Staff-Only Pediatric Hospitalist Care of Patients With Medically Complex Subspecialty Conditions in a Major Teaching Hospital

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Objective: To assess cost and length of stay for subspecialty patients on a staff-only general pediatric hospitalist service vs traditional faculty/housestaff subspecialty services in a major teaching hospital.

Design: Retrospective study of 2 cohort groups: a staff-only general pediatric hospitalist group and subspecialty faculty/housestaff gastroenterology and hematology/oncology groups.

Setting: Major referral center providing full-spectrum, complex surgical, and subspecialty care including transplantation.

Participants: Nine hundred twenty-five pediatric patients with gastroenterologic and hematologic/oncologic diseases admitted and discharged between July 1, 2005, and June 30, 2006.

Main Exposure: Patients with gastroenterologic and hematologic/oncologic diseases were assigned to the hospitalist team when faculty/housestaff teams reached their maximum census of patients per intern.

Main Outcome Measures: Cost, length of stay, mortality, and readmission to the hospital within 72 hours of discharge.

Results: Cost averaged $11,000 and $16,500, respectively, for patients on the hospitalist service compared with those on nonhospitalist services. On average, length of stay was 7.2 days and 9.8 days, respectively. In negative binomial regression analyses controlling for subspecialty, demographic data, disease severity, and average daily census, patients on the hospitalist service had 29% lower costs ($\times 0.05$) and 38% fewer hospital days ($P < .01$) per admission compared with patients on subspecialty faculty/housestaff services, with no clear differences in mortality and readmission rates.

Conclusion: Compared with the subspecialist faculty/housestaff system, the staff-only pediatric hospitalist system was associated with a marked reduction in cost and length of stay for patients with medically complex subspecialty diseases. In this era of resident duty-hour restrictions and medical complexity of conditions in inpatients, staff-only hospitalist programs may have a vital role in pediatric teaching hospitals.

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Since the introduction of the term “hospitalist” in 1996, hospital-based medicine has become the fastest growing medical field in the United States. A hospitalist is a physician who is chiefly engaged in the medical care of hospitalized patients. In 2006, pediatricians represented 11% of the members of the Society of Hospital Medicine, with an estimated 800 to 1000 practicing pediatric hospitalists. Pediatric hospitalists have gained increasing recognition by the American Academy of Pediatrics, which recently issued principles for the development of pediatric hospitalist programs. In 2005, the American Academy of Pediatrics and the Society of Hospital Medicine cohosted the first Pediatric Hospitalist Meeting.

Hospitalists meet the growing need for efficient care through their accessibility to patients and staff, their experience in caring for hospitalized patients, and their familiarity with their specific hospital system. Most of the literature has demonstrated improved costs, reduced length of stay (LOS), or both for pediatric and adult hospitalist programs. Significant differences in mortality or readmission rates have not been identified, and patient and/or family satisfaction has been unchanged or improved. A systematic review of the pediatric literature in 2006 revealed an average decrease of 10% in costs and LOS in pediatric hospitalist systems compared with traditional systems. Therefore, hospitalists seem to improve efficiency of inpatient care without reducing quality of care.

According to a 2001 survey of academic pediatric centers in the United States and Canada, 50% employed hospitalists and another 27% expected that they would. As the hospitalist field evolves,
general pediatric hospitalists are increasingly relied on to manage patients with subspecialty or complex medical conditions.13,15 Although general pediatric hospitalists seem to be more efficient than nonhospitalist general pediatricians, few studies have compared general pediatric hospitalists vs pediatric subspecialists. Srivastava et al15 reported that pediatric hospitalists caring for children with medically complex conditions with special health care needs had reduced LOS and costs.

Furthermore, in most studies of pediatric hospitalist programs, pediatric residents have been assigned to the hospitalist team.11,16-18 In 2003, however, the Accreditation Council for Graduate Medical Education in the United States mandated duty-hour standards, limiting the resident workweek to a maximum of 80 hours. This restriction in resident availability for inpatient care has created a labor shortage in many teaching hospitals, prompting the adoption of staff-only pediatric hospitalist models for the care of both critically and noncritically ill patients.20,21

However, to our knowledge, a staff-only pediatric hospitalist model for care of patients with medically complex subspecialty conditions has never been studied in the United States. It is unclear whether a staff-only hospitalist model would confer the same advantages that a faculty/housestaff hospitalist model does. In a system driven largely by resident and fellow interactions, a lone staff hospitalist might be prone to isolation that might be particularly costly when managing patients with medically complex conditions. On the other hand, a staff hospitalist, unencumbered by the need to encourage housestaff autonomy and to deal with regular disruptions in continuity caused by housestaff transitions, could act in ways that more consistently maximize efficiency of care. The purpose of this study, therefore, was to assess LOS and cost for patients with subspecialty conditions on a staff-only general pediatric hospitalist service compared with traditional faculty/housestaff subspecialty services in a major teaching hospital.

