Comparison of Hospitalists and Nonhospitalists in Inpatient Length of Stay Adjusting for Patient and Physician Characteristics

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OBJECTIVE: **To determine the independent effect of hospitalist status upon inpatient length of stay after controlling for case mix, as well as patient-level and provider-level variables such as age, years since physician medical school graduation, and volume status of provider.**

DESIGN: **Observational retrospective cohort study employing a hierarchical random intercept logistic regression model.**

SETTING: **Tertiary-care teaching hospital.**

PATIENTS: **All admissions during 2001 to the department of medicine not sent initially to the medical intensive care unit or coronary care unit.**

MEASUREMENTS: **Observed length of stay (LOS) compared to principle diagnosis related group (DRG)-specific mean LOS for hospitalist and nonhospitalist patients adjusting for patient age, gender, years since physician graduation from medical school, and physician volume status.**

MAIN RESULTS: **The 9 hospitalists discharged 2,027 patients while the nonhospitalists discharged 9,361 patients. On average, hospitalist patients were younger, 63.3 versus 73.3 years ($P < .0001$). Hospitalists were more recently graduated from medical school, 13.8 versus 22.5 years ($P = .02$). Each year of patient age was found to increase the likelihood of an above average LOS (odds ratio [OR], 1.01; 95% confidence interval [CI], 1.01 to 1.02; $P < .001$). In unadjusted analysis, hospitalists were less likely to have an above average LOS (OR, 0.51; 95% CI, 0.28 to 0.93; $P = .03$). Adjustment for effects of patient age and gender, physician gender, years since medical school graduation, and quintile of physician admission volume did not appreciably change the point estimate that hospitalist patients remained less likely to have above average LOS (OR, 0.60; 95% CI, 0.32 to 1.11; $P = .11$).**

CONCLUSIONS: **For a given principle DRG, hospitalist patients were less likely to exceed the average LOS than were nonhospitalist patients. This effect was rather large, in that hospitalist status reduced the likelihood of above average LOS by about 49%. Adjustment for patient age, years since physician graduation, and admission volume did not significantly alter this finding. Further research should focus on identifying specific practices that account for hospitalism's effects.**

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Previous studies have concluded that use of hospitalists to care for inpatients yields efficiencies, mostly in terms of shorter length of stay (LOS) for hospitalist patients as compared to nonhospitalist patients.[1–14] It is not clear which characteristics of hospitalists or their specific patient care practices that drive this shorter LOS. It has been proposed that some intrinsic variables of hospitalism, such as being onsite, being able to round multiple times each day, familiarity with hospital systems, or comfort with common inpatient diagnoses, are the "active ingredients" in hospitalism.[2,15–17]

Limiting variables in earlier studies have included differing clinical characteristics between hospitalist and nonhospitalist patients requiring statistical adjustment, measurement of small numbers of hospitalists, use of only historical controls, or examination of a limited number of diagnostic entities.[1–14]

Previous studies have also not adequately accounted for the effects of physician-specific characteristics, most notably the observation that the majority of hospitalists are recent graduates of residency training programs. Stein et al. noted that the hospitalists they examined were of a mean age of 40 while the nonhospitalists' mean age was 48.[3] Davis et al. noted that the hospitalists were younger and more recently trained, without quantification.[6] Palmer et al. stated that all the hospitalists were within 3 years of residency completion.[10] Although not discussed in their report, Rifkin et al. studied hospitalists who were within 5.1 years of medical school graduation on average, while the nonhospitalists were on average 20.6 years out[12] (postpublication analysis). Meltzer et al. noted that the two hospitalists they examined were 2 and 10 years postresidency, while the nonhospitalists were on average 9 years out.[13] Finally, Auerbach et al. stated that the hospitalists' mean age was 34, the rotating faculty mean age was 40, and the community-based physician comparison group had a mean age of 51 years.[14]

None of these previous studies specifically examined this potentially important difference between hospitalists and nonhospitalists. It is possible that a component of the effect seen in the use of hospitalists is mediated through their more recent training as opposed to job-specific parameters such as being onsite.

Further, it is possible that nonhospitalists that admit an above average number of patients per year may differ

from those who admit fewer patients, that is, possible effects of physician volumes have not been controlled for in previous studies.

