This first-admission analysis also yielded significant reductions in length-of-stay for teaching hospitalists vs. non-hospitalists (4.96 days vs. 5.69 days, $p = 0.04$).

Length-of-stay Among Patients with Specific Diagnoses and Discharge Dispositions

To determine whether reduction in length-of-stay is more pronounced among patients with specific diagnoses, level of acuity, or discharge needs, length-of-stay data were analyzed after stratifying by clinical conditions, DRG-weight, and discharge disposition (Table 3). Reductions in length-of-stay associated with hospitalist care were most pronounced in patients with diagnoses of cerebrovascular accident (CVA or stroke), sepsis, asthma/COPD, or urinary tract infection, without appreciable differences in length-of-stay among patients with diagnoses of acute MI, coronary disease without MI, arrhythmia, or gastrointestinal bleeding. Lengths-of-stay were marginally shorter in patients with pneumonia ($p = 0.13$) and congestive heart failure ($p = 0.06$). The mean length-of-stay was low for patients admitted with chest pain in both groups, but slightly lower in the teaching hospitalist group ($p = 0.04$). Regarding overall acuity, differences between hospitalists and non-hospitalists were significant in patients with lower overall acuity (DRG-weight quartiles 1-3; mean difference = 0.49 days; $p = 0.02$), but widened and remained significant in patients with the highest overall acuity (4^{th} quartile of DRG-weight; mean difference = 1.95 days; $p < 0.001$). Regarding discharge disposition, significant differences between groups were smaller in patients who were discharged home with self-care, widened when home services were required, and were largest when transfer to a nursing facility at the time of discharge was required.

Readmission and Mortality Rates

After adjustment for demographic and clinical characteristics, there were no differences between the groups in readmission, in-hospital mortality, or 30-day mortality (Table 4). In first-admission only analysis, after adjustment, there were no differences between the two groups in readmission (OR = 0.92; 95% CI: 0.80 – 1.06), in-hospital mortality (OR = 0.95; 95% CI: 0.72 – 1.27), or 30-day mortality (OR = 0.99; 95% CI: 0.82 – 1.18).

Discussion

Our experience with a teaching hospitalist service confirmed several now-familiar findings of hospitalist care, including lower lengths-of-stay for patients on teaching hospitalist teams. We further showed that teaching hospitalist care appears to have a stronger association with length-of-stay in patients requiring specialized services upon discharge, such as homecare services or transfer to a nursing facility. We were able to measure discharge planning needs using a separate discharge disposition code, assigned independent of billing at the time of discharge. We believe the greater reduction in length-of-stay associated with complex discharge planning reflects hospitalist skills in working with ancillary staff, such as social workers or discharge planners.

In addition, we found that hospitalist care had the strongest association with length-of-stay in patients with the highest acuity, as measured by the DRG-weight. This important finding might help guide the use of hospitalist services, given that small numbers of patients at the highest acuity levels account for disproportionate numbers of total hospital days.[27]

Hospitalist care had the strongest association with length-of-stay in patients with specific diagnoses, including cerebrovascular accidents (strokes), congestive heart failure, pneumonia, sepsis, urinary tract infection (UTI) and asthma/COPD. These findings may reflect hospitalists' ability to closely monitor patients with dynamic conditions, such as congestive heart failure, pneumonia, sepsis, UTI, or asthma/COPD. The close monitoring and continuous presence offered by hospitalists may allow for earlier discharge, because hospitalists are more likely to detect clinical improvement in real time, and to make appropriate adjustments in treatment regimens. For stroke patients in particular, lower lengths-of-stay associated with hospitalist care may also reflect more effective attention to complex discharge needs, such as rehabilitation services.

When we analyzed length-of-stay by the number of months the attending spent on service per year, we showed a statistically significant negative linear trend towards lower lengths-of-stay with increasing numbers of inpatient months. This suggests that extra inpatient experience is associated with even larger reductions in length-of-stay, and supports earlier findings that showed that reductions in length-of-stay with hospitalist care were greater,[14] or became significant,[11] in the second year of hospitalist programs.

