ORIGINAL ARTICLES

What Effect Does Inpatient Physician Specialty and Experience Have on Clinical Outcomes and Resource Utilization on a General Medical Service?

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OBJECTIVE: To examine the effects of internal medicine specialty and physician experience on inpatient resource use and clinical outcomes on an academic general medicine service.

DESIGN: A 1-year retrospective cohort study.

SETTING: The University of Michigan Hospitals, Ann Arbor, Michigan.

PATIENTS: Two thousand six hundred seventeen admissions to the general medicine service from July 2001 to June 2002, excluding those for whom data were incomplete ($n = 18$).

MEASUREMENTS AND MAIN RESULTS: Length of stay (LOS) and total hospital costs were used to measure resource utilization. Hospital mortality and 14-day and 30-day readmission rates were used to measure clinical outcomes. Adjusted mean LOS was significantly greater for rheumatologists (0.56 days greater; $P = .002$) and endocrinologists (0.38 days greater; $P = .03$) compared to general internists. Total costs were lower for general internists compared to endocrinologists (\$1100 lower; $P = .01$) and rheumatologists (\$431 lower; $P = .07$). Hospitalists showed a trend toward reduced LOS compared to all other physicians (0.31 days lower; $P = .06$). The top two deciles of physicians stratified by recent inpatient general medical experience showed significantly reduced LOS compared to all other physicians (0.35 days lower; $P = .04$). No significant differences were seen in readmission rates or in-hospital mortality among the various physician groups.

CONCLUSIONS: General internists had lower lengths of stay and costs compared to endocrinologists and rheumatologists. Hospitalists showed a trend toward reduced LOS compared to all other physicians. Recent inpatient general medicine experience appears to be a determinant of reduced inpatient resource use.

KEY WORDS: hospitalist; subspecialist; length of stay; outcomes; cost.

J GEN INTERN MED 2004;19:395–401.

The delivery of inpatient medical care over the past several years has changed substantially with the advent of hospitalists. These inpatient physicians, who usually care for patients only during their hospitalization, have grown to number almost 6,000 nationwide and are projected to increase to more than 10,000 in the next 3 years.¹ Traditionally, hospitalists have been defined as physicians who spend 25% or more of their time caring for hospitalized patients,² although newer definitions now include “academic hospitalists” who may have fewer clinical duties but whose primary research or administrative focus is on inpatient medicine.³

Several studies have demonstrated that hospitalists or the implementation of a hospitalist program results in greater efficiency, shorter hospital stays, and lower costs;^{4–6} two recent studies have demonstrated significant reductions in mortality.^{7,8} Many of these studies, however, have examined either very small groups of hospitalists, or lacked the concurrent control groups necessary to contrast hospitalist care with the underlying secular trend. In addition, most of these studies have examined the results of a newly implemented hospitalist program, which has led to difficulties in determining what factors underlie the beneficial hospitalist effect.

We report the results of a 1-year study that examined the inpatient care provided by a large group of physicians on the general medicine service at the University of Michigan Medical Center. Our physician group included hospitalists and a mix of general internists and medical subspecialists. We examined the costs and outcomes of

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Portions of this study were initially presented at the meetings of the Society of Hospital Medicine, San Diego, Calif, April 1–2, 2003 and the Society of General Internal Medicine, Vancouver, Canada, May 3, 2003.

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care provided by these various subgroups and compared both hospitalists and general internists to specialists on this same service.

METHODS

Inpatient Service Structure

The University of Michigan Medical Center is a major tertiary care teaching hospital. The general medicine service was reorganized in July 2001 in an effort to improve the educational environment and meet resident workload limits mandated by the Accreditation Council for Graduate Medical Education. This reorganization involved expanding the traditional general medical services from two to four and eliminating the rheumatology and nephrology inpatient services. Patients previously seen on these specialty services were now assigned to general medicine, and many specialty attendings from these services chose to attend on the new general medicine service. No preference in patient assignment, however, was provided to renal or rheumatology patients—they were assigned based only on the day they were admitted to the hospital.

