

HEALTH POLICY

Comparison of Hospital Costs and Length of Stay for Community Internists, Hospitalists, and Academicians

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BACKGROUND: The model of inpatient medical management has evolved toward Hospitalists because of greater cost efficiency compared to traditional practice. The optimal model of inpatient care is not known.

OBJECTIVE: To compare three models of inpatient Internal Medicine (traditional private practice Internists, private Hospitalist Internists, and Academic Internists with resident teams) for cost efficiency and quality at a community teaching hospital.

DESIGN: Single-institution retrospective cohort study.

MEASUREMENTS AND MAIN RESULTS: Measurements were hospital cost, length of stay (LOS), mortality, and 30-day readmission rate adjusted for severity, demographics, and case mix. Academic Internist teams had 30% lower cost and 40% lower LOS compared to traditional private Internists and 24% lower cost and 30% lower LOS compared to private Hospitalists. Hospital mortality was equivalent for all groups. Academic teams had 2.3–2.6% more 30-day readmissions than the other groups.

CONCLUSIONS: Academic teams compare favorably to private Hospitalists and traditional Internists for hospital cost efficiency and quality.

KEY WORDS: hospitalist; medical care costs; academic medicine.

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INTRODUCTION

The inpatient medical care model has been rapidly evolving at many urban medical centers.^{1,2} Hospitalists and hospital-based physicians are assuming a larger proportion of inpatient care because of evidence of improved efficiency of inpatient care compared to traditional combined inpatient and outpatient practice.^{3,4} Recently, academic Hospitalists were shown to have equivalent or lower hospital costs than private

Hospitalists or traditional practices.^{5–7} The optimal design of inpatient medical practice is not yet established and may well vary for different hospitals.

We report our experience at a community teaching hospital with several private Hospitalist groups, traditional private practice, and an academic physician group with resident physician teams. Our analysis covers nearly 4 years and compares hospital cost, length of stay (LOS), hospital mortality and 30-day readmissions among three types of physicians: private Hospitalists, traditional General Internist practice, and a hospital-based academic practice group with resident physicians.

METHODS

Study Setting

The study was conducted at a large (500+ bed), urban, not-for-profit, community teaching hospital in Florida. The study began October 1, 2000, and ended June 30, 2004. This beginning timeframe corresponded to the conclusion of a prior study³ and to the availability of severity categories in the data set. The ending corresponded to the end of the academic year. The study population consisted of all patients admitted to an Internal Medicine physician at the hospital. The hospital has residencies in categorical Internal Medicine, Medicine–Pediatrics, Pediatrics, General Surgery, Orthopedics, Obstetrics and Gynecology, Emergency Medicine, and Pathology. There were no Internal Medicine fellowships. There were 57,174 admissions to Internal Medicine physicians, of which 46,094 were to Hospitalists, General Internists, or academic physician teams during the time frame of the study.

Physician Groups

Community General Internists (Generalists). Fifty-two Generalists admitted to the hospital and served as attending physicians for at least ten or more patients during the study period. Nearly all were in solo or small group practices of varying size. The Generalists organized their own arrangements among each other for night and weekend coverage, but usually admitted and did their own daily hospital rounds on their own patients. Resident physicians did not provide any nonemergency care to the patients of Generalists.

Private Hospitalists (Hospitalists). Forty Hospitalists admitted ten or more patients to the hospital during the study period.

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They were organized into seven groups with sizes varying from two to ten physicians. No group was exclusively practicing at the study hospital. The groups varied in size and number over the study years, and some physicians moved from one group to another during the time frame. No group or physician was employed by the hospital. The physicians provided hospital care to patients from local physicians who either did not practice in any hospital or did not practice at the study hospital.

The Hospitalist groups each provided care to patients 24 hours per day, but none provided in-house, 24-hour physician presence. Most groups had nurse practitioners or physician assistants to assist in hospital care. Resident physicians did not provide any nonemergency care to the patients of Hospitalists.