**METHODS**

**SETTING**

The UCLA Hospital and Medical Center is a nonprofit 667-bed tertiary-care teaching hospital in Los Angeles, California. The Mattel Children’s Hospital is a hospital within a hospital, with a 65-bed pediatric ward, a 19-bed pediatric intensive care unit, and approximately 3000 admissions per year. The hospital is an international referral center that provides a full spectrum of complex surgical and subspecialty care including transplantation. We compared traditional faculty/housestaff groups on the gastroenterology and hematology/oncology services with a hospitalist group caring for overflow patients on these 2 services.

Traditional faculty/housestaff groups consisted of 5 members: 3 residents who carried out most patient care responsibilities, a subspecialist fellow, and a fellowship-trained subspecialist attending physician. None of the traditional faculty were hospitalists. The gastroenterology faculty attended on the ward on average for 7 weeks (range, 4-10 weeks) per year, and the hematology/oncology faculty attended on average for 6 weeks (range, 4-10 weeks) per year. The faculty attending physicians rotated coverage of their inpatient service every 1 to 2 weeks, and time off of the service was dedicated to outpatient clinics, research, teaching, and administration. While caring for inpatients, most subspecialist attending physicians also staffed 1 half-day clinic every week and continued research, teaching, and administrative duties. In contrast, the hospitalists had fewer teaching and administrative duties and devoted most of their time to the care of pediatric inpatients.

The hospitalist team consisted of a full-time pediatrician trained in general pediatrics who cared for patients Monday through Friday from 8:00 AM to 5:00 PM. The hospitalist was on service 48 weeks per year. There were no residents on the hospitalist team; however, residents cared for the hospitalist patients overnight and on weekends. The hospitalist team cared almost exclusively for overflow patients from the gastroenterology and hematology/oncology services, consulting the subspecialists primarily about subspecialty-specific procedures. The roles of the subspecialty attending physician and fellow in the care of hospitalist patients included ordering chemotherapy, ordering immunosuppression for patients with transplants, and performing endoscopy, liver biopsy, bone marrow biopsy, and intrathecal chemotherapy. The hospitalist was responsible for day-to-day management of patients.

**PATIENTS**

Patients were admitted from urgent care clinics, subspecialty clinics, transferring hospitals, community practices, and the emergency department. Patients were assigned to the hospitalist team when the resident teams reached their maximum capacity of 6 to 8 patients per intern, depending on the subspecialty team. Patient census was, therefore, the sole deciding factor for patient assignment to the hospitalist team, making patient assignment quasi-random with respect to acuity and complexity of illness. The hospitalist was responsible for patient admission and daily clinical evaluation and documentation, orders, review of diagnostic studies, communication with subspecialists and community primary care providers, discharge planning, and arrangement of home health care. On the faculty teams, most of these activities were assumed by the housestaff.

**DATA COLLECTION**

Patient information was obtained from existing data collected by the UCLA Hospital Financial Department Electronic Health Records database. These data were originally collected by the UCLA Hospital Financial Department for the purpose of hospital management and billing. The Product Line Management System was searched for patients admitted and discharged between July 1, 2005, and June 30, 2006, the first full academic year that included the new hospitalist system.

The outcome variables were LOS, actual variable direct cost (AVDC), in-hospital mortality, and readmission within 72 hours. The LOS was measured in calendar days. Readmission within 72 hours was chosen rather than a longer time because many chronically ill patients were readmitted frequently for routine treatment (eg, chemotherapy) or because of unrelated conditions. The AVDC included total direct cost (controlling for relative shifts in activity over time) for nursing, supply, pharmacy, laboratory, and radiology utilization. This is a hospital-specific calculation and is not based on cost-to-charge ratio. Physician fees were not included in costs because the hospital does not bill for these and the data were not available through the same database.

