

A Comparison of Outcomes of General Medical Inpatient Care Provided by a Hospitalist-Physician Assistant Model Vs a Traditional Resident-Based Model

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BACKGROUND: Residency reform in the form of work hour restrictions has forced academic medical centers to develop alternate models of care to provide inpatient care. One such model is the use of physician assistants (PAs) with hospitalists. However, these models of care have not been widely evaluated.

OBJECTIVE: To compare the outcomes of inpatient care provided by a hospitalist-PA (H-PA) model with the traditional resident based model.

DESIGN, SETTING and PATIENTS: We conducted a retrospective cohort study of 9681 general medical (GM) hospitalizations between January 2005 and December 2006 using a hospital administrative database. We used multivariable mixed models to adjust for a wide variety of potential confounders and account for multiple patient visits to the hospital to compare the outcomes of 2171 hospitalizations to H-PA teams with those of 7510 hospitalizations to resident teams (RES).

MEASUREMENTS: Length of stay (LOS), charges, readmission within 7, 14, and 30 days and inpatient mortality.

RESULTS: Inpatient care provided by H-PA teams was associated with a 6.73% longer LOS ($P = 0.005$) but charges, risk of readmission at 7, 14, and 30 days and inpatient mortality were similar to resident-based teams. The increase in LOS was dependent on the time of admission of the patients.

CONCLUSIONS: H-PA team-based GM inpatient care was associated with a higher LOS but similar charges, readmission rates, and inpatient mortality to traditional resident-based teams, a finding that persisted in sensitivity analyses. *Journal of Hospital Medicine* 2011;6:122–130. © 2011 Society of Hospital Medicine.

KEYWORDS: education, outcomes measurement, physician assistant, resident.

Additional Supporting Information may be found in the online version of this article.

In 2003 the Accreditation Council for Graduate Medical Education (ACGME) prescribed residency reform in the form of work hour restrictions without prescribing alternatives to resident based care.¹ As a response, many academic medical centers have developed innovative models for providing inpatient care, some of which incorporate Physician Assistants (PAs).² With further restrictions in resident work hours possible,³ teaching hospitals may increase use of these alternate models to provide inpatient care. Widespread implementation of such new and untested models could impact the care of the approximately 20 million hospitalizations that occur every year in US teaching hospitals.⁴

Few reports have compared the care delivered by these alternate models with the care provided by traditional resident-based models of care.^{5–8} Roy et al.⁸ have provided the only recent comparison of a PA-based model of care with a resident-based model. They showed lower adjusted

costs of inpatient care associated with PA based care but other outcomes were similar to resident-based teams.

The objective of this study is to provide a valid and usable comparison of the outcomes of a hospitalist-PA (H-PA) model of inpatient care with the traditional resident-based model. This will add to the quantity and quality of the limited research on PA-based inpatient care, and informs the anticipated increase in the involvement of PAs in this arena.

Methods

Study Design and Setting

We conducted a retrospective cohort study at a 430-bed urban academic medical center in the Midwestern United States.

Models of General Medical (GM) Inpatient Care at the Study Hospital During the Study Period

In November 2004, as a response to the ACGME-mandated work hour regulations, we formed 2 Hospitalist-PA teams

TABLE 1. Differences in Structure and Function Between Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams

	H-PA Teams	RES Teams
Attending physician	Always a hospitalist	Hospitalist, non-hospitalist general internist or rarely a specialist
Attending physician role	Supervisory for some patients (about half) and sole care provider for others.	Supervisory for all patients
Team composition	One attending paired with 1 PA	Attending + senior resident + (2) interns + (2-3) medical students
Rotation schedule		
Attending	Every 2 weeks	Every 2 weeks
Physician assistant	Off on weekends	—
House staff & medical students	—	Every month
Weekend	No new admissions & hospitalist manages all patients	Accept new admissions
Admission times (weekdays)	7 AM TO 3 PM	Noon to 7 AM
Source of admissions	Emergency room, clinics, other hospitals	Emergency room, clinics, other hospitals
Number of admissions (weekdays)	4-6 patients per day per team	Noon to 5 PM: 2 teams admit a maximum of 9 patients total 5 PM to 7 AM: 3 teams admit a maximum 5 patients each.
Overnight coverage—roles and responsibilities	One in-house faculty Cross-covering 2 H-PA teams Performing triage Admitting patients if necessary Assisting residents if necessary General medical consultation	3 on call interns Cross-covering 2 teams each Admitting up to 5 patients each

(H-PA) to supplement the 6 preexisting general medicine resident teams (RES).