Academic Internists (Academicians). Ten full-time, hospital-employed Academicians provided care to inpatients and outpatients in conjunction with the Internal Medicine Residency Program. All had at least ten inpatient admissions during the study period. There were usually 24 Internal Medicine residents and eight Medicine–Pediatric residents in the program.

The Academicians all participated in the inpatient and outpatient care of patients in conjunction with the residents. All inpatients were admitted to one of the four resident physician ward teams, consisting of one second- or third-year resident, two first-year residents, and an attending physician. All Academicians supervised the residents in outpatient care and provided care to their own panel of outpatients. Academicians had ward teams from 1–12 months per year. The number of inpatient months of responsibility was determined by the choice of the Academician. All Academicians had concurrent outpatient resident supervisory (20–40% of total time), private outpatient practice (20–50% of total time), and program administration (10–30% of total time) responsibilities.

Physician–Hospital Relationships. There were no financial relationships between the hospital and the Generalists or Hospitalists during the study period. Academicians were employed by the hospital. The hospital did not provide a financial inducement or incentive to any physician or group related to efficiency of hospital care or with regard to the admission or discharge of patients.

Generalists and Hospitalists were responsible for all of their own billing for services to their patients. The hospital provided billing services for all Academicians' patients. The hospital did not own or have control over medical facilities related to the discharge care of patients. The hospital owned and controlled the predominant visiting nurse service.

Data Source and Collection

Trendstar Clinical Costing Software (McKesson HBOC, San Francisco, CA, United States) was used to collect information on all hospitalized patients for the duration of the study. Trendstar uses an activity-based cost accounting system derived from the hospital's ledger.^{8,9} Costs are then reported, including direct, indirect, fixed, and variable costs.

Patients were grouped using all patient refined diagnosis related group (APRDRG), severity level (1–4), and risk-

of-mortality (ROM) level.^{1–4} APRDRG is assigned based on principal and secondary diagnosis, age, and procedure.¹⁰ The severity level and ROM are then assigned within the APRDRG based on diagnoses and procedures. All costs were assigned to the single attending physician of each hospital admission. Costs generated by consultants or by resident physicians were assigned to the single attending physician throughout the hospitalization episode.

Study Patients

All APRDRGs with more than 200 cases total and at least 50 cases in each physician group during the study period were included in the analysis. The study was limited to patients with Medicare, Medicaid, or commercial insurance. Procedural-based APRDRGs were excluded. High-frequency APRDRGs were selected for analysis to assure that statistical adjustment for severity of illness and other confounding factors could be done among all physician groups. Uninsured patients (4,595) were excluded because they were almost exclusively seen by Academicians, precluding comparisons among the three physician groups for this category of patients. There were 22,972 admissions that met these criteria. All patients were admitted to the same hospital units. The intensive care units (ICU) were of "open" design. The attending physician did rounds in the ICU and sought consultation with specialists as needed. The study was approved by the organization's institutional review board prior to any investigation.

Study Design and Statistical Analysis

The study design was a retrospective cohort design. The period of the study was October 1, 2000, through June 30, 2004. The primary endpoints were hospital cost (cost) in dollars, LOS in days, readmission to the hospital within 30 days, and hospital mortality. Secondary endpoints were pharmacy costs, imaging costs, laboratory costs, supply costs, and respiratory therapy costs. Endpoints were calculated per hospital admission. Physician fees were not included in costs. Costs were controlled for inflation by introduction of an adjustment factor for year of study into the multivariate analysis. This assures that costs are equally compared among physician groups over the entire study period. Readmissions within 30 days of hospital discharge were attributed to the original discharging physician regardless of who admitted the patient secondarily. Demographic information collected on each case included age, gender, race (white, black, Hispanic, other), and health insurance coverage (Medicare, Medicaid, commercial/HMO).