The primary predictor variable was a hospitalist indicator. Potential covariates included patient age, payer group, severity of illness, average daily census, and a service indicator. Age was calculated in years. We collapsed payers into 3 groups: pri-
vate insurance, Medicaid, and other. Severity of illness was assig-
ned by trained hospital records technicians according to a stan-
dardized coding system (All Patient Refined Diagnosis
Related Groups [APR-DRGs], version 24; 3M Health Information
Systems, Wallingford, Connecticut).22,23 Severity of ill-
ness was ranked on a scale of 1 to 4, as follows: 1, minor (un-
complicated hospital stay); 2, moderate (complicated hos-
Mental stay related to serious conditions); 3, major (complicated
stay related to chronic conditions); and 4, extreme (com-
licated hospital stay related to potentially life-threatening con-
tions). This study was approved by the institutional review
board at the UCLA Medical Center.

ANALYSIS

Both LOS and AVDC violated normality assumptions even af-
after log transformation and analysis of outliers and, therefore,
could not be examined using simple t tests or linear regres-
sion. Data most resembled count data (eg, LOS could be con-
sidered a count of days per hospital admission), which often
has a Poisson-type distribution (a high peak near zero fol-
lowed by a long tail to the right).24 Data, however, were too
overdispersed to satisfy Poisson assumptions (ie, the variance
substantially exceeded the mean); therefore, negative bino-
mial regression, a generalization of the Poisson procedure, was
used. We performed bivariate regressions between each out-
come variable and the hospitalist indicator, as well as each of
the potential covariates. In addition to the hospitalist indica-
tor, patient age, payer group, severity of illness, average daily
census, and service indicators all qualified for inclusion in mul-
tivariate analyses, with the inclusion threshold set at a P < .20
familywise error rate (a common standard).25

RESULTS

Medical records for 925 pediatric patients were analyzed
according to the discharging physician service and di-
agnosis. The pediatric hospitalist service cared for a total
of 119 inpatients. Because most hospitalist patients were
overflow from either the gastroenterology or hematology/
oncology service, the entire sample was restricted to those
2 services, leaving 111 patients on the hospitalist ser-
vice. Two other patients, who, for logistical reasons, were
transferred between hospitalist and gastroenterology or
hematology/oncology services, were also excluded. The final
sample included 109 hospitalist patients (81 gastro-
enterology and 28 hematology/oncology) and 816 fac-
tuly/housestaff patients (313 gastroenterology and 503
hematology/oncology).

A comparison of patients cared for by the study groups
is given in Table 1. Average daily censuses were 3.8 pa-
tients for the hospitalist group, 13.5 (±4.5 per resident)
for the gastroenterology group, and 12.6 (±4.2 per resi-
dent) for the hematology/oncology group. There was no
difference for patient age, payer type, APR-DRG severity
weight, or APR-DRG severity subclass between the groups.
Patients cared for by the hospitalist group were more
likely than other patients to have gastroentero-
logic conditions (P < .001). The 3 most common major
disease categories (derived from DRGs) were digestive
system, liver-pancreas, and myeloproliferative disor-
ders in both the hospitalist and nonhospitalist groups.
These diagnoses accounted for 60% of all patients seen
by both groups.

Table 1. Patient Characteristics of Traditional
Faculty/Housestaff and Staff-Only Hospitalist Groups

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Faculty/Housestaff Group</th>
<th>Hospitalist Group</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>816</td>
<td>109</td>
<td>NA</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>8.5 (6.1)</td>
<td>7.78 (6.19)</td>
<td>.25</td>
</tr>
<tr>
<td>APR-DRG severity weight, mean (SD)</td>
<td>2.2 (3.4)</td>
<td>2.2 (3.2)</td>
<td>.82</td>
</tr>
<tr>
<td>APR-DRG severity subclass, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>11</td>
<td>.16</td>
</tr>
<tr>
<td>2</td>
<td>44</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Service, %</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>38</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Hematology/oncology</td>
<td>62</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Average daily census</td>
<td>12.9</td>
<td>3.8</td>
<td>.82</td>
</tr>
<tr>
<td>Payer, %</td>
<td></td>
<td></td>
<td>.33</td>
</tr>
<tr>
<td>Private insurance</td>
<td>69</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>27</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LOS, mean (SD), d</td>
<td>9.8 (18.5)</td>
<td>7.2 (10.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>AVDC, mean (SD)</td>
<td>16.5 (45.9)</td>
<td>11.0 (23.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Readmission within 72 hours, %</td>
<td>4.4</td>
<td>0</td>
<td>.02</td>
</tr>
<tr>
<td>Mortality, %</td>
<td>1.8</td>
<td>0.9</td>
<td>.71</td>
</tr>
</tbody>
</table>

Abbreviations: APR-DRG, All Patient Refined Diagnosis Related Group;
AVDC, actual variable direct cost; LOS, length of stay; NA, not applicable.