In contrast to other analyses, the patients in the two groups compared in this analysis were largely similar, but some differences persisted. Slightly “sicker” patients may have been assigned to teaching hospitalist teams because at any given time, due to lower length-of-stay, the existing census was likely to be lower on a teaching hospitalist team.

Despite the strengths of our study, it has some limitations. Similar to other studies of hospitalist care, the groups of attendings were small (five teaching hospitalists and 54 non-hospitalists), and thus an individual outlier may have had a significant effect on the outcomes. Given the large number of diagnoses examined, the results of length-of-stay in specific diagnoses needs to be interpreted with caution. An additional limitation is that we had limited power to detect small differences in mortality rates. While it is reassuring that we did not find a statistically significant difference in readmission or mortality rates associated with hospitalist care, it would be erroneous to infer that there is no difference. Given our sample size and the event rates in the non-hospitalist group, requiring a power of 80% we have a minimal detectable odds ratio of 1.18 for readmission, 1.38 for in-hospital events, and 1.24 for 30-day mortality. The strongest claim that can be inferred from this analysis is that if there is a difference in these outcomes with hospitalist care, it is likely less than the above. Smaller differences in mortality rates would only be detectable with a larger sample. Finally, although our data were collected in 2002-04, they reflect a practice in common use today, namely, hospitalists being used for inpatient teaching service in academic medical centers.

We conclude that teaching hospitalist care was associated with reduced length-of-stay on an academic teaching service, but not with increased readmission or mortality rates. There were several patient groups identified in whom this association was particularly strong: patients who require close clinical monitoring, patients in whom real-time adjustment of therapy is critical, patients with high overall acuity, and patients in whom complex discharge planning is necessary.

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Table 1

Demographic and Clinical Characteristics of Patients Assigned To Teaching Hospitalist vs. Non-Hospitalist Services

	All (n = 9037)	TH (n = 2913)	NH (n =6124)	p value*
Demographics				
Age- mean ± SD	64.9 ± 17.8	65.3 ± 17.6	64.7 ± 17.9	0.21
Female- no.(%)	5254 (58.1)	1659 (57.0)	3595 (58.7)	0.12
Service- no.(%)	6650 (73.6)	2167 (74.4)	4483 (73.2)	0.23
Prior Admit no. (%)	2390 (26.4)	797 (27.4)	1593 (26.0)	0.18
Albumin mean ± SD	3.80 ± 0.70	3.77 ± 0.68	3.82 ± 0.66	0.002
DRG wt- mean ± SD	1.24 ± 1.56	1.20 ± 1.33	1.27 ± 1.66	0.03
DRG wt- median	0.95	0.95	0.96	0.90
Insurance No. (%)				0.04
Self-Pay	78 (0.9)	19 (0.7)	59 (1.0)	
Medicaid	2964 (32.8)	1008 (34.6)	1956 (31.9)	
Medicare	3984 (44.1)	1244 (42.7)	2740 (44.7)	
Commercial	2008 (22.2)	640 (22.0)	1368 (22.3)	
Race-Ethnicity No. (%)				0.44
White	2527 (28.0)	786 (27.0)	1741 (28.4)	
Black	2617 (29.0)	847 (29.1)	1770 (28.9)	
Hispanic	2958 (32.7)	964 (33.1)	1994 (32.6)	
Unknown/Other	935 (10.3)	316 (10.8)	619 (10.1)	
Diagnosis† No. (%)				
Congestive Heart Failure	817 (9.0)	262 (9.0)	555 (9.1)	0.92
Chest Pain	679 (7.5)	221 (7.6)	458 (7.5)	0.86
Acute Myocardial Infarction	497 (5.5)	167 (5.7)	330 (5.4)	0.50
Pneumonia	618 (6.8)	180 (6.2)	438 (7.2)	0.09
Asthma/COPD	523 (5.8)	168 (5.8)	355 (5.8)	0.96
Coronary Disease w/o Infarction	406 (4.5)	131 (4.5)	275 (4.5)	0.99
Diabetes Decompensated‡	333 (3.7)	96 (3.3)	237 (3.9)	0.18
Arrhythmia	294 (3.3)	85 (2.9)	209 (3.4)	0.22
Sepsis	257 (2.8)	79 (2.7)	178 (2.9)	0.60
Gastrointestinal Bleeding	247 (2.7)	79 (2.7)	168 (2.7)	0.93
Syncope	232 (2.6)	80 (2.7)	152 (2.5)	0.46
Urinary Tract Infection	228 (2.5)	82 (2.8)	146 (2.4)	0.22
Fluid/Electrolyte Disorder	209 (2.3)	76 (2.6)	133 (2.2)	0.20
Neoplasm	200 (2.2)	69 (2.4)	131 (2.1)	0.49
Enteritis/Diarrhea	191 (2.1)	55 (1.9)	136 (2.2)	0.30
Renal Failure	190 (2.1)	66 (2.3)	124 (2.0)	0.46
Acid/Peptic Disease	177 (2.0)	71 (2.4)	106 (1.7)	0.02
Cellulitis	175 (1.9)	62 (2.1)	113 (1.8)	0.36
Complication of Surgery/Procedure	162 (1.8)	57 (2.0)	105 (1.7)	0.42