The statistical analysis was done using SAS 9.1 (SAS Institute, Cary, NC, United States). Because of skewness and nonnormality, costs and LOS were log-transformed prior to analysis. The highest and lowest 0.5% cost admissions were removed as outliers prior to analysis. General linear modeling (GLM) was used to adjust for differences in confounding variables for cost and LOS endpoints. For mortality and 30-day readmissions, logistic regression analysis was used to control for confounding factors. Cost, LOS, hospital mortality, and 30-day readmissions were dependant variables; age was a continuous independent covariable and other independent variables (gender, race, APRDRG, insurance, year of admission, severity category, ROM, and physician group) were categorical variables. Severity category was nested within the

APRDRG. ROM was only utilized in the mortality model. Statistically significant factors (independent variables) in the regression models were determined using stepwise automatic variable selection procedures. Age and physician group were always contained in the model. Statistical significance was set at $P < .05$ for confounding variables to remain in the models. Pair-wise comparisons of physician groups within the GLM model were analyzed using t tests with Tukey's adjustment for multiple comparisons.

RESULTS

Table 1 reveals the basic demographic characteristics of the patients in the three physician groups. The patients differ in basic demographic characteristics. The Generalists' patients were older, more likely to have Medicare, and more likely to be white than the other groups. The Academicians' patients were younger, more likely to have Medicaid, and more likely to be black than other groups. There were small differences in the frequency of APRDRGs among the physician groups. There were no significant differences in severity level among the physician groups.

Table 2 provides basic characteristics of the three physician groups. All groups were 100% certified by the American Board of Internal Medicine. Generalists were further from medical school graduation, were more likely to be international grad-

uates, and had fewer admissions per year to the hospital than the other physician groups.

Table 3 displays the cost and LOS by physician group. Other than the unadjusted arithmetic mean values, all other values in Table 3 represent fully adjusted results of GLM models. Unadjusted arithmetic mean values of overall cost and LOS appeared to have differences among the physician groups. An adjusted analysis of log-transformed values of cost and LOS was performed with age, gender, race, APRDRG, insurance, year of admission, and severity (nested within APRDRG) as adjustment factors. The final models, after removal of nonsignificant factors, contained age, APRDRG, year of admission, severity, and gender for both cost and LOS models. Insurance was also significant in the LOS model. The R^2 was 0.36 for the cost model and 0.39 for the LOS model. The overall adjusted cost and LOS were statistically significantly lowest for Academicians and highest for Generalists. Subsequently, the least squares means of each statistically significant demographic factor, severity level, and admission year were reported after adjustment of all other factors. The results indicate highly consistent and statistically significant differences among the physician groups within each category of gender, insurance, severity, and year of admission. Academicians' overall adjusted cost and LOS were, respectively, 30.0 and 39.5% lower than Generalists and 24.37 and 29.7% lower than Hospitalists. Costs and LOS were more consistently lower for academicians compared to Generalists or Hospitalists for each category of

Table 1. Characteristics of Patients by Physician Group

Characteristic	Physician group			P value*
	Generalist (n=5,536)	Hospitalist (n=11,565)	Academician (n=5,691)	
Mean age \pm SD	66.5 \pm 16.5	62.8 \pm 17.3	58.6 \pm 18.9	<.001
Female gender [†]	59.6	57.1	55.7	<.001
Ethnicity [†]				<.001
White	59.3	59.4	47.7	
Black	23.2	25.6	34.1	
Hispanic	13.9	12.5	13.8	
Other	3.7	2.5	4.4	
Insurance [†]				<.001
Medicare	67.9	58.8	50.7	
Medicaid	6.5	7.7	32.3	
Commercial/HMO	25.6	33.5	17.0	
APRDRG [†]				<.001
Neurological disorders 45,46,53,54	6.1	7.0	8.7	
Respiratory disorders 137,139-141, 144	14.4	14.0	17.0	
Cardiovascular disorders 190,194,197-199,201,204	32.9	30.9	27.5	
Chest pain 203	10.3	12.5	10.6	
Digestive diseases 241,243,244,247,249,251,253,254,282	16.2	15.0	13.7	
Musculoskeletal disorders 347,351	3.2	3.3	2.7	
Skin infection 383	2.3	2.7	3.2	
Diabetes 420	1.9	1.8	3.7	
Disorders of electrolytes 422,425	3.0	2.9	3.2	
Renal failure 460	2.3	2.6	2.1	
UTI 463	3.7	3.8	4.5	
Anemia 663	1.6	1.2	1.2	
Septicemia 720	2.2	2.4	2.0	
Severity level [†]				0.752
1	27.9	28.0	28.6	
2	47.5	47.0	47.4	
3	21.5	21.3	20.8	
4	3.2	3.7	3.1	