The H-PA and RES teams differed in staffing, admitting times and weekend/overnight cross coverage structure (Table 1). There were no predesigned differences between the teams in the ward location of their patients, availability of laboratory/radiology services, specialty consultation, social services/case management resources, nursing resources or documentation requirements for admission, daily care, and discharge.

Admission Schedule for H-PA or RES Teams

The admitting schedule was designed to decrease the workload of the house staff and to do so specifically during the periods of peak educational activity (morning report, attending-led teaching rounds, and noon report). A faculty admitting medical officer (AMO) assigned patients strictly based on the time an admission was requested. Importantly, the request for admission preceded the time of actual admission recorded when the patient reached the ward. The time difference between request for admission and actual admission depended on the source of admission and the delay associated with assigning a patient room. The AMO assigned 8 to 12 new patients to the H-PA teams every weekday between 7 AM and 3 PM and to the RES teams between noon and 7 AM the next day. There was a designed period of overlap from noon to 3 PM during which both H-PA and RES teams could admit patients. This period allowed for flexibility in assigning patients to either type of team depending on their workload. The AMO did not use patient complexity or “teaching value” to assign patients.

Exceptions to Admission Schedule

Patients admitted overnight after the on call RES had reached their admission limits were assigned to H-PA teams the next morning. In addition, recently discharged patients who were readmitted while the discharging hospitalist (H-PA teams) or the discharging resident (RES teams) was still scheduled for inpatient duties, were assigned back to the discharging team irrespective of the admitting schedule.

The same medicine team cared for a patient from admission to discharge but on transfer to the intensive care unit (ICU), an intensivist led critical care team assumed care. On transfer out of the ICU these patients were assigned back to the original team irrespective of admitting schedule—the so called “bounce back rule” to promote inpatient continuity of care. But if the residents (RES teams) or the hospitalist (H-PA teams) had changed—the “bounce back rule” was no longer in effect and these patients were assigned to a team according to the admission schedule.

Study Population and Study Period

We included all hospitalizations of adult patients to GM teams if both their date of admission and their date of discharge fell within the study period (January 1, 2005 to December 31, 2006). We excluded hospitalizations with admissions during the weekend—when H-PA teams did not admit patients; hospitalizations to GM services with transfer to nonGM service (excluding ICU) and hospitalizations involving comanagement with specialty services—as the contribution of GM teams for these was variable; and hospitalizations of private patients.

Data Collection and Team Assignment

We collected patient data from our hospital's discharge abstract database. This database did not contain team information so to assign teams we matched the discharging attending and the day of discharge to the type of team that the discharging attending was leading that day.

We collected patient age, gender, race, insurance status, zip-code, primary care provider, source of admission, ward type, time and day of admission, and time and day of discharge for use as independent variables. The time of admission captured in the database was the time of actual admission and not the time the admission was requested.

We grouped the principal diagnosis International Statistical Classification of Diseases and Related Health Problems, 9th edition (ICD-9) codes into clinically relevant categories using the "Clinical Classification Software."⁹ We created comorbidity measures using "Healthcare Cost and Utilization Project Comorbidity Software, version 3.4."¹⁰

Outcome Measures

We used length of stay (LOS), charges, readmissions within 7, 14, and 30 days and inpatient mortality as our outcome measures. We calculated LOS by subtracting the discharge day and time from the admission day and time. The LOS included time spent in the ICU. We summed all charges accrued during the entire hospitalization including any stay in the ICU but did not include professional fees. We considered any repeat hospitalization to our hospital within 7, 14, and 30 days following a discharge to be a readmission except that we excluded readmissions for a planned procedure or for inpatient rehabilitation.

Statistical Analysis

Descriptive Analysis

We performed unadjusted descriptive statistics at the level of an individual hospitalization using medians and interquartile ranges for continuous data and frequencies and percentages for categorical data. We used chi-square tests of association and Kruskal–Wallis analysis of variance to compare H-PA and RES teams.

Missing Data

Because we lacked data on whether a primary outpatient care provider was available for 284 (2.9%) of our study hospitalizations, we dropped them from our multivariable analyses. We used an arbitrary discharge time of noon for the 11 hospitalizations which did not have a discharge time recorded.

