Outcomes and Costs Associated With Hospitalist Comanagement of Medically Complex Children Undergoing Spinal Fusion Surgery

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KEY WORDS
comanagement, hospitalist, interdisciplinary health team, medically complex, orthopedics, pediatrics, scoliosis

ABBREVIATIONS
AED: antiepileptic drug
EMR: electronic medical record
IQR: interquartile range
LOS: length of stay
UTI: urinary tract infection

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abstract

OBJECTIVE: The goal of this study was to assess outcomes and costs associated with hospitalist comanagement of medically complex children undergoing spinal fusion surgery for neuromuscular scoliosis.

METHODS: A hospitalist comanagement program was implemented at a children's hospital. We conducted a retrospective case series study of patients during 2003–2008 to compare clinical and cost outcomes for 87 preimplementation patients, 40 patients during a partially implemented program, and 80 patients during a fully implemented program.

RESULTS: When compared with preimplementation patients, full implementation program patients did not demonstrate a statistically significant difference in median length of stay on the medical/surgical unit after transfer from the PICU (median: 6 vs 8 days; $P = .07$). Patients in the full implementation group received fewer days of parenteral nutrition (median: 0 vs 6 days; $P = .0006$) and had fewer planned and unplanned laboratory studies on the inpatient unit. There was no statistically significant change in returns to the operating room ($P = .08$ between preimplementation and full implementation), other complications, or 30-day readmissions. Median hospital costs increased from preimplementation ($59 372) to partial implementation ($89 302) and remained elevated during full implementation ($81 651) compared with preimplementation ($P = .004$). Mean physician costs followed a similar trajectory from preimplementation ($18 425) to partial implementation ($24 101) to full implementation ($22 578; $P = .0006$ [versus preimplementation]).

CONCLUSIONS: A hospitalist comanagement program can significantly affect the care of medically complex children undergoing spinal fusion surgery. Initial program costs may increase.

Hospitalized children, including those undergoing elective surgery, are becoming more complex.[1–4] Although the definition of "medically complex" children may vary, these patients likely represent a heterogeneous population at risk for intraoperative and postoperative complications.[5]

Comanagement of adult surgical patients between surgeons and hospitalists has become common.[6] In 1997, 44% of adult and pediatric hospitalists reported performing this role,[7] whereas by 2006, this percentage had almost doubled.[8] Although there has been some controversy regarding adult comanagement,[9] these issues have generally not arisen in pediatrics.

Comanagement offers several proposed benefits over "traditional" consultation. Comanagement allows the medical provider to write orders and consult a third service, which may streamline care via consultation of proper subspecialists, coordinating communication, and facilitating implementation of medical management changes.[10] Comanagement of adult orthopedic patients has shown reduced complications,[11,12] reduced length of stay (LOS),[13] and increased surgeon and nurse satisfaction.[11] A study of comanagement of adult neurosurgery patients found no changes in outcomes but did report reduced hospital costs and nurses' perception that care had improved.[14]

Data about comanagement of children undergoing surgery, especially medically complex children, are sparse. One study of 14 children undergoing spinal fusion for neuromuscular scoliosis suggested that comanagement may reduce LOS.[15] Nurses seem to strongly support pediatric hospitalist comanagement of medically complex children.[16]

We describe a pediatric hospitalist comanagement program at a children's hospital and associated clinical and cost outcomes.

METHODS

We conducted a retrospective chart review of patients cross-sectionally sampled during implementation of a hospitalist comanagement program. We chose patients undergoing spinal fusion surgery because many are medically complex and are at high risk for postoperative complications.

Setting/Background

Alfred I. duPont Hospital is a 200-bed, freestanding children's hospital with ~1800 orthopedic admissions per year. Of the 10 orthopedic surgeons at the hospital, 6 operate on medically complex patients. Analysis of a sentinel event in a medically complex patient after spinal fusion surgery prompted this program's development. An interdisciplinary group including orthopedic surgeons, pediatricians, anesthesiologists, hospital administrators, and nurses met regularly during 2005 and 2006 to develop this program.

Definition of Medically Complex Patients

This interdisciplinary group defined medically complex patients as those in whom at least 1 of the following applies[17]: (1) chronic medical problem (defined broadly as any medical problem requiring chronic medication or ongoing medical supervision); (2) technology dependence; (3) ≥2 chronic prescription medications; and (4) spastic quadriplegia.

Patients defined as medically complex received hospitalist comanagement after undergoing any elective orthopedic surgery, including spinal fusion surgery; however, only spinal fusion patients were studied.

Hospitalist Comanagement Program Structure

The comanagement program was implemented in 3 stages; in all phases, neuromuscular scoliosis patients were seen by a nurse practitioner and an anesthesiologist in the presurgical care center 1 to 2 weeks before surgery. Surgeries for all 3 groups were performed by the same group of 6 orthopedic surgeons.