APRDRG = all patient refined diagnosis related group

*Chi square tests were used for categorical variables and one-way ANOVA for age

[†]Percent

Table 2. Characteristics of Physicians by Group

Characteristics	Physician group		
	Generalist (n=52)	Hospitalist (n=40)	Academician (n=10)
Years since medical school graduation, mean (range)	16.4 (2-38)	7.8(1-23)	12.0 (1-26)
Board certified (%)	100	100	100
International graduate (%)	59.6	37.5	20.0
Admissions per physician per year mean ± SD	36.2±33.9	97.2±132	162.6±124.1
Employed by hospital (%)	0	0	100
Work with residents (%)	0	0	100

gender, insurance type, severity level, and year of study. In general, Hospitalists' costs and LOS were lower than those of Generalists (7.5 and 14.0%, respectively, overall) and in most categories of gender, insurance status, severity level, and year.

Table 4 gives the results of the secondary cost endpoints of the study: pharmacy, laboratory, imaging, supply, and respiratory therapy costs. Academicians' costs were lowest, especially in pharmacy costs. The costs are unadjusted average costs because a suitable transformation could not be found to allow for statistical analysis of the data. Consistent with the

overall cost analysis, academicians had lower costs than Hospitalists or Generalists for pharmacy, imaging, supply, and respiratory therapy.

Table 5 displays the results of hospital discharge status and hospital mortality and 30-day readmissions. Academicians had a greater proportion of discharges to nursing homes and hospice than the other groups. Adjusted odds ratios of hospital mortality rates did not differ among the physician groups.

Readmissions within 30 days were more frequent for Academicians than the other groups. Unadjusted readmissions were 2.3-2.6% more frequent for Academicians than for Hospitalists or Generalists. After adjustments for confounding factors, Academicians' odds of readmission were about 0.2 greater than those of Hospitalists or Generalists, a difference that was statistically significant. Confounding factors that were significantly associated with readmission rates in the logistic regression analysis were APRDRG, ethnicity, and insurance type. Whites, blacks, and Hispanics were, respectively, 1.64 [confidence interval (CI) 1.16-2.32], 1.81 (CI 1.28-2.57), and 1.40 (CI 0.97-2.02) times more likely than the "other" group to be readmitted. Also, commercial insurance patients and Medicaid patients were, respectively, 0.46 (CI 0.39-0.55) and 1.00 (CI 0.84-0.18) times as likely as Medicare patients to be readmitted.

We analyzed the effect that readmissions had on cost and LOS. We wanted to be sure that the apparently lower

Table 3. General Lineal Model Regression Analysis of Admission Cost and Length of Stay by Physician Group and Subject Characteristic; Percent Difference and Statistical Significance by Physician Group Pairs