	All (n = 9037)	TH (n = 2913)	NH (n =6124)	p value*
Hepatitis/Cirrhosis	153 (1.7)	53 (1.8)	100 (1.6)	0.52
Acute Cerebro-vascular Accident	129 (1.4)	37 (1.3)	92 (1.5)	0.39
Thromboembolic Disease	120 (1.3)	43 (1.5)	77 (1.3)	0.40
HIV	119 (1.3)	40 (1.4)	79 (1.3)	0.75
Anemia	101 (1.1)	31 (1.1)	70 (1.1)	0.74
Pancreatitis	72 (0.8)	29 (1.0)	43 (0.7)	0.14
Hemoglobin SS Disease	38 (0.4)	13 (0.5)	25 (0.4)	0.79
Other Diagnosis	1870 (20.7)	581 (19.9)	1289 (21.0)	0.23

TH= Teaching Hospitalist; NH= Non-Hospitalist

*Continuous variables reported as mean ± Standard deviation and groups compared using t-test with equal or unequal variance, as appropriate.

Categorical variables reported as number (percent) and compared using $\chi 2$. Medians of Age and DRG-Weight compared using Mann-Whitney.

For zero-sum variables race-ethnicity and insurance $\chi 2$ reported for whole group and by category.

†Diagnoses grouped by ICD-9 code according to clinical classifications by the Agency for Healthcare Research and Quality, and collapsed into clinical categories.

‡Includes Diabetic-ketoacidosis, hyper-osmolar non-ketotic, and hyperglycemia

Table 2

Length-of-Stay Among Patients Assigned to Teaching Hospitalist vs. Non-Hospitalist Teams

All Admissions	All (n=9037)	TH (n=2913)	NH (n=6124)	p value*
Mean Length-of-stay	5.59 ± 7.10	5.01 ± 6.12	5.87 ± 7.51	0.02
Mean Truncated Length-of-stay†	5.31 ± 5.24	4.82 ± 4.80	5.54 ± 5.42	0.02
First Admission	(n = 6883)	(n = 2150)	(n = 4733)	
Mean Length-of-stay	5.46 ± 7.10	4.96 ± 5.93	5.69 ± 7.56	0.04
Mean Truncated Length-of-stay†	5.17 ± 5.09	4.79 ± 4.76	5.34 ± 5.23	0.04

TH= Teaching Hospitalist; NH= Non-Hospitalist; LOS = Length-of-stay

*Rank-based testing using Somers' D, with standard errors robust to clusters of patients by physician

†LOS truncated at mean + 3 standard deviations

Table 3

Length-of-stay in Days Among Patients with Specific Diagnoses, Levels of Overall Acuity, and Discharge Dispositions Assigned to Teaching Hospitalist vs. Non-Hospitalist Services