It would appear that the hospitalists examined in the literature are roughly representative, in terms of years in practice, of hospitalists nationwide. The most recent national survey of hospitalists found a mean age of 40 years, with a third under the age of 35 and only 10% over the age of 50. Respondents were a mean of only 3.6 years out of residency training.[18]

In the present analysis we sought to address some of these limitations. We included all patients admitted during a calendar year to the department of medicine cared for by a large hospitalist group or by nonhospitalists. Further, we examined the effect of years since physician medical school graduation in order to determine the contribution of hospitalist status to inpatient LOS independent of their more recent training. We hypothesized that physicians who trained more recently may have experienced different inpatient environments with respect to managed care, shorter inpatient LOS, and higher acuity of illness. It is possible that this may contribute to differences between generally more recently trained hospitalists and less recently trained nonhospitalists. We also examined the effects of physician-specific volume of admissions. In this way, we attempted to assess the independent effect of hospitalist status, that is, to see how high-volume and low-volume nonhospitalists compare to hospitalists.

METHODS

All inpatient admissions during 2001 to the department of medicine at a community-based, tertiary-care teaching hospital were assessed for attending of record, patient LOS, and principle diagnosis related group (DRG) as coded by full-time chart abstracters. Because the year of residency completion could not be determined with sufficient accuracy, we used the physician's year of medical school graduation which was available in hospital's database (Eagle 2000, Siemens American Healthware, Malvern, PA). Admissions directly to the medical intensive care unit or the coronary care unit were not included. We grouped attendings as being either hospitalists or nonhospitalists. A hospitalist was defined as an attending employed by the hospital whose full-time clinical focus was the care of inpatients. This is in keeping with previous definitions of hospitalists.[17,19] The nonhospitalists were community-based physicians who admitted and served as attending of record for at least one patient on the medical service during 2001.

Bivariate analyses were first performed for each physician group and reported as means or percentages with descriptive statistics where appropriate. We then performed a two-level hierarchical multivariate random intercept regression model with the patient as the first level and the attending physician as the second level. Outcome was coded as 1 if the observed LOS was greater than the DRG-adjusted standardized LOS, and 0 if not. The first level of the model included patient demographics, age (years), female (yes/no), white (yes/no), and attending as hospitalist (yes/no). The model takes into account the variance within physicians and also accounts for the variance between physicians, and the second level of the model included physician characteristics of years since graduation and female gender (yes/no). The point was to examine the impact of physician-level characteristics on the overall LOS. The third level of the model adjusted for volume of admissions by each nonhospitalist physician organized by quintiles.

Because we adjusted for patient case mix by using discharge DRGs, the difference between hospitalists and nonhospitalists is expressed as the odds that the hospitalists were associated with patients whose LOSs were above mean for the principle DRG. We also examined the board certification status of the physicians. All analyses were performed with using SAS version 8.02 (SAS Institute, Cary, NC) and HLM version 5.0 (Scientific Software International Inc., Lincolnwood, Ill).

RESULTS

Overall, our analysis included 207 physicians who were the attending of record for 11,388 patients. The 9 hospitalists cared for 2,027 patients during 2001, or 225 patients each on average, while 198 nonhospitalists admitted 9,361 patients, or 47 patients each on average. Five patients did not have complete data available; thus, our analysis included 11,383 patients.

Principle DRGs accounting for at least 1% of all admitted patients are listed in Table 1. These top 28 principle DRGs accounted for almost two thirds of the total number of admissions (63.6%). The top 10 diagnoses accounted for over a third of the total (36.6%), the top 15 for over half the total (54.1%).

Overall, patients cared for by hospitalists were 10 years younger on average (63.3 vs. 73.3 years; $P < .0001$). Each year of patient age was found to increase the likelihood of an above average LOS by about 1% (odds ratio [OR], 1.01; 95% confidence interval [CI], 1.01 to 1.02; $P < .001$). There were not significant differences in the proportion of female patients or physicians between groups. Hospitalists were more recently graduated from medical school (13.8 vs. 22.5 years ago; $P = .02$; Table 2).

Apparent differences in certification status were seen (Table 2). A higher percentage of the hospitalists were only certified in general medicine (55.6% vs. 34.3%). None of the hospitalists were certified in any subspecialties, except one each in infectious diseases and cardiology. A larger percentage of the nonhospitalists were certified in cardiology (35.9% vs. 11.1%). A significant proportion of both the hospitalists and the nonhospitalists were not American Board of Internal Medicine (ABIM) certified (22.2% and 17.2%, respectively). This group also included an unknown percentage certified by the American Osteopathic Association or in other countries.