	Physician group						Physician group pairs*					
	Generalist (n=5,536)		Hospitalist (n=11,565)		Academician (n=5,691)		Hospitalist-Generalist		Academician-Hospitalist		Academician-Generalist	
	Cost	LOS	Cost	LOS	Cost	LOS	Cost	LOS	Cost	LOS	Cost	LOS
Unadjusted arithmetic mean	4,814.3	4.4	4,613.9	3.9	3,307.4	2.7	-4.2	-18.2	-28.3	-30.8	-31.1	-38.6
Adjusted overall† geometric mean	4,761.3	4.3	4,402.5‡	3.7‡	3,333.8§	2.6§	-7.5	-14.0	-24.3	-29.7	-30.0	-39.5
Gender†												
Female	4,854.6	4.4	4,438.3‡	3.8‡	3,330.5§	2.7§	-8.6	-13.6	-25.0	-28.9	-31.4	-38.6
Male	4,643.3	4.0	4,365.9‡	3.6‡	3,343.8§	2.6§	-6.0	-10.0	-23.4	-27.8	-28.0	-35.0
Insurance†												
Commercial	-	4.0	-	3.5‡	-	2.9§	-	-12.5	-	-17.1	-	-27.5
Medicaid	-	4.2	-	3.8‡	-	2.7§	-	-9.5	-	-28.9	-	-35.7
Medicare	-	4.4	-	3.8‡	-	2.6§	-	-15.8	-	-31.6	-	-40.9
Severity†												
1	2,694.7	2.5	2,542.2‡	2.2‡	2,115.4§	1.8§	-5.7	-12.0	-16.8	-18.2	-21.5	-28.0
2	3,629.2	3.4	3,339.3‡	3.0‡	2,534.7§	2.1§	-8.0	-11.8	-24.1	-30.0	-30.2	-38.2
3	5,622.5	5.2	5,111.8‡	4.5‡	3,473.1§	2.9§	-9.1	-13.5	-32.1	-35.6	-38.2	-44.2
4	9,543.1	6.9	8,893.3¶	6.8¶	5,731.3§	3.7§	-6.8	-1.4	-35.6	-45.6	-40.0	-46.4
Year†												
1	4,339.2	4.1	4,011.7‡	3.6‡	3,138.0§	2.7§	-7.5	-12.2	-21.8	-25.0	-27.7	-34.1
2	4,610.0	4.3	4,226.5‡	3.8‡	3,242.4§	2.7§	-8.3	-11.6	-23.3	-28.9	-29.7	-37.2
3	4,877.0	4.3	4,610.5**	3.7‡	3,390.5§	2.5§	-5.5	-14.0	-26.5	-32.4	-30.5	-41.9
4	5,311.6	4.3	4,788.6‡	3.7‡	3,539.9§	2.7§	-9.8	-14.0	-26.1	-27.0	-33.4	-37.2

LOS = length of stay

*Percent difference between mean pairs calculated as (Physician¹ - Physician² / Physician²)100.

†Least squares means from general linear model of log-transformed cost and LOS adjusted for age as covariate, gender, insurance, year, all patient refined diagnosis related group (APRDRG), and severity nested in APRDRG. Ethnicity was not significant (P>.05) in cost or LOS model. Insurance was not significant in cost model

‡Hospitalist lower than Generalist at P<.001

§Academician lower than Generalist and Hospitalist each at P<.001

¶Hospitalist lower than Generalist at P=.25

**Hospitalist lower than Generalist at P=.51

¶Hospitalist lower than Generalist at P=.92

**Hospitalist lower than Generalist at P=.12

utilization by academic teams was not simply dilution of average costs by more frequent admissions. We combined all readmissions within 30 days into one combined admission and reanalyzed the data using the same adjustment process as described earlier. The overall adjusted cost for the Hospitalists, Generalists, and Academicians were, respectively, 4,617.4, 4,988.1, and 3,615.5. The overall adjusted LOS for the Hospitalists, Generalists, and Academicians were, respectively, 3.9, 4.4, and 2.8. Each of the values of cost and LOS are statistically significantly different at $P < 0.001$. The effect of the readmission differences is therefore minimal with regards to cost efficiency.

DISCUSSION

The emergence of Hospitalists represents a significant change in the care of hospital patients. Whereas the optimal strategy for hospital-based medicine is still evolving, evidence is mounting that academic, hospital-based physicians with resident physician teams can be very efficient providers.

Our study supports and expands upon earlier reports of reduced hospital costs and LOS by academic physicians with residency teams.^{5,6} Our study includes more patients and covers a longer period of time than other studies. There was internal consistency in the data with costs and LOS reductions following a similar pattern through all demographic, severity, and admission year categories. We also found that, as in other studies,^{3,5} private Hospitalists were modestly more efficient than community General Internists in the care of inpatients.

Although mortality was equivalent among all physician groups, hospital readmissions were modestly increased for patients in the academic physician category. All three groups' readmission rates were similar to or lower than those reported in other studies.^{4-7,11} The reason for the differences is unclear but might be in part caused by the lower socioeconomic status of the academic physician group patients compared to that of the other groups. We could only evaluate readmissions to the hospital where the research was conducted. We do not know how frequently patients were admitted to other area hospitals, a potential problem in all research of this type reported to date.