The 4 traditional general medicine services each consisted of an attending physician, a senior resident, 2 interns, and several medical students. These 4 teams rotated admissions in a 4-day call cycle. This call cycle was arranged so all patients admitted on each day between 6:30 AM and 12 midnight—up to a limit of 10 patients—were admitted to the same team (except for the first 3 patients on weekdays before 3 PM). The 3 excluded patients admitted before 3 PM were assigned to the “short-call” team for that day, which was on day 3 of the call cycle. All patients admitted after midnight or beyond the team “cap” of 10 new admissions were assigned to a fifth “overflow” service that had a separate attending physician and resident. Therefore, in this model, the 4 traditional services were assigned patients based entirely on their positions in the call cycle, without regard to the attending physician. We did not examine the fifth overflow service in this study due to substantial differences in its structure and patient population.

There was no weekend coverage for attending physicians on the 4 traditional teams, as attending physicians had no days off during their assigned blocks. Most attendings during this time, including those who were defined as hospitalists, maintained some portion of their usual outpatient duties in the afternoons. Attendings were assigned to these inpatient services in blocks of 2 or 4 weeks, and assignment of attendings to senior residents was without any prior knowledge of the specific pairings in most instances. Occasionally, when a resident was felt to require additional oversight, or an attending was new to the service, some consideration of the relative strengths of the pairing may have occurred. These instances, however, were rare.

House staff wrote all patient orders and generally did not discuss new cases admitted after 5 PM with the

attending physician until the next morning. The University of Michigan's Institutional Review Board approved the study. The authors report no financial conflicts of interest related to this paper. Dr. Parekh had full access to all the data in the study and takes full responsibility for the integrity of the data and the accuracy of the data analysis.

Patient Population and Data Collection

A total of 2,617 patients were discharged from the 4 traditional general medical services at the University of Michigan from July 1, 2001 through June 30, 2002. We excluded those patients for whom some administrative data were unavailable ($n = 18$). The resulting cohort consisted of 2,599 patients.

Hospital administrative data provided information on patient diagnoses, race, gender, age, insurance status, length of stay (LOS), discharge disposition (including in-hospital deaths), diagnosis-related group (DRG), DRG weight (case mix index), and hospital costs. Costs were assessed by using an activity-based accounting system (TSI by Eclipsys, Boca Raton, Fla). Physician fees were not included in cost estimates. Readmission to the hospital at both 14 days and 30 days was also examined for each patient admission. An admission was considered a readmission if the patient had been admitted to the University of Michigan Medical Center for any reason during the 14 or 30 days prior to that admission. Admissions to other facilities were not available and thus were not included. Data on attending physician experience and primary specialty were obtained from the department of internal medicine's databases.

Statistical Analysis

Attending physicians (generalists or specialists) were designated either hospitalists or nonhospitalists based on the amount of general medicine inpatient time at the University of Michigan Medical Center during the study year only. Hospitalists were defined as those who attended for 3 or more months during the study year. All others were deemed nonhospitalists for this comparison. Physician specialty was based on primary specialty of practice as listed in the department of internal medicine's physician information database. In an attempt to clarify the role of inpatient experience, a secondary analysis used the total number of months over the past 2 years as a basis for determining the top 10% and top 20% of physicians in terms of inpatient experience. For this analysis only, we included months as attending physician of record at the Ann Arbor Veterans Affairs (VA) Medical Center and on the former renal and rheumatology inpatient services. We also conducted an additional sensitivity analysis, examining only general medical months at the affiliated VA Medical Center and University of Michigan Medical Center, excluding all specialty experiences to determine whether general medicine experience alone was a factor in determining efficiency and outcomes.

Primary analyses compared the patients cared for by the various groups of physicians. General internists were compared to the 3 largest specialty groups in our cohort (endocrinologists, rheumatologists, and nephrologists). We also examined hospitalists compared to all other physicians. Our primary outcome measures were LOS, cost, in-hospital death, and readmission at 14 and 30 days.

We used STATA version 8.0 (STATA Corporation, College Station, Tex) for all statistical analyses. We used logistic regression for dichotomous variables (mortality and readmission) and linear regression for analyses of continuous variables (LOS and costs). Multivariable regression models were used to determine the independent effect of the attending physician on each outcome measure. In our final model we adjusted for age, gender, race (black, white, or other) and case mix using DRG-weight (case mix index, CMI). (In the remainder of the results when we refer to "adjusted" results, we refer to results that have been adjusted for age, gender, race, and CMI). In our analyses, insurance plan was not significantly associated with our outcome measures and adjustment for insurance plan minimally impacted the effect size of the predictor variable of interest. We therefore omitted insurance status as a variable in our final model. All analyses used robust variance estimates and adjusted for possible clustering by attending physician. To reduce skew and account for outliers, we excluded those patients whose LOS or costs were more than 3 standard deviations above the mean.