Preimplementation Group

The preimplementation group included patients whose surgery occurred during the 30 months before the onset of the hospitalist program in September 2005. Preimplementation patients underwent routine operative care and postoperative care in the PICU by the critical care team. When patients were transferred to the medical/surgical unit, postoperative care was provided by the orthopedic team unless specific problems required a medical consultation with a general academic pediatrician or a subspecialist.

Partial Implementation Group

The second group consisted of patients managed during a developmental phase from September 2005 through June 2006 before the hospitalist program was fully staffed. Three pediatric hospitalists and a nurse practitioner began seeing medically complex patients postoperatively after transfer from the PICU to the medical/surgical inpatient unit. During this phase, a hospitalist was not consistently assigned to comanage medically complex patients. Hospitalists were not routinely aware of patients before the day of surgery. Hospitalists typically left the hospital at 5 PM and did not necessarily see patients daily.

Full Implementation Group

The third group represented patients managed by a full complement of 6 pediatric hospitalists from July 2006 through March 2008. In this program, hospitalists coordinated care of comanaged patients with the presurgical care center, anesthesiology, critical care, medical subspecialties, nursing, and dietitians before and after surgery. Selected cases were discussed at preoperative conferences. A hospitalist was dedicated to see medically complex patients during weekday hours and made rounds daily with the orthopedic team. A dedicated nurse practitioner worked 4 days per week with the comanaging hospitalist. On weekends, these patients were seen by the hospitalist on service for general pediatrics inpatients. Hospitalists were in-house until midnight Monday through Friday and 8 PM on weekends and were available for emergent issues at all hours. Patients underwent routine operative care and were initially managed postoperatively in the PICU by the critical care team; hospitalists communicated with PICU staff but did not actively manage these patients in the PICU.

After transfer to the medical/surgical inpatient unit, hospitalists actively managed patients' medical issues in coordination with the orthopedic service and consulted medical or surgical subspecialists as appropriate. Hospitalists placed nearly all orders involving nutrition, medications, and laboratory and radiology studies; orthopedic residents or nurse practitioners typically placed orders regarding patient mobility, physical therapy, and wound care. Orthopedic residents or nurse practitioners completed discharge paperwork. This model included a dedicated pager for the comanaging hospitalist, a mechanism for placing medically complex consultations in our electronic medical record (EMR), daily formal hospitalist/orthopedics rounding, weekly discussion of upcoming cases, and education for nurses and orthopedic residents. Hospitalists received education about spinal fusion surgery through lectures, case discussions with orthopedic surgeons, and literature review. Hospitalists provided feedback to each other about selected cases.

Study Procedure

This was a retrospective case series study of patients with neuromuscular scoliosis who underwent spinal fusion surgery at Alfred I. duPont Hospital for Children from February 2003 through March 2008. The hospital institutional review board approved the study.

During 2009 through 2011, 6 pediatric hospitalists reviewed charts of spinal fusion patients seen from 2003 through 2008. We identified patients in the preimplementation group according to *International Classification of Diseases, Ninth Revision* codes (737.3 and 737.4); we reviewed the EMR to confirm these patients had neuromuscular scoliosis and were "medically complex." The intervention groups were likewise identified according to these codes.

Data Collection and Analysis

Baseline clinical data and intraoperative data were collected by using a standardized data collection tool to review the EMR and paper charts. We used medically complex consultations performed by hospitalists either in the PICU or on the medical/surgical unit and operative notes as primary data sources. Parental report about baseline clinical data, obtained during hospitalist consultation, was considered definitive. If parents were unavailable in person, hospitalists contacted parents by telephone or obtained data from the EMR. Data abstractions were performed with all reviewers working from standardized definitions. The primary outcome measured was total LOS. Spearman correlations were used to evaluate the association between LOS and anesthesia time and operative time.

Clinical outcomes were uniformly defined by 6 hospitalist chart reviewers by using a structured data collection tool with standardized definitions. These reviewers were those hospitalists who participated in the comanagement program. To ensure interrater reliability, all 6 chart reviewers reviewed 10 charts as a group and altered the collection tool until consensus was achieved. To measure complications, we collected data on postoperative pneumonias, urinary tract infections (UTIs), central line infections, pancreatitis, and increased seizure activity. Postoperative pneumonia was defined as a pathogen obtained from a respiratory culture or appearance of a new chest radiograph consolidation with fever and respiratory symptoms. UTI was defined as a fever and single pathogen of >20 000 colony-forming units from catheterized urine or any growth with clinical symptoms attributed to a UTI. Central line infection was defined as a pathogen grown from a line culture or >1 positive culture result of skin flora from a central line or other blood sample. Pancreatitis was diagnosed if the lipase level exceeded 3 times the upper limit of normal. Unplanned changes in antiepileptic drugs (AEDs) were defined as seizure medication adjustments due to seizure activity, not due to "nothing by mouth" status. As a marker of resource utilization, the number of sodium measurements and unplanned studies performed on the medical/surgical unit were counted. We chose sodium as an arbitrary marker of laboratory studies because it is typically part of both a basic and a comprehensive metabolic panel, either of which is often checked postoperatively. Unplanned studies included radiologic studies, electrocardiograms, or other studies excluding routine postoperative scoliosis films. An emergent consultation was one that was ordered and occurred between 6 PM and 8 AM for an acute problem.