Multivariable Analysis

We used multivariable mixed models to risk adjust for a wide variety of variables. We included age, gender, race, insurance, presence of primary care physician, and total number of comorbidities as fixed effects in all models because of the high face validity of these variables. We then added

admission source, ward, time, day of week, discharge day of week, and comorbidity measures one by one as fixed effects, including them only if significant at $P < 0.01$. For assessing LOS, charges, and readmissions, we added a variable identifying each patient as a random effect to account for multiple admissions for the same patient. We then added variables identifying attending physician, principal diagnostic group, and ZIP code of residence as random effects to account for clustering of hospitalizations within these categories, including them only if significant at $P < 0.01$. For the model assessing mortality we included variables for attending physician, principal diagnostic group, and ZIP code of residence as random effects if significant at $P < 0.01$. We log transformed LOS and charges because they were extremely skewed in nature. Readmissions were analyzed after excluding patients who died or were discharged alive within 7, 14, or 30 days of the end of the study period.

Sensitivity Analyses

To assess the influence of LOS outliers, we changed LOS to 6 hours if it was less than 6 hours, and 45 days if it was more than 45 days—a process called "winsorizing." We consider winsorizing superior to dropping outliers because it acknowledges that outliers contribute information, but prevent them from being too influential. We chose the 6 hour cut off because we believed that was the minimum time required to admit and then discharge a patient. We chose the upper limit of 45 days on reviewing the frequency distribution for outliers. Similarly, we winsorized charges at the first and 99th percentile after reviewing the frequency distribution for outliers. We then log transformed the winsorized data before analysis.

Inpatient deaths reduce the LOS and charges associated with a hospitalization. Thus excess mortality may provide a false concession in terms of lower LOS or charges. To check if this occurred in our study we repeated the analyses after excluding inpatient deaths.

ICU stays are associated with higher LOS, charges, and mortality. In our model of care, some patients transferred to the ICU are not cared for by the original team on transfer out. Moreover, care in the ICU is not controlled by the team that discharges them. Since this might obscure differences in outcomes achieved by RES vs. H-PA teams, we repeated these analyses after excluding hospitalizations with an ICU stay.

Since mortality can only occur during 1 hospitalization per patient, we repeated the mortality analysis using only each patient's first admission or last admission and using a randomly selected single admission for each patient.

Subgroup Analysis

To limit the effect of different physician characteristics on H-PA and RES teams we separately analyzed the hospitalizations under the care of hospitalists who served on both H-PA and RES teams.

To limit the effect of different admission schedules of H-PA and RES teams we analyzed the hospitalizations with