RESULTS

Physician Characteristics

During the study period, 40 physicians served as inpatient attending physicians. Of these 40, there were 16 general internists, 8 rheumatologists, 5 nephrologists, 3 endocrinologists, and 8 represented some other specialty (2 hematology/oncology, 2 allergy/immunology, 2 geriatrics, 1 infectious diseases, and 1 pulmonary). Of the inpatient medical attendings, 7 were defined as hospitalists based on number of attending months on general medicine during the study year. All of these hospitalists were general internists, although 1 was board certified in rheumatology but practiced primarily general internal medicine and was a member of the division of general medicine.

Patient Characteristics

In our final study population, after eliminating LOS outliers, 913 patients were cared for by hospitalists and 1,639 by nonhospitalists (total = 2,552). When divided by specialty, 1,397 patients were cared for by general internists, 640 by rheumatologists, 218 by nephrologists, and 132 by endocrinologists, with the remainder by other specialists. Consistent with the quasi-random assignment of patients by call cycle, the groups were similar in terms of case mix index, primary DRG diagnosis, age, gender, and insurance status (Table 1). Patients of hospitalists, however,

were more likely to have a DRG diagnosis of gastroenteritis (DRG 182) compared to nonhospitalists' patients. Compared to hospitalists, the patients of rheumatologists were more likely to be female. Nephrologists' patients were more likely to have a DRG diagnosis of gastroenteritis (DRG 182) than those of hospitalists or general internists, and endocrinologists cared for more black patients and fewer white patients than both hospitalists and general internists.

Specialists' Effects on Length of Stay and Costs

We examined LOS and costs for specialists compared to general internists and hospitalists. The mean adjusted LOS for rheumatologists was 4.97 days compared to 4.41 days for general internists (difference, +0.56 days; confidence interval [CI], +0.22 to +0.91 days; $P = .002$); adjusted total costs were increased, with an average cost per case of \$7,707 compared to \$7,276 (difference, +431 dollars; CI, -41 to +904 dollars; $P = .07$). Endocrinologists showed an adjusted LOS of 4.79 days, a statistically significant increase compared to general internists (difference, +0.38 days; CI, +0.04 to +0.72 days; $P = .03$) as well as significantly increased adjusted total costs per case of \$8,376 compared to \$7,276 for generalists (difference, +1,100 dollars; CI, +278 to +1,922 dollars; $P = .01$). Nephrologists, on the other hand, did not show a statistically different adjusted LOS (difference, -0.16 days; CI, -0.60 day to +0.28 days; $P = .46$) or adjusted total costs per case (difference, -665 dollars; CI, -1,582 to +252 dollars; $P = .15$) compared to general internists.

Hospitalist Effects on Length of Stay and Costs

Over the study period, mean adjusted LOS was 4.35 days for those cared for by hospitalists and 4.66 days for those cared for by nonhospitalists (difference, -0.31 days; CI, -0.63 to +0.01 days; $P = .06$). Total adjusted hospital costs per case were \$7,323 for the hospitalists compared to \$7,394 for the nonhospitalists (difference, -71 dollars; CI, -506 to +364; $P = .74$).

Hospitalist physicians had a significant reduction in adjusted mean LOS compared both to rheumatologists and endocrinologists as well as significantly reduced adjusted total costs compared to endocrinologists. Specifically, hospitalists' adjusted LOS was 4.33 days compared to 4.99 days for rheumatologists (difference, -0.66 days; CI, -0.27 to -1.04 days; $P = .002$) and 4.79 days for endocrinologists (difference, -0.46 days; CI, -0.06 to -0.86 days; $P = .03$). Mean adjusted total costs per case were lower for hospitalists compared to both rheumatologists (difference, -443 dollars; CI, -949 to +63; $P = .08$) and endocrinologists (difference, -1,093 dollars; CI, -178 to -2,007; $P = .03$).