Table 1. Most Common Principle Diagnosis Related Groups

Principal DRG	Patients (*N*)	% of Total
1. Heart failure and shock	870	7.6
2. Other permanent cardiac pacemaker implated or PTCA with coronary artery stent implanted	677	5.9
3. Chest pain	540	4.7
4. Simple pneumonia and pleurisy age > 17 w/CC	404	3.6
5. GI hemorrhage w/CC	307	2.7
6. Specific cerebrovascular disorders except TIA	298	2.6
7. Chronic obstructive pulmonary disease	281	2.5
8. Cardiac arrhythmia and conduction disorders w/CC	267	2.3
9. Kidney and urinary tract infections age > 17 w/CC	265	2.3
10. Circulatory disorders except AMI, with cardiac catheterization and complex diagnosis	253	2.2
11. Esophagitis, gastroent, and misc digest disorders age > 17 w/CC	249	2.2
12. Circulatory disorders except AMI, with cardiac catheterization and complex diagnosis	247	2.2
13. Nutritional and miscellaneous metabolic disorders age > 17 w/CC	240	2.1
14. Cardiac arrhythmia and conduction disorder w/o CC	213	1.9
15. Percutaneous cardiovascular procedures	196	1.7
16. Septicemia age > 17	188	1.7
17. Circulatory disorders w/AMI and major complications, d/c alive	167	1.5
18. Respiratory system diagnosis w/ventilator support	166	1.5
19. Tracheostomy except for face, mouth, and neck diagnoses	164	1.4
20. Transient ischemic attack and precerebral occlusions	162	1.4
21. Atherosclerosis w/CC	160	1.4
22. Esophagitis, gastroenteritis, and miscellaneous digestive disorders age > 17 w/o CC	144	1.3
23. Diabetes age > 35	144	1.3
24. Cellulitis age > 17 w/CC	141	1.2
25. PTCA w/stent but w/o AMI	140	1.2
26. Red blood cell disorders age > 17	126	1.1
27. Renal failure	122	1.1
28. Syncope and collapse w/o CC	112	1.0
Total	7,243	63.6

DRG, diagnosis related group; PTCA, percutaneous transluminal coronary angioplasty; CC, complications; GI, gastroenteric; TIA, transient ischemic attack; AMI, acute myocardial infarction.

Table 2. Bivariate Comparisons of Physician and Patient Characteristics by Hospitalist Versus Nonhospitalist

Characteristic	Hospitalist	Nonhospitalist	*P* Value
Number of patients	2,027	9,361	
Mean patient age, y (SD)	63.3 (18.3)	73.3 (15.0)	<.001
Patients, % female	50.5	52.0	.22
Number of physicians	9	198	
Mean years since medical school graduation (SD)	13.8 (8.4)	22.5 (10.2)	.02
Physicians, % female	33.3	13.6	.10
Not ABIM certified, %	22.2	17.2	
Certified in general medicine alone, %	55.6	34.3	
Certified in cardiovascular disease, %	11.1	35.9	
Certified in infectious diseases, %	11.1	1.0	
Certified in critical care, %	0	4.0	
Certified in endocrinology, %	0	6.1	
Certified in geriatrics, %	0	7.6	
Certified in hematology, %	0	8.1	
Certified in oncology, %	0	8.1	
Certified in pulmonary, %	0	5.5	
Certified in nephrology, %	0	5.1	

ABIM, American Board of Internal Medicine; SD, standard deviation.

Number of patients admitted did not predict mean LOS (Table 3). When assessed by quintiles of volume status, the trend in LOS was of borderline statistical significance ($P = .08$), and actually in the opposite direction of what might have been predicted, specifically that patients of more active physicians had a longer mean LOS than did those of the least active physicians (6.6 vs. 4.8 days).

Table 3. Mean LOS by Nonhospitalist Physician Volume Status

Volume Group	Patients (*N*)	LOS (SD)	*P* Value for Trend
By number admitted patients			
12	360	5.1 (6.8)	.165
13–50	1,519	6.1 (7.8)	
>50	7,475	6.4 (8.6)	
By quintile of admitted patients			
I (1–3 patients)	67	4.8 (5.5)	.08
II (4–10 patients)	227	5.5 (7.8)	
III (11–43 patients)	943	5.7 (7.1)	
IV (44–74 patients)	2,206	6.1 (8.2)	
V (75+)	2,911	6.6 (8.7)	

Excluded 7 patients with LOS > 100 days.
LOS, length of stay; SD, standard deviation.