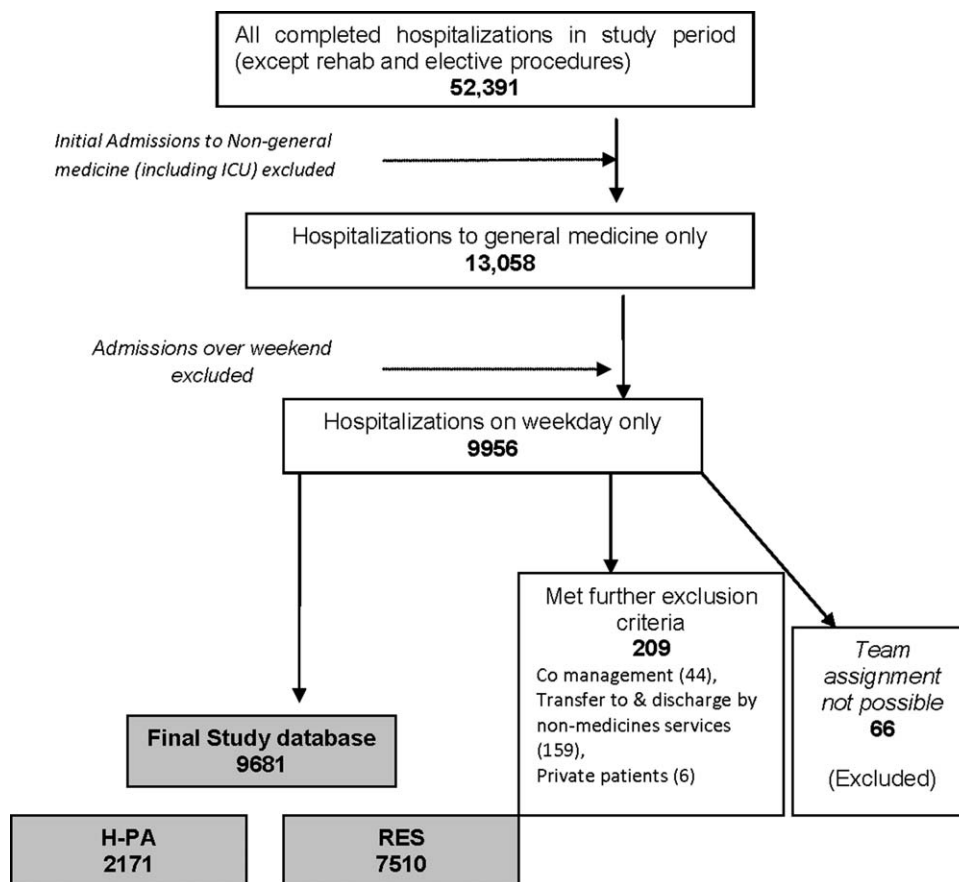


FIGURE 1. Study population (H-PA, hospitalist-physician assistant team; RES, traditional resident team).

admission times between 11.00 AM and 4.00 PM. Such hospitalizations were likely to be assigned during the noon to 3 PM period when they could be assigned to either an H-PA or RES team.

Interactions

Finally we explored interactions between the type of team and the fixed effect variables included in each model.

Statistical Software

We performed the statistical analysis using SAS software version 9.0 for UNIX (SAS Institute, Inc., Cary, NC) and R software (The R Project for Statistical Computing).

This study protocol was approved by the hospital's institutional review board.

Results

Study Population

Of the 52,391 hospitalizations to our hospital during the study period, 13,058 were admitted to general medicine. We excluded 3102 weekend admissions and 209 who met other exclusion criteria. We could not determine the team assignment for 66. Of the remaining 9681 hospitalizations, we assigned 2171 to H-PA teams and 7510 to RES teams (Figure 1).

Descriptive Analysis

We compare patients assigned to H-PA and RES teams in Table 2. They were similar in age, gender, race, having a primary care provider or not, and insurance status. Clinically, they had similar comorbidities and a similar distribution of common principal diagnoses. Consistent with their admitting schedule, H-PA teams admitted and discharged more patients earlier in the day and admitted more patients earlier in the work week. Patients cared for by H-PA teams were admitted from the Emergency Room (ER) less often and were more likely to reside on wards designated as non-medicine by nursing specialty. Hospitalizations to H-PA teams more often included an ICU stay.

In unadjusted comparisons of outcomes (Table 3), hospitalizations on H-PA teams had higher lengths of stay and charges than hospitalizations on RES teams, possibly higher inpatient mortality rates but similar unadjusted readmission rates at 7, 14, and 30 days

Multivariable Analysis

LOS

Hospitalizations to H-PA teams were associated with a 6.73% longer LOS ($P = 0.005$) (Table 4). This difference persisted when we used the winsorized data (6.45% increase, $P = 0.006$), excluded inpatient deaths (6.81%

TABLE 2. Characteristics of Hospitalization to Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams

	H-PA (n = 2171)	RES (n = 7510)	P Value
Age			
Mean	56.80	57.04	
Median	56	56	0.15
Interquartile range	43-72	43-73	
Age group (years), n (%)			
< 20	10 (0.5)	57 (0.8)	
20-29	186 (8.6)	632 (8.7)	
30-39	221 (10.2)	766 (10.3)	
40-49	387 (17.8)	1341 (18.1)	
50-59	434 (20.0)	1492 (20.2)	0.28
60-69	325 (15.0)	974 (12.8)	
70-79	271 (12.5)	1035 (13.6)	
80-89	262 (12.0)	951 (12.3)	
90<	75 (3.5)	262 (3.4)	
Female, n (%)	1175 (54.1)	4138 (55.1)	0.42
Race, n (%)			
White	1282 (59.1)	4419 (58.9)	
Black	793 (36.5)	2754 (36.7)	0.98
Other	96 (4.4)	337 (4.5)	
Primary care provider, n (%)			0.16
Yes	1537 (73.2)	5451 (74.7)	
Missing: 284	71 (3.3)	213 (2.8)	
Insurance status, n (%)			
Commercial/worker's comp	440 (20.3)	1442 (19.2)	
Medicare	1017 (46.8)	3589 (47.8)	0.52
Medicaid/others	714 (32.9)	2479 (33.0)	
Time of admission, n (%)			
0000-0259	167 (7.7)	1068 (14.2)	
0300-0559	244 (11.2)	485 (6.5)	
0600-0859	456 (21.0)	270 (3.6)	
0900-1159	782 (36.0)	1146 (15.3)	<0.001
1200-1459	299 (13.8)	1750 (23.3)	
1500-1759	155 (7.1)	1676 (22.3)	
1800-2359	68 (3.1)	1115 (14.9)	
Time of discharge, n (%)			
2100-0859	36 (1.7)	174 (2.3)	
0900-1159	275 (12.7)	495 (6.6)	
1200-1459	858 (39.6)	2608 (34.8)	<0.001
1500-1759	749 (34.6)	3122 (41.6)	
1800-2059	249 (11.5)	1104 (14.7)	
Missing	4	7	
Day of week of admission, n (%)			
Monday	462 (21.3)	1549 (20.6)	
Tuesday	499 (23.0)	1470 (19.6)	
Wednesday	430 (19.8)	1479 (19.7)	0.001
Thursday	400 (18.4)	1482 (19.7)	
Friday	380 (17.5)	1530 (20.4)	
Day of week of discharge, n (%)			
Monday	207 (9.5)	829 (11.0)	
Tuesday	268 (12.3)	973 (13.0)	
Wednesday	334 (15.4)	1142 (15.2)	
Thursday	362 (16.7)	1297 (17.3)	0.16
Friday	485 (22.3)	1523 (20.3)	
Saturday	330 (15.2)	1165 (15.5)	
Sunday	185 (8.5)	581 (7.7)	
Admit to non-medicine wards, n (%)	1332 (61.4)	2624 (34.9)	<0.001
Transfer to ICU (at least once), n (%)	299 (13.8)	504 (6.7)	<0.001
Admit from ER No (%)	1663 (76.6)	6063 (80.7)	<0.001
10 most frequent diagnosis (%)	Pneumonia (4.9)	Pneumonia (5.5)	
	Congestive heart failure; nonhypertensive (4.2)	Congestive heart failure; nonhypertensive (3.9)	