Effect of Experience on Length of Stay

In order to clarify the impact of inpatient experience on resource utilization, we also examined the top 10% and top 20% of attending physicians based on total inpatient

Table 1. Patient Characteristics: DRG Diagnoses, Case Mix, and Demographics

	Nonhospitalists	Hospitalists	Generalists	Rheumatologists	Endocrinologists	Nephrologists
Number of patients	1,639	913	1,397	640	132	218
Distribution of 10 most common DRG diagnoses, <i>n</i> (%)						
Pneumonia (DRG 89)	83 (5.1)	51 (5.6)	74 (5.3)	32 (4.9)	7 (5.0)	11 (4.9)
Kidney and urinary tract Diagnoses (DRG 331)	68 (4.1)	45 (4.9)	73 (5.1)	24 (3.7)	6 (4.3)	10 (4.5)
Renal failure (DRG 316)	66 (4.0)	26 (2.8)	48 (3.4)	26 (4.0)	4 (2.9)	7 (3.1)
Kidney/urinary tract Infections (DRG 320)	61 (3.7)	30 (3.3)	54 (3.9)	21 (3.2)	5 (3.6)	7 (3.1)
Nutritional/metabolic disorders (DRG 296)	65 (4.0)	24 (2.6)	47 (3.4)	28 (4.3)	2 (1.4)	9 (4.0)
Gastroenteritis and digestive system diagnoses (DRG 182)	64 (3.9)	22 (2.4)*	40 (2.9)	16 (2.5)	5 (3.6)	16 (7.1) ^{†‡}
Connective tissue disease (DRG 240)	53 (3.2)	25 (2.7)	36 (2.6)	25 (3.8)	4 (2.9)	6 (2.7)
Other circulatory system diagnoses (DRG 144)	47 (2.9)	26 (2.8)	46 (3.3)	14 (2.2)	5 (3.6)	5 (2.2)
Cellulitis (DRG 277)	45 (2.8)	28 (3.1)	40 (2.9)	20 (3.1)	4 (2.9)	2 (0.9)
Heart failure (DRG 127)	36 (2.2)	26 (2.8)	39 (2.8)	14 (2.1)	4 (2.9)	4 (1.8)
Case mix index	1.21	1.20	1.19	1.21	1.23	1.23
Mean age, y	57.0	57.0	56.9	57.3	58.5	55.7
Male, %	40.9	44	43.1	37.4 [†]	48.5	48.0
Race, %						
Asian	1.3	1.2	1.4	1.2	0.7	0.9
Black	16.4	14.7	14.3	17.1	24.3 ^{†‡}	16.6
Hispanic	0.8	1.1	1.1	1.1	1.5	0.5
White	78.9	80.2	80.4	78.4	71.3 ^{†‡}	81.2
Insurance, %						
Medicare	48.1	48.5	48.0	46.6	50.7	46.1
Medicaid	10.0	8.1	8.7	10.5	8.1	11.4
Managed care/HMO	16.7	16.0	16.5	17.2	14.0	16.9
Other	24.5	26.4	25.0	26.1	24.2	25.1

* $P < .05$ for comparison to nonhospitalists.[†] $P < .01$ for comparison to hospitalists.[‡] $P \leq .01$ for comparison to generalists.

months over the past 2 years. In order to account for prior inpatient attending experience, we included months both at the Ann Arbor VA Medical Center and on the former renal and rheumatology inpatient services at the University of Michigan Medical Center in this analysis. The number of inpatient months per physician for the 2-year period ranged from 1 to 8. The top 10% cutoff was at 5 months, and the top 20% cutoff was at 4.5 months. The top 10% had a significantly lower adjusted average LOS than did all other physicians (4.26 days and 4.65 days, respectively) (difference, -0.39 day; CI, -0.72 to -0.05 day; $P = .03$). There was no significant difference in adjusted LOS for the top 20% group compared to all others (4.44 days vs 4.60 days; $P = .39$).

Additional analysis was performed to examine the importance of inpatient general medical experience alone by defining the top 10% and top 20% of physicians by the total number of general medical months attended over the past 2 years (excluding all inpatient specialty months). In this group, the top 10% remained the same as with our earlier broader definition, but the top 20% changed and no longer contained any specialists. In this comparison,

both the top 10% group (LOS, 4.26 days; CI, 3.93 to 4.60 days; $P = .03$) and top 20% group (LOS, 4.31 days; CI, 3.99 to 4.64 days; $P = .04$) showed significantly reduced adjusted LOS compared to the remainder of the group (LOS, 4.66 days).