Patients' baseline preoperative and intraoperative data and postoperative outcomes were analyzed by using STATA software (College Station, TX) version 12. The Student *t* test for interval data and χ^2 for nominal data were used for analysis. For nonnormally distributed data, we calculated medians and interquartile ranges (IQRs) and used standard nonparametric analyses. Cost data were obtained from our financial services department. Because we were unable to separate total PICU costs from total medical/surgical inpatient costs due to accounting limitations, costs for patient care were those of the entire hospitalization. Costs included direct, indirect, variable, and fixed costs. All costs were adjusted to 2008 dollars by using the Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.[18]

RESULTS

A total of 207 medically complex patients with neuromuscular scoliosis underwent spinal fusion surgery between March 2003 and March 2008. The preimplementation group included 87 patients before hospitalist involvement. The partial implementation group included 40 patients from September 2005 through June 2006. The full implementation group included 80 patients from July 2006 through March 2008.

Presurgical and intraoperative patient characteristics are summarized in Table 1. Patients in the 3 groups were statistically similar in terms of underlying disease, number and types of comorbid conditions, number of preoperative medications, and dependence on medical technology. Compared with the preimplementation group, there was a statistically significant difference in mean BMI, with the full implementation patients having the highest (18.4 vs 17.6; $P = .05$). Other statistically significant differences included anesthesia time (55 minutes between full implementation [median: 480 (IQR: 320–760)] and preimplementation [median: 425 (IQR: 295–652)]; $P = .01$) and surgery time (92 minutes between full implementation [median: 390 (IQR: 209–667)] and preimplementation [median: 298 (IQR: 191–520)]; $P = .001$).

Clinical outcomes are shown in Table 2. Overall median LOS (14 days for full implementation vs 15 days for preimplementation; $P = .95$) was similar between the 2 groups. However, full comanagement patients showed a statistically significantly higher median PICU LOS (5 days for full implementation [IQR: 1–24] vs 4 days for preimplementation [IQR: 1–14]; $P = .03$). Full comanagement was not associated with a statistically significant change in median inpatient unit LOS (6 days for full implementation [IQR: 2–19] vs 8 days for preimplementation [IQR: 3–26]; $P = .07$). There were no deaths.

Secondary outcomes included duration of aspects of care, resource utilization, complications, and costs. Full implementation patients demonstrated a median of 0 day (IQR: 0–17) receiving total parenteral nutrition versus preimplementation patients who received a median of 6 days (IQR: 0–25; $P < .0006$). There were no significant differences in Foley catheter days or central venous line days. Patients in the full implementation group were statistically significantly more likely to receive more days of oxygen (6.5 days [IQR: 0–20] vs 5 days [IQR: 0–14]) and days of BiPAP (0 day [IQR: 0–14] vs 0 day [IQR: 0–0]) longer ($P = .04$ for both variables compared with preimplementation).

In terms of resource utilization, there were several statistically significant differences between the full implementation and preimplementation groups. Full implementation patients showed a statistically significant decrease in median number of sodium levels checked on the medical/surgical unit (3 [IQR: 0–9] vs 5 [IQR: 0–19]; $P = .0002$) and unplanned studies on the medical/surgical unit (0 [IQR: 0–8] vs 2 [IQR: 0–8]; $P = .0005$).

In terms of complications, there were no statistically significant differences in numbers of patients who developed pancreatitis, pneumonia, UTIs, central venous line infections, or who required emergent consultations, unplanned seizure medication change, return to PICU, or 30-day readmission. Full implementation patients did not show a statistically significant change in rate of return to the operating room (1.3% vs 8.0%; $P = .08$). Clinical trends of selected variables per program year are depicted in Fig 1.

There was no statistically significant correlation between length of anesthesia and total LOS ($P = .93$), PICU LOS ($P = .64$), or medical/surgical unit LOS ($P = .50$) for the overall population or for any group. Surgical time likewise showed no correlation with total LOS ($P = .83$), PICU LOS ($P = .84$), or medical/surgical unit LOS ($P = .82$).