TABLE 2. Characteristics of Hospitalization to Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams (Continued)

	H-PA (n = 2171)	RES (n = 7510)	P Value
	Sickle cell anemia (3.9)	Nonspecific chest pain (3.7)	
	Chronic obstructive pulmonary disease and Bronchiectasis (3.3)	Urinary tract infections(3.6)	
	Diabetes mellitus with complications (3.2)	Skin and subcutaneous tissue infections (3.3)	
	Urinary tract infections (3.2)	Sickle cell anemia (3.3)	
	Asthma (3.0)	Pancreatic disorders (not diabetes) (2.8)	
	Nonspecific chest pain (3.0)	Asthma (2.8)	
	Pancreatic disorders (not diabetes) (2.9)	Chronic obstructive pulmonary disease and Bronchiectasis (2.6)	
	Septicemia (2.2)	Diabetes mellitus with complications (2.6)	
Average number of comorbidities mean (95% CI)	0.39 (0.37-0.42)	0.38 (0.36-0.39)	0.23

Abbreviations: CI, confidence interval; ER, emergency room; H-PA, hospitalist-physician assistant; ICU, Intensive care unit; RES, traditional resident.

increase, $P = 0.005$), or excluded hospitalizations that involved an ICU stay (6.40% increase, $P = 0.011$) (Table 5).

Charges

Hospitalizations to H-PA and RES teams were associated with similar charges (Table 4). The results were similar when we used winsorized data, excluded inpatient deaths or excluded hospitalizations involving an ICU stay (Table 5).

Readmissions

The risk of readmission at 7, 14, and 30 days was similar between hospitalizations to H-PA and RES teams (Table 4).

Mortality

The risk of inpatient death was similar between all hospitalizations to H-PA and RES teams or only hospitalizations without an ICU stay (Table 4). The results also remained the

same in analyses restricted to first admissions, last admissions, or 1 randomly selected admission per patient.

Sub-Group Analysis

On restricting the multivariable analyses to the subset of hospitalists who staffed both types of teams (Table 4), the increase in LOS associated with H-PA care was no longer significant (5.44% higher, $P = 0.081$). The charges, risk of readmission at 7 and 30 days, and risk of inpatient mortality remained similar. The risk of readmission at 14 days was slightly lower following hospitalizations to H-PA teams (odds ratio 0.71, 95% confidence interval [CI] 0.51-0.99).

The increase in LOS associated with H-PA care was further attenuated in analyses of the subset of admissions between 11.00 AM and 4.00 PM (2.97% higher, $P = 0.444$). The difference in charges approached significance (6.45% higher, $P = 0.07$), but risk of readmission at 7, 14, and 30 days and risk of inpatient mortality were no different (Table 4).