Table 4. Hierarchical Random Intercept Logistic Regression Model

Model*	OR† of LOS Above DRG-specific Mean	95% CI	*P* Value
Model 1 (Unadjusted)			
Nonhospitalist (reference)	1.00		
Hospitalist	0.51	0.28 to 0.93	.03
Model 2 (Adjusted for patient-level demographics)			
Age (each year)	1.01	1.01 to 1.02	<.001
Female	1.04	0.89 to 1.22	.60
Nonhospitalist (reference)	1.00		
Hospitalist	0.56	0.31 to 1.00	.05
Model 3 (Adjusted for patient- and physician-level demographics)			
Patient level			
Age (each year)	1.01	1.01 to 1.02	<.001
Female	1.04	0.89 to 1.22	.62
Physician level			
Each year since graduation	1.01	0.99 to 1.02	.35
Female	1.01	0.55 to 1.85	.98
Nonhospitalist (reference)	1.00		
Hospitalist	0.59	0.32 to 1.07	.08
Model 4 (Adjusted for patient and physician demographics plus volume group)			
Patient level			
Age	1.01	1.01 to 1.02	<.001
Female	1.04	0.89 to 1.22	.61
Physician level			
Each year since graduation	1.01	0.99 to 1.02	.36
Female	1.38	0.74 to 2.60	.92
Quintile group‡	1.02	0.89 to 1.16	.79
Nonhospitalist (reference)	1.00		
Hospitalist	0.60	0.32 to 1.11	.11

* *Random variance at physician level for Model 1 was 0.2879 (P < .001), for Model 2 was 0.2507 (P < .001), for Model 3 was 0.2560 (P < .001), and for Model 4 was 0.2604 (P < .001).*

† *Odds ratios were derived from a multilevel logistic regression analysis. OR < 1 indicates that patients treated by a hospitalist had a lower likelihood of an LOS greater than the log-transferred average DRG-based expected LOS than those patients treated by a nonhospitalist.*

‡ *Physicians were divided into quintiles by number of patients admitted during the study period.*

LOS, length of stay; DRG, diagnosis related group; OR, odds ratio; CI, confidence interval.

In the initial unadjusted regression model (Table 4), hospitalists had a lower likelihood of an above average LOS (OR, 0.51; 95% CI, 0.28 to 0.93; $P = .027$) for a given principle DRG. Adjusting for the additional patient variables of age and female gender resulted in a very similar finding (OR, 0.56; 95% CI, 0.31 to 1.00; $P = .049$), that is, hospitalists were about half as likely to have an above average LOS. Further adjustment for the physician-level variables of years since graduation and female gender did not appreciably alter the point estimate of the likelihood of an above average LOS (OR, 0.59; 95% CI, 0.32 to 1.08; $P = .085$), nor did adjustment for physician volume status (OR, 0.60; 95% CI, 0.32 to 1.11; $P = .11$).

DISCUSSION

In our analysis of over 200 attending physicians supervising over 11,000 discrete inpatient episodes, we found evidence that patients cared for by hospitalists had a much lower likelihood of experiencing an above average principle DRG-specific LOS. These findings were remarkably stable despite adjustment for additional patient- and physician-level characteristics.

Considering that much of the previous literature demonstrating shorter LOS for hospitalist patients also indicates that the hospitalists tended to be more recently trained than the nonhospitalists, a significant proportion of the "active ingredient" of hospitalism, in terms of LOS, could indeed have been their relatively recent training. This supposition was not borne out by our finding that adjustment for years since graduation did not significantly alter our findings. We believe this is the first analysis of hospitalists to take into account the timing of their training.

It could be suggested that "high-volume" nonhospitalists should enjoy several of the advantages as do hospitalists, such as being familiar with the hospital and more experience with the range and acuity of inpatient illness. While acknowledging that the volume-LOS relationship examination itself did not include case mix adjustment, it nevertheless appears that hospitalist patients were less likely than both high- and low-volume nonhospitalist patients to have above average LOS for a given DRG.

Previous examinations of hospitalists have proposed various mechanisms intrinsic to hospitalism for the principle finding of shorter, case mix-adjusted LOS, such as more time onsite and more frequent rounding.[2,15–17] Another possible underlying mechanism is that in most instances, hospitalists are specifically motivated to work toward lowering the LOS, that is, they would know that a shorter LOS is part of their mission and may feel that some aspect of their evaluations will be based upon their LOS data. Alternatively, private attendings would have less of this sort of motivation, and may actually have incentives in the opposite direction.