Effects on Patient Outcomes

We found no significant differences in adjusted in-hospital mortality or same hospital readmissions at 14 or 30 days between hospitalists and nonhospitalists (Table 2).

Table 2. Hospitalists: Resource Use and Patient Outcomes

	Hospitalists	Nonhospitalists	<i>P</i> Value
Length of stay, days	4.35	4.66	.06
Total costs, \$	7,323	7,394	.74
14-day readmission, <i>n</i> (%)	106 (11.6)	194 (11.8)	.98
30-day readmission, <i>n</i> (%)	148 (16.3)	288 (17.5)	.56
Inpatient death, <i>n</i> (%)	18 (2.0)	19 (1.1)	.13

All outcomes are adjusted for patient age, gender, race, and case mix index.

Table 3. Generalists and Specialists: Resource Use and Patient Outcomes

	Generalists (16 Physicians; 1,397 Patients)	Rheumatologists (8 Physicians; 640 Patients)	P Value	Endocrinologists (3 Physicians; 132 Patients)	P Value	Nephrologists (5 Physicians; 218 Patients)	P Value
Length of stay, days	4.41	4.97	.002	4.79	.03	4.25	.46
Total costs, \$	7,276	7,707	.07	8,376	.01	6,611	.15
14-day readmission, n (%)	166 (11.8)	80 (12.5)	.77	12 (8.8)	.57	28 (12.8)	.69
30-day readmission, n (%)	239 (17.1)	107 (16.7)	.76	24 (17.6)	.83	48 (21.9)	.16
Inpatient death, n (%)	23 (1.6)	7 (1.1)	.33	0 (0.0)	.26*	1 (0.5)	.24

* Fischer's Exact Test.

All outcomes are adjusted for patient age, gender, race, and case mix index.

In addition, no differences were seen between generalists and the various specialists in these measures of patient outcome (Table 3).

DISCUSSION

The primary finding from our evaluation of an academic general medicine service is that general internists seem to use fewer resources compared to rheumatologists or endocrinologists when caring for hospitalized inpatients. We also found that physicians who meet one of the established definitions of a hospitalist had a trend toward decreased resource use compared to all other physicians. In contrast to recent studies that have shown a mortality benefit for hospitalists,^{7,8} we observed no significant differences in inpatient mortality or readmission rates in any of our comparisons. Our results reveal that general internists tend to be more efficient than certain specialists when providing inpatient care to general medical patients, and suggest a possible benefit of hospitalists on resource use. By refining our definition of hospitalists to account for recent experience in caring for hospitalized patients, we could see a benefit in terms of reduced LOS for those physicians who were in the top of our group in terms of total inpatient experience.

While the overall benefit of hospitalists has been demonstrated by other investigators during the past few years,^{4,7,8} several questions remain. One important question is: how many months of inpatient work are required to show a substantial benefit in resource use? Our study helps to answer this question.

In our initial analysis, which evaluated current year general medicine inpatient experience only, we saw a trend toward decreased LOS for those who had more than 3 months of inpatient experience in the study year. This threshold was met by only 18% of our physicians during this year, with 6 out of the 7 physicians serving less than 4 months per year. Yet with this low threshold we saw a trend toward benefit. When we looked at a broader definition of total inpatient experience and included prior experience, we saw that the top 10% of physicians ($n = 5$) had a significantly reduced adjusted LOS. Yet this threshold was only 5 months over 2 years, lower than the threshold

used in most studies, but comparable to the average experience in the original University of California, San Francisco report on its managed care service.⁴ Many recent studies^{6,7,8} have shown statistically significant benefits of a hospitalist system only after 2 years of data were analyzed and suggested that cumulative inpatient experience may be a significant factor in reducing resource use. When we evaluated the top 20% of physicians in terms of total inpatient experience in the past 2 years, a group that included 2 specialists among 8 total physicians, we found results that contrast to those of the top 10% group. At this cutoff point, we saw no significant benefit on resource use, yet the total number of average inpatient months per year in this group did not differ that much from our top 10% group (2 months/year vs 2.4 months/year). This leaves the question of what explains the differences between the 2 groups.