The LOS and AVDC for the hospitalist group were less
than those for the faculty group. On average, patients on
the hospitalist service stayed 7.2 days (8.2 days for gastro-
enterology and 4.2 days for hematology/oncology) com-
pared with 9.8 days for patients on nonhospitalist services
(13.5 days for gastroenterology and 7.6 days for hematology/
oncology). The AVDC was $11 000 on the hospitalist ser-
vice ($11 900 for gastroenterology and $8300 for hema-
tology/oncology) and $16 500 on nonhospitalist services
($23 000 for gastroenterology and $12 400 for hematology/
oncology). After adjustment for patient age, payer group,
severity of illness, average daily census, and service using
multivariate negative binomial regression (Table 2), we
found that patients on the hospitalist service had 38% fewer
hospital days (P < .01) and 29% lower direct costs (P < .05)
compared with patients on the subspecialty faculty/
housestaff services. Associations were similar regardless of
whether we used APR-DRG severity subclasses (Table 2)
or APR-DRG severity weights (data not shown). Associa-
tions were equally strong using linear regressions with log-
transformed outcome variables (data not shown). When
LOS was added as a covariate in the AVDC regression, di-
rect costs on the hospital service were no longer signifi-
cantly less than on the subspecialty faculty/housestaff ser-
ices (3% lower costs; P = .75; data not shown). The study
was underpowered to conduct multivariate analyses with
respect to mortality and rate of readmission within 72 hours
between the 2 study groups. Bivariate Fisher exact compari-
on, however, the faculty group had 15 deaths (1.8%)
compared with 1 (0.9%) for the hospitalist group (P = .71)
and 36 readmissions within 72 hours (4.4%) compared with
none for the hospitalist group (P = .02).
To our knowledge, ours is the first US study to compare the performance of a staff-only pediatric hospitalist system with a traditional faculty/housestaff system in a major teaching hospital. We showed that patients admitted to a staff-only hospitalist group in a large, urban, tertiary-care pediatric center in Los Angeles, California, experienced a 38% reduction in LOS and a 29% reduction in direct costs compared with patients admitted to a faculty/housestaff system. Reduction in direct costs was almost entirely due to reduction in LOS.

Our findings are similar to those of previous reports that demonstrated reduced LOS or improved cost for pediatric hospitalist programs.12 The mechanisms by which hospitalist systems reduce LOS and cost are uncertain.20 However, we suspect that the greatest advantages of a hospitalist system in a teaching hospital may be the greater availability and inpatient experience of the attending physician. Greater availability ensures frequent expert assessment of patient status and progress and immediate follow-up of laboratory tests and radiologic studies, and greater inpatient experience creates enhanced understanding of the hospital system and successful troubleshooting techniques. Hospitalists are also in a position to form consistent relationships with other members of the caregiving team, which further expedites care.27 In addition, in a national survey comparing hospitalists and community pediatricians, hospitalists reported more frequent use of evidence-based management in the care of inpatients and less frequent use of diagnostic and therapeutic methods not recommended by national guidelines.28 Other studies have demonstrated decreased laboratory,29 radiology,29,30 respiratory therapy,18,20 and pharmacy charges.50

Our study differs from previous reports in several important respects. Excluding weekends and nights, residents were not present on the hospitalist service. Only 1 other study has compared a staff-only hospitalist system with the traditional faculty/housestaff model, and that was in a setting not in the United States. Dwight et al20 from the Hospital for Sick Children in Toronto, Ontario, Canada, a tertiary-care pediatric academic health center, found that LOS was decreased by 14% for patients on a hospitalist service without substantially different mortality and hospital readmission rates.20 We report a longer LOS and higher cost than most other published pediatric hospitalist studies (1.54-3.36 days and $1024-$88581 for hospitalists and 1.77-3.63 days and $1110-$9122 for nonhospitalists).11,12,17-20 This is likely because our patient population had much higher APR-DRG severity weights (2.2 for hospitalists and 2.4 for nonhospitalists) than did patients in other pediatric hospitalist studies conducted in tertiary-care hospitals (0.68-1.6).11,19 In these studies, hospitalists cared for general pediatric patients with diagnoses such as asthma, fever, pneumonia, viral illness, and gastroenteritis.17-20 At our institution, more than 90% of the patients cared for by our hospitalist service, and all of the patients included in this study, were subspecialty patients, including 29 patients with liver transplants and 11 with combined liver and small-bowel transplants. Compared with the subspecialty faculty/housestaff service, the hospitalist service had a higher percentage of patients with gastroenterologic conditions than hematologic/oncologic conditions. Although it was possible for this to confound our results, our findings persisted after controlling for this variable.