TABLE 3. Unadjusted Comparison of Outcomes of Hospitalization to Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams

	H-PA (n = 2171)	RES (n = 7150)	% Difference* [†] (CI)	P Value
LOS	Median (IQR)	Median (IQR)		
Days	3.17 (2.03-5.30)	2.99 (1.80-5.08)	+8.9% (4.71-13.29%)	<0.001
Charges				
US Dollars	9390 (6196-16,239)	9044 (6106-14,805)	+5.56% (1.96-9.28%)	0.002
Readmissions	n (%)	n (%)	Odds Ratio (CI)[†]	
Within 7 days	147 (6.96)	571 (7.78)	0.88 (0.73-1.06)	0.19
Within 14 days	236 (11.34)	924 (12.76)	0.87 (0.75-1.01)	0.07
Within 30 days	383 (18.91)	1436 (20.31)	0.91 (0.80-1.03)	0.14
Inpatient deaths	39 (1.8)	95 (1.3)	1.36 (0.90-2.00)	0.06

Abbreviations: CI, 95% confidence intervals; IQR, interquartile range; LOS, length of stay; * On comparing log transformed LOS; [†] RES is reference group.

TABLE 4. Adjusted Comparison of Outcomes of Hospitalization to Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams (RES is the reference group)

	Overall		Subgroup: Restricted to Physicians Attending on Both H-PA and RES Teams*		Subgroup: Restricted to Hospitalizations Between 11.00 AM and 4.00 PM†	
	% Difference (CI)	P Value	% Difference (CI)	P Value	% Difference (CI)	P Value
LOS	6.73% (1.99% to 11.70%)	0.005	5.44% (-0.65% to 11.91%)	0.08	2.97% (-4.47% to 10.98%)	0.44
Charges	2.75% (-1.30% to 6.97%)	0.19	1.55% (-3.76% to 7.16%)	0.57	6.45% (-0.62% to 14.03%)	0.07
Risk of Readmission	Adjusted OR (95%CI)	P Value	Adjusted OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Within 7 days	0.88 (0.64-1.20)	0.42	0.74 (0.40-1.35)	0.32	0.90 (0.40-2.00)	0.78
Within 14 days	0.90 (0.69-1.19)	0.46	0.71 (0.51-0.99)	0.05	0.87 (0.36-2.13)	0.77
Within 30 days	0.89 (0.75-1.06)	0.20	0.75 (0.51-1.08)	0.12	0.92 (0.55-1.54)	0.75
Inpatient mortality	1.27 (0.82-1.97)	0.28	1.46 (0.67-3.17)	0.33	1.14 (0.47-2.74)	0.77

Abbreviations: CI, 95% confidence intervals; LOS, length of stay; OR, odds ratio; * Number of observations included in subgroup ranges from 2992 to 3196; † Number of observations included in subgroup ranges from 3174 to 3384.

Interactions

On adding interaction terms between the team assignment and the fixed effect variables in each model we detected that the effect of H-PA care on LOS ($P < 0.001$) and charges ($P < 0.001$) varied by time of admission (Figure 2a and b). Hospitalizations to H-PA teams from 6.00 PM to 6.00 AM had greater relative increases in LOS as compared to hospitalizations to RES teams during those times. Similarly, hospitalizations during the period 3.00 PM to 3.00 AM had relatively higher charges associated with H-PA care compared to RES care.

Discussion

We found that hospitalizations to our H-PA teams had longer LOS but similar charges, readmission rates, and mortality as compared to traditional resident-based teams. These findings were robust to multiple sensitivity and subgroup analyses but when we examined times when both types of teams could receive admissions, the difference in LOS was markedly attenuated and nonsignificant.

We note that most prior reports comparing PA-based models of inpatient care predate the ACGME work hour regulations. In a randomized control trial (1987-1988) Simmer

et al.⁵ showed lower lengths of stay and charges but possibly higher risk of readmission for PA based teams as compared to resident based teams. Van Rhee et al.⁷ conducted a non-randomized retrospective cohort study (1994-1995) using administrative data which showed lower resource utilization for PA-based inpatient care. Our results from 2005 to 2006 reflect the important changes in the organization and delivery of inpatient care since these previous investigations.

Roy et al.⁸ report the only previously published comparison of PA and resident based GM inpatient care after the ACGME mandated work hour regulations. They found PA-based care was associated with lower costs, whereas we found similar charges for admissions to RES and H-PA teams. They also found that LOS was similar for PA and resident-based care, while we found a higher LOS for admissions to our H-PA team. We note that although the design of Roy's study was similar to our own, patients cared for by PA-based teams were geographically localized in their model. This may contribute to the differences in results noted between our studies.