Group (No.)	TH	NH	Difference (days)	p value*
Diagnosis				
Acute Cerebro-vascular Accident (129)	8.59 ± 7.46	12.45 ± 8.74	3.86	0.001
Sepsis (257)	8.63 ± 8.25	12.33 ± 16.58	3.70	0.03
Pneumonia (618)	6.97 ± 8.40	8.35 ± 10.05	1.38	0.13
Congestive Heart Failure (817)	4.63 ± 3.72	5.81 ± 5.63	1.18	0.06
Asthma/COPD (523)	3.53 ± 2.69	4.46 ± 4.29	0.93	0.009
Urinary Tract Infection (228)	4.48 ± 4.61	5.31 ± 6.21	0.83	0.05
Diabetes Decompensated† (333)	4.50 ± 6.12	5.03 ± 6.47	0.53	0.31
Cellulitis (175)	5.15 ± 7.66	5.66 ± 5.06	0.51	0.17
Fluid/Electrolyte disorder (209)	4.26 ± 2.55	4.62 ± 4.03	0.36	0.54
Acute Myocardial Infarction (497)	7.11 ± 6.22	7.44 ± 6.48	0.33	0.57
Gastrointestinal Bleeding (247)	5.25 ± 4.68	5.44 ± 5.99	0.19	0.73
Chest Pain (679)	1.76 ± 1.50	1.85 ± 1.36	0.09	0.04
Coronary Disease w/o Infarction (406)	3.56 ± 3.27	3.62 ± 3.36	0.06	0.43
Arrhythmia (294)	4.27 ± 4.73	4.03 ± 3.39	-0.24	0.35
Quartiles of DRG-weight				
1st Quartile (2309)	2.22 ± 2.00	2.68 ± 2.51	0.46	< 0.001
2nd Quartile (2210)	4.14 ± 3.72	4.58 ± 3.94	0.44	0.07
3rd Quartile (2259)	4.96 ± 4.22	5.59 ± 5.03	0.63	0.12
4th Quartile (2259)	8.74 ± 9.59	10.69 ± 11.97	1.95	< 0.001
Disposition				
Home-Self (5175)	3.40 ± 3.13	3.80 ± 3.59	0.40	0.02
Home Care (1601)	5.24 ± 4.42	6.25 ± 5.18	1.01	0.005
SNF (1402)	8.21 ± 9.56	10.22 ± 10.74	2.01	0.005

TH= Teaching Hospitalist; NH= Non-Hospitalist

Variables reported as mean ± standard deviation

*Rank-based testing using Somers' D, with standard errors robust to clusters of patients by physician

Diagnoses grouped by ICD-9 code according to clinical classifications by the Agency for Healthcare Research and Quality, and collapsed into clinical categories.

†Includes Diabetic-ketoacidosis, hyper-osmolar non-ketotic, and hyperglycemia

Dispositions: Home-self= discharged home without services; Home Care= discharged home with arranged visiting nurse;

SNF= at discharge, transferred to a skilled nursing facility

Table 4

Clinical Outcomes Among Patients Assigned to Teaching Hospitalist and Non-Hospitalist Services

	TH	NH
30-Day Readmission*	0.97 (0.88 - 1.08)	reference
In-Hosp Mortality†	1.03 (0.83 - 1.28)	reference
30-Day Mortality‡	1.05 (0.88 - 1.26)	reference

TH= Teaching Hospitalist; NH= Non-Hospitalist

Odds Ratios (95% confidence intervals) for events if assigned to a hospitalist team using non-hospitalist teams as reference

95% confidence intervals reported cluster robust for clusters of patients by physician

*Adjusted for age, sex, insurance, diabetes, albumin, DRG-weight, number of admissions in prior 90 days

†Adjusted for age, sex, race-ethnicity, insurance, diabetes, albumin, DRG-weight

‡Adjusted for age, sex, insurance, albumin, DRG-Weight, number of admissions in prior 90-days

30-day mortality taken from social security death registry using social security number matching.