Our findings would seem to support these various suppositions, in that hospitalism exerted an independent influence beyond those of case mix, age of patient, recent

training of physician, and volume of admissions. While some of the previous literature supported the possibility of a J-shaped curve for the efficiency of hospitalists, that is, they improve over the first few years of practice, our analysis was not able to examine this, as all our hospitalists were beyond the 1 to 2 years in practice that has been postulated as the critical part of the learning curve[13,14] (range 5 to 31 years since graduation).

Several limitations to this study should be noted. First, we adjusted for case mix indirectly by using DRG-specific LOS as the outcome variable, and there is the potential for bias in coding if the status of the physician is known. However, the professional coders (hospital billing staff) were not aware of attending status in terms of years since graduation or hospitalist status. They were merely using the prevailing standards of coding as was justified by chart documentation. In this way, even if one group of physicians was more thorough in documentation or truly had sicker patients, the comparison group was the national mean for that same DRG and its corresponding intensity of care. It remains possible that principle DRG alone was an insensitive measure of case mix. Although DRGs only account for a proportion of the variance in patient case mix, it is unlikely that this would have significantly affected one group of providers more than the other or would be sufficient to explain the magnitude of our findings. In this light, even adjustment for a known confounder such as patient age did not significantly affect the results.

Second, the results come from a hospital database and not chart audit. Given the limitations on the number of codes allowed per discharge, it is conceivable that other important patient conditions were not accounted for in the analysis. Further, it is clear that many factors influence a patient's LOS beyond whom their attending of record was. It is possible that unmeasured differences in consultation, testing, and patient-based social factors were partly responsible for differences observed as opposed to the individual attending's patient care plan. Again, our aim was not to examine specific patient care practices, consultation rate, or adherence to guidelines, but to ascertain whether supervision by hospitalists was associated, by whatever means, with shorter lengths of stay.

Finally, although our examination included more hospitalists than have most previous analyses and a representative, unrestricted sample of inpatient DRGs, it is still a single-center study so it is not clear whether our findings are generalizable to hospitalist practices elsewhere. It is also possible that the comparison groups for our study were not typical, because about 20% of each group was not ABIM certified, and the nonhospitalists included a relatively high proportion of cardiologists.

However, the preponderance of the evidence thus far[12–14,19] has found a net benefit, at least in terms of inpatient LOS and costs, from the implementation of a hospitalist model without a measurable decrease in quality of care, thus rendering it unlikely that the benefit is due to individual clinicians. Clearly, LOS is at best only a proxy measure of overall quality of care. Other aspects of care were not measured and may prove important.

Our concern that how recently a physician trained could affect clinical decision making has some basis in the literature. To our knowledge, the only previous study that specifically examined how inpatient LOS was independently affected by the experience of the physician found that for internal medicine attendings, more years of experience resulted in longer mean LOS. Curiously, they found the reverse for surgical attendings.[20] Other studies have found that length of time in practice independently influenced the evaluation and treatment of breast cancer,[21] mortality post-acute myocardial infarction,[22] variation in the use of mammography,[23,24] and the use of prostate-specific antigen testing in the screening for prostate cancer.[25] Controlled videotape-based experiments designed to isolate the effects of physician characteristics have found that the age of the clinician affected medical decision making.[26,27]

We can only hypothesize as to why more recent training was not associated with reduced LOS among hospitalists. It is likely that the magnitude of benefit due to the potential advantages of onsite location and experience with inpatient diagnoses and systems outweighs and obscures any variance in LOS attributable to being more recently trained. Certainly, as hospitalists nationwide are younger, on average, than the nonhospitalist physician population, it is important to be able to conclude that hospitalism itself, as opposed to the fact that it is a younger specialty, is the likely source of LOS efficiencies.

In conclusion, we present evidence that care supervised by hospitalists results in shorter principle DRG-specific inpatient LOS, after accounting for patient- and physician-level variables. Proximity to postgraduate training does not appear to have a significant impact on hospitalists' skills in reducing LOS. These conclusions would seem to hold with respect to comparisons with both high- and low-volume nonhospitalists. Further research will be needed to clarify whether a shorter LOS is indeed a valid proxy for efficiency or quality, that is: are costs shifted to the outpatient arena? Are patients more satisfied? In addition, future examinations of hospitalism should focus on specific practices employed, that is: what are hospitalists doing that results in shorter inpatient LOS?

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