Despite no designed differences in patients assigned to either type of team other than time of admission we noted some differences between the H-PA and RES teams in the

TABLE 5. Sensitivity Analysis: Adjusted Comparison of Outcomes of Hospitalization to Hospitalist-Physician Assistant (H-PA) and Traditional Resident (RES) Teams (RES is the Reference Group)

	Analysis With Winsorized Data		Analysis After Excluding Inpatient Deaths		Analysis After Excluding Patients With ICU Stays	
	% Difference (CI)	P Value	% Difference (CI)	P Value	% Difference (CI)	P Value
LOS	6.45% (4.04 to 8.91%)	0.006	6.81% (2.03 to 11.80%)	0.005	6.40% (1.46 to 11.58%)	0.011
Charges	2.67 (-1.27 to 6.76%)	0.187	2.89% (-1.16 to 7.11%)	0.164	0.74% (-3.11 to 4.76%)	0.710

Abbreviations: CI, 95% confidence intervals; ICU, intensive care unit; LOS, length of stay; OR, odds ratio.

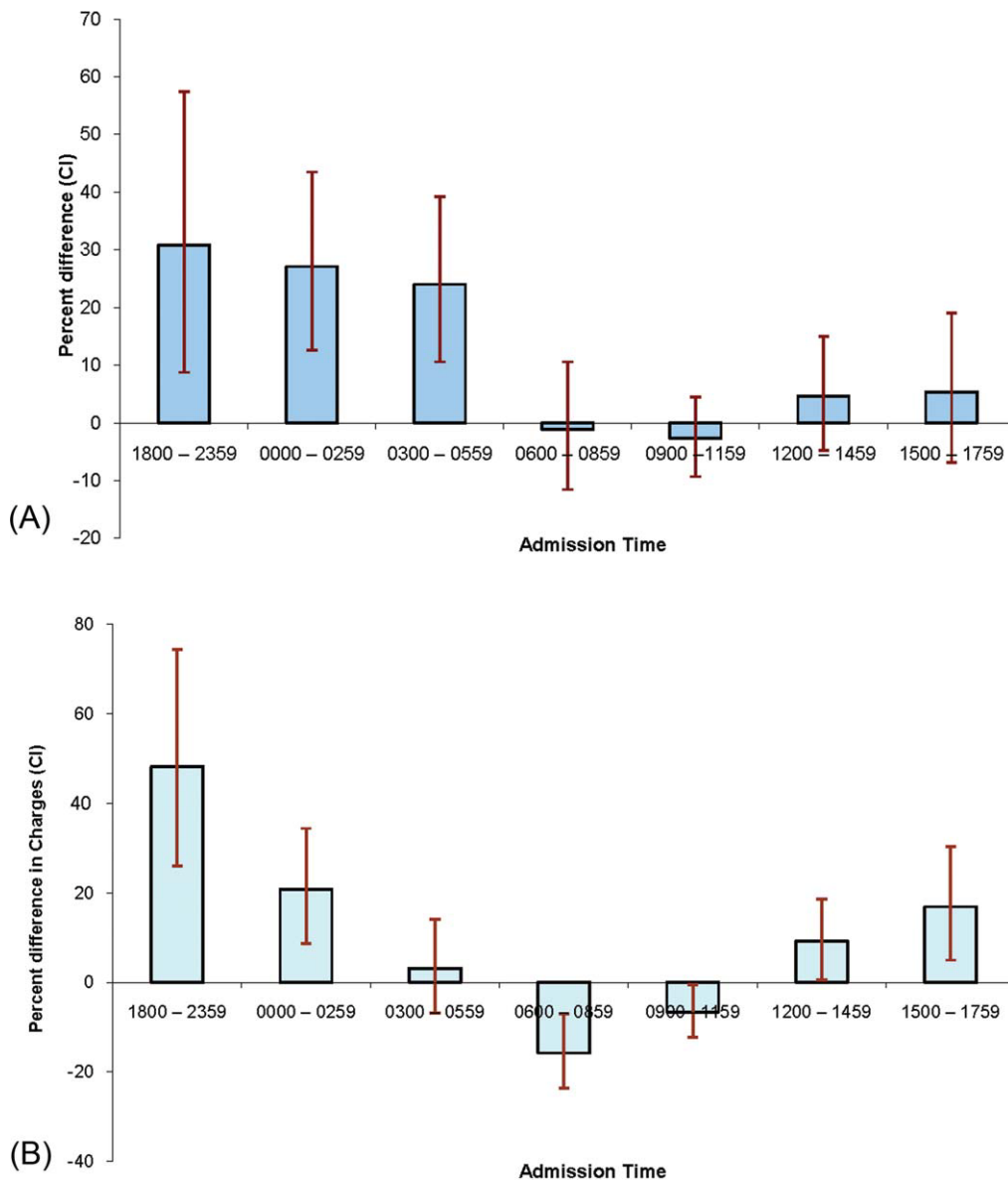


FIGURE 2. (A) Relative difference in length of stay associated with care by H-PA teams by times of admission (in percent change with RES as reference). (B) Relative difference in charges associated with care by H-PA teams by time of admission (in percent with RES as reference). Abbreviations: H-PA, hospitalist-physician assistant team; RES traditional resident team. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

descriptive analysis. These differences, such as a higher proportion of hospitalizations to H-PA teams being admitted from the ER, residing on nonmedicine wards or having an ICU stay are likely a result of our system of assigning admissions to H-PA teams early during the workday. For example patients on H-PA teams were more often located on nonmedicine wards as a result of later discharges and bed availability on medicine wards. The difference that deserves special comment is the much higher proportion (13.8% vs. 6.7%) of hospitalizations with an ICU stay on the H-PA teams. Hospitalizations directly to the ICU were excluded from our study which means that the hospitalizations with

an ICU stay in our study were initially admitted to either H-PA or RES teams and then transferred to the ICU. Transfers out of the ICU usually occur early in the workday when H-PA teams accepted patients per our admission schedule. These patients may have been preferentially assigned to H-PA teams, if on returning from the ICU the original team's resident had changed (and the "bounce back rule" was not in effect). Importantly, the conclusions of our research are not altered on controlling for this difference in the teams by excluding hospitalizations with an ICU stay.

Hospitalizations to H-PA teams were associated with higher resource utilization if they occurred later in the day