We can only speculate on the reasons for lower inpatient costs and LOS for academic physician teams. Each team consisted of multiple physicians who could attend to patient social and medical needs and collect needed information more rapidly than the other physician types. One or more team members were present continuously in the hospital for at least 10 hours each day, and the care was "handed off" to an on-call

Table 4. Unadjusted Average Pharmacy, Laboratory, Imaging, Supply, and Respiratory Therapy Costs per Admission by Physician Group

Type of cost	Physician group		
	Generalist	Hospitalist	Academician
Pharmacy*	646.4	634.7	419.6
Laboratory*	448.2	416.2	405.1
Imaging*	342.3	334.7	276.6
Supply*	91.1	92.1	59.1
Respiratory therapy*	95.4	79.7	52.6

*Unadjusted average cost in dollars per admission

Table 5. Discharge Status and Logistic Regression Analysis of Hospital Mortality and 30-day Readmissions by Physician Group

Discharge/ readmission status	Physician group		
	Generalist	Hospitalist	Academician
Hospital mortality (%)	2.2	2.3	2.1
Home (%)	84.1	83.7	79.6
Hospice (%)	0.3	0.5	0.6
Nursing home (%)	12.5	12.1	16.0
Other (%)	0.8	1.4	1.7
30-day readmission (%)	7.5	7.2	9.8
Adjusted hospital mortality OR (CI)*	0.89 (0.68–1.16)	1.02 (0.81–1.28)	1.0
Adjusted 30-day readmission OR (CI)†	0.78 (0.68–0.90)	0.79 (0.70–0.88)	1.0

*OR (CI)=odds ratio and 95% confidence intervals of logistic regression analysis adjusted for age, all patient refined diagnosis related group (APRDRG), and gender

†OR (CI)=odds ratio and 95% confidence interval adjusted for age, ethnicity, insurance, and APRDRG

team for the remaining hours. Neither Hospitalists nor Generalists maintained this level of hospital presence.

Familiarity with the hospital environment and resources could potentially play a modest role in hospital efficiency. Academic physicians had the most patients and Generalists had the least patients per year. We performed an analysis that examined the effect of each individual attending physician's yearly admission volume on cost and LOS. There was a statistically significant ($P < .001$) inverse relationship between cost and LOS and admission volume per attending. However, the effect was small (R^2 gain < 2%).

Our study has several strengths. It is the largest study reported to date comparing academic physician teams with other Hospitalists and Internists. The data reported are internally consistent across a spectrum of demographic and severity categories. The data relating to academic physician teams are supported by prior studies in other geographic areas.^{5,6}

Our study has limitations, which we acknowledge. The study is from one hospital and academic setting. The results may not necessarily be generalized to other settings. We are confident in the accuracy of hospital costs, LOS, hospital mortality, and physician data, but we do not know global health care costs of the patients. Costs could have been differentially shifted to other settings by one group of physicians more than others. We also realize that statistical adjustment of differences in demographic factors has limitations in accuracy. We were not able to adjust the subcategories of cost (pharmacy, laboratory, images, and supply and prescriptions) for confounding factors. Thus, these data should be interpreted with caution. Finally, the higher rate of readmission by academic physicians could potentially indicate a deficiency in discharge planning or a difference in alternative health care access by Academicians' patients compared to other groups' patients.

Conclusion. The type of hospital physician provider can have a dramatic effect on hospital costs and LOS. The current and projected rise of Medicare, Medicaid, and uninsured

populations characterized by fixed payment or very low payment will likely place increased economic pressure on hospital managers to seek the most cost-effective inpatient providers. Future research should be done to better delineate total health care costs within specific geographic areas to evaluate the quantity of cost shifting that is occurring between inpatient, outpatient, and long-term care facilities. Also, objective quality-of-care markers, in addition to mortality, are needed to compare the true efficiency of health care providers.

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