Meltzer and colleagues suggest that disease-specific experience is the most important factor in creating efficient practice patterns.⁸ It can be argued that inpatient months on the renal and rheumatology service would not provide any specific experience for a large portion of the problems encountered among our general medical service patients. In addition, historically these two services admitted significantly fewer patients per month than the general medical teams. When the top 10% and 20% groups were defined based only on total general medical months excluding these specialty months, we saw a significant decrease in LOS for both the top 10% and 20% levels. This finding of significant benefit when specialty experience is excluded suggests that more experience with general medical patients is an important factor in developing efficient practice patterns. Alternatively, it could suggest that there is a negative independent effect of specialists (as the new definition results in the 2 specialists previously in the top 20% being excluded). Unfortunately, in our current cohort, we have only a few specialists with significant prior general medicine inpatient experience and so cannot determine which factor is more important.

Our results comparing general internists and hospitalists with rheumatologists and endocrinologists are also noteworthy. In our traditional attending structure, rheumatology and nephrology previously maintained a separate specialty-specific inpatient service. In July 2001 these

services were combined into our general medicine service, with their respective specialty attendings becoming attendings on general medicine. Endocrinology never had a specialty inpatient service, and for many years one or two endocrinologists have served as attendings on general medicine. The increased resource use for rheumatologists and endocrinologists could be attributed to a variety of factors. One could be a lack of experience with the wide array of diagnoses commonly seen on our general medical teams. Another possibility is the outpatient nature of these specialties, which could lead to a more cost-intensive inpatient practice style if evaluations that could take place in the outpatient setting instead are undertaken during a patient's hospitalization. Other studies have shown similar results,⁹⁻¹¹ although an older study did not show this difference between generalists and specialists.¹² Future studies of hospitalists should examine the differences between specialists and generalists, and perhaps also examine whether there is a threshold effect for inpatient experience for specialists practicing within their own specialty.

We must be cautious in generalizing our results, which occurred over 1 year in a large academic general medicine service, to other settings. We have separate services for gastroenterology and hepatology, hematology and oncology, pulmonary medicine, and cardiology. Therefore, our general medical services tend to have a wide array of diagnoses with no single diagnosis representing more than 10% of our patients. Subjectively, we also note that due to the specialty focus of our hospital, general medical patients tend to have several comorbid illnesses and complex social situations. All of these factors would influence our results. The complex array of medical and social problems may favor the approach of generalists over specialists. In addition, the presence of a cadre of well-respected general internists who are selected, in large part based on favorable teaching evaluations and prior experience, could make it difficult to detect a separate hospitalist effect using our original definition.

Of note, our medical service structure is different in structure from those evaluated in several prior studies. During this study period no formal hospitalist program existed. Other studies in academic centers^{4,8} have examined newly implemented formal hospitalist programs with dedicated inpatient physicians who had clear mandates to reduce and contain costs. We also note that in these other studies the hospitalist physicians were given more time to focus on inpatient care and had extremely limited (if any) outpatient duties during their months as attending physicians. This differs from our group of "hospitalists," who maintained an outpatient practice, albeit limited, during ward attending months. It is important also to examine our results in the context of the entire medical team, which includes medical residents, who also influence medical decision making.¹³ In our current model, resident physicians generally do not discuss admissions with the attending physician until the next morning. It has been hypothesized that early attending involvement, even over

the phone, may explain some of the LOS benefits seen in some earlier studies.⁴ We also note that our group of 8 hospitalists represents a much larger group of physicians than in some studies^{7,8} and may allow for more varied practice patterns. Finally, our study used a retrospective cohort design, which relied on quasi-random assignment of patients to physicians. While we controlled for several potential confounding variables, we cannot exclude unmeasured differences among patients or physicians that could have influenced our results. Only a true randomized control trial, which randomizes both patients to physicians and physicians to specialty (something that is nearly impossible to do) would solve this problem.

To fully explain the hospitalist effect, future studies on inpatient care practice patterns should more carefully examine the influence of experience and specialty on resource utilization, both in a general medical setting and in a subspecialty inpatient setting. As has been previously suggested,¹⁴ it will also be increasingly important to focus on additional outcome measures beyond simple readmission and mortality rates to determine whether the differences in resource use are accompanied by clinically important improvement in the quality of care.

Dr. Saint is supported by a Career Development Award from the Health Services Research and Development Program of the Department of Veterans Affairs and a Patient Safety Developmental Center Grant from the Agency for Healthcare Research and Quality (P20-HS11540).

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