or overnight (Figure 2a and b). During these times a transition of care occurred shortly after admission. For a late day admission the H-PA teams would transfer care for overnight cross cover soon after the admission and for patients admitted overnight as overflow they would assume care of a patient from the nighttime covering physician performing the admission. On the other hand, on RES teams, interns admitting patients overnight continued to care for their patients for part of the following day (30-hour call). Similar findings of higher resource utilization associated with transfer of care after admission in the daytime¹¹ and nighttime¹² have been previously reported. An alternative hypothesis for our findings is that the hospital maybe busier and thus less efficient during times when H-PA teams had to admit later in the day or accept patients admitted overnight as overflow. Future research to determine the cause of this significant interaction between team assignment and time of admission on resource utilization is important as the large increases in LOS (up to 30%) and charges (up to 50%) noted, could have a potentially large impact if a higher proportion of hospitalizations were affected by this phenomenon.

Our H-PA teams were assigned equally complex patients as our RES teams, in contrast to previous reports.^{8,13} This was accomplished while improving the resident's educational experience and we have previously reported increases in our resident's board pass rates and in-service training exam scores with that introduction of our H-PA teams.¹⁴ We thus believe that selection of less complex patients to H-PA teams such as ours is unnecessary and may give them a second tier status in academic settings.

Our report has limitations. It is a retrospective, non-randomized investigation using a single institution's administrative database and has the limitations of not being able to account for unmeasured confounders, severity of illness, errors in the database, selection bias and has limited generalizability. We measured charges not actual costs,¹⁵ but we feel charges are a true reflection of relative resource use when compared between similar patients within a single institution. We also did not account for the readmissions that occur to other hospitals¹⁶ and our results do not reflect resource utilization for the healthcare system in total. For example, we could not tell if higher LOS on H-PA teams resulted in lower readmissions for their patients in all hospitals in the region, which may reveal an overall resource savings. Additionally, we measured in-hospital mortality and could not capture deaths related to hospital care that may occur shortly after discharge.

ACGME has proposed revised standards that may further restrict resident duty hours when they take effect in July 2011.³ This may lead to further decreases in resident-based inpatient care. Teaching hospitals will need to continue to develop alternate models for inpatient care that do not depend on house staff. Our findings provide important evidence to inform the development of such models. Our study

shows that one such model: PAs paired with hospitalists, accepting admissions early in the workday, with hospitalist coverage over the weekend and nights can care for GM inpatients as complex as those cared for by resident-based teams without increasing readmission rates, inpatient mortality, or charges but at the cost of slightly higher LOS.

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