Studies of hospitalist care of medically complex or subspecialty pediatric patients are few. Only 1 other study has compared pediatric hospitalists with subspecialists. Maggioni19 reported a 20% decrease in LOS (3.8 vs 4.8 days) and a 31% decrease in charges ($10 529 vs $15 380) in fa-
vor of hospitalists. Srivastava et al reported that pediatric hospitalists caring for children with medically complex conditions with special health care needs had an LOS of 7.9 days at a cost of $16,677, similar to our findings. Pediatric hospitalists in that study reduced LOS and costs by 15% and 13%, respectively, after adjusting for age, severity of illness, and medical complexity. In 2003, the American Academy of Pediatrics Committee on Hospital Care recommended pediatric hospitalist consultation for pediatric surgical patients. Simon et al showed that a hospitalist trained in general pediatrics improved the pre- and postoperative management of patients with medically complex conditions undergoing spinal fusion surgery. The LOS was decreased from 6.5 days to 4.8 days. Our study shows that a hospitalist trained in general pediatrics decreased LOS and cost without increasing readmissions of patients requiring subspecialty care including those with higher severity of illness or organ transplantation.

Perhaps our study is most similar to that reported by Tenner et al, which examined the effects of replacing residents with hospitalists trained in general pediatrics to provide after-hours care in an intensive care unit. Both the residents and hospitalists were supervised by an on-call intensive care unit attending physician who was available for telephone consultation and could be present in case of emergencies. Compared with the resident era, odds of survival in the hospitalist era were 2.8 times as high, and LOS decreased from 96 hours to 89.7 hours. The study suggests that the quality of care of critically ill patients may be improved when more experienced physicians are providing bedside care. Therefore, in the care of children with medically complex conditions, pediatric hospitalists may improve care by their continuous bedside availability compared with subspecialty attending physicians and by their clinical expertise compared with residents. A robust general pediatric perspective might also be useful in the care of some subspecialty patients who may have general pediatric issues requiring attention.

Our study had a number of strengths that distinguish it from previous studies in the literature. First, there was minimal selection bias because patients were assigned to the different groups on the basis of census only. Second, information bias was also reduced because the same standardized data source was used for collection of patient information. Potential confounding variables (age, payer, subspecialty, and disease severity) were taken into account in the multivariate analysis. Third, the use of concurrent cases selected from the same target population within the same hospital eliminated the biases that would have been associated with a before/after study design.

There were, however, several limitations. First, the study was conducted at a single medical center with a new hospitalist service. The long-term effect of the hospitalist system is unknown. Second, average daily census was substantially lower on the hospitalist service than on the faculty/housestaff services, potentially creating unmeasured confounders. However, average daily census was not associated with outcomes at multivariate regression, possibly because each faculty/housestaff service had 3 residents carrying out most patient-care responsibilities (hospitalist and faculty/housestaff census were comparable on a per-physician basis). Third, lack of data on physician fees also limited cost analysis. Fourth, we were unable to measure the satisfaction of patients, their families, and other health care providers. Fifth, we did not explore the educational effect on residents of having a staff-only service. Potentially, a staff-only service could deprive residents of patient care opportunities. Alternatively, it could provide residents with a useful window into a system of care that seems to work with much greater efficiency than traditional faculty/housestaff systems.

In conclusion, compared with a subspecialty faculty/housestaff system, the staff-only pediatric hospitalist system was associated with a substantial reduction in LOS and direct costs. In this era of resident duty-hour restrictions and increasing severity of illness and medical complexity in inpatients, our findings suggest that the adoption of staff-only hospitalist programs in US pediatric teaching hospitals may be useful. Further research is needed to determine the specific characteristics of the performance of hospitalist physicians that reduce LOS and cost to ascertain which types of programs are most effective and which patients are most likely to benefit, and to examine the educational effect of a staff-only service on pediatric residents.

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Author Contributions: Dr Bekmezian had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Bekmezian and Yazdani. Acquisition of data: Bekmezian. Analysis and interpretation of data: Bekmezian and Chung. Drafting of the manuscript: Bekmezian and Yazdani. Critical revision of the manuscript for important intellectual content: Bekmezian and Chung. Statistical analysis: Chung. Administrative, technical, and material support: Bekmezian. Study supervision: Bekmezian, Chung, and Yazdani.

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REFERENCES


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