Cost data are summarized in Table 3. We found that median hospital costs increased from the preimplementation phase ($59 372 [IQR: 32 334–150 510]) to the partial implementation phase ($89 302 [IQR: 55 699–225 432]) and then declined somewhat during the full implementation phase ($81 651 [IQR: 41 644–162 710]). The full implementation group showed a statistically significant increase in total hospital costs

TABLE 1 Baseline and Intraoperative Characteristics of Patients in Each Group

Characteristic	Preimplementation (2003–September 2005) ($n = 87$)	Partial Implementation (September 2005–June 2006) ($n = 40$)	Full Implementation (July 2006–March 2008) ($n = 80$)
Demographic			
Gender, female	43 (49)	18 (45)	42 (53)
Age, y	13.6 ± 3.7	13.2 ± 3.7	13.7 ± 3.4
Preoperative medical status			
Underlying disease			
Cerebral palsy	51 (59)	24 (60)	53 (66)
Neuropathy	5 (5.7)	3 (7.5)	2 (2.5)
Myopathy	9 (10)	2 (5.0)	7 (8.8)
Metabolic disorder	1 (1.1)	1 (2.5)	0
Skeletal dysplasia	3 (3.4)	1 (2.5)	2 (2.5)
Spina bifida	1 (1.1)	0	1 (1.3)
Genetic disorder	10 (11)	6 (15)	10 (13)
Other	7 (8.0)	3 (7.5)	7 (8.8)
BMI, mean*	17.6 ± 4.5	17.4 ± 4.7	18.4 ± 5.5
Absolute largest curve	72.5 ± 23	69.9 ± 20	66.0 ± 22
No. of preoperative medications	3 (0–12)	2 (0–7)	3.5 (0–11)
Institutionalized	9 (10)	5 (12.5)	5 (6.3)
Nonverbal	37 (43)	22 (55)	46 (58)
Nonambulatory	54 (62)	25 (63)	59 (74)
Seizure disorder	43 (49)	20 (50)	38 (48)
Ventriculoperitoneal shunt	3 (3.4)	4 (10)	10 (13)
Asthma	38 (44)	16 (40)	33 (41)
History of hospitalized pneumonia	29 (33)	11 (28)	29 (36)
Daily home oxygen requirement	7 (8.0)	5 (12.5)	5 (6.3)
Tracheostomy	6 (6.9)	3 (7.5)	8 (10)
Home mechanical ventilation (not BiPAP)	5 (5.7)	3 (7.5)	5 (6.3)
Full oral feeder	54 (62)	25 (63)	50 (63)
Operative data			
Surgery type			
Posterior fusion	72 (83)	37 (93)	70 (88)
Anterior/posterior fusion	12 (14)	2 (5.0)	7 (8.8)
Growing rod	3 (3.4)	1 (2.5)	3 (3.8)
Anesthesia time, min**	425 (295–652)	486 (335–653)	480 (320–760)
Surgery time, min***	298 (191–520)	354 (239–565)	390 (209–667)
Estimated blood loss, mL	1685 (300–7026)	2544 (700–5000)	2626 (400–6450)
Red blood cells transfused, mL	922 (0–2618)	1272 (564–2257)	1102 (0–2902)
Fresh frozen plasma transfused, mL	282 (0–1202)	540 (0–1164)	386 (0–1536)
Cell saver transfused, mL	250 (0–1375)	250 (0–1000)	375 (0–1750)
Platelets transfused, mL	0 (0–407)	0 (0–353)	0 (0–413)

Data are presented as *n* (%), median ± SD, or median (IQR). *P* values among all groups were >.05 except for those noted. The Kruskal-Wallis test was used to compare medians among the 3 groups.
* *P* value for 3 groups = .05.
** *P* value for 3 groups = .01.
*** *P* value for 3 groups = .001.

compared with the preimplementation group ($P = .0004$). General pediatrics physician costs referred to those associated with general academic pediatricians before the hospitalist program and those associated with hospitalists after implementation. These costs increased from a median of \$0 (IQR: 0–2115) in the preimplementation group to \$1287 (IQR: 374–4096) in the full implementation group ($P < .00001$). Subpecialty physician costs showed no statistically significant change between the preimplementation group and the full implementation group ($P = .24$). Inpatient nursing, radiology, and pharmacy costs also showed no statistically significant change.

DISCUSSION

This is the first large study of pediatric hospitalist comanagement of medically complex orthopedic patients. Our comanagement program was developed in response to a sentinel event in a high-risk, medically complex patient. Even among this population, these types of events are relatively rare, however,

TABLE 2 Clinical Outcome Data for the Study Groups

Characteristic	Preimplementation (*n* = 87)	Partial Implementation (*n* = 40)	Full Implementation (*n* = 80)	*P* Full Implementation Versus Control
LOS				
Total LOS				
Median (IQR)	15 (5–37)	17 (8–28)	14 (6–40)	.95
Mean ± SD	18.1 ± 23.6	19.6 ± 13.6	16.7 ± 13.2	.34
PICU LOS				
Median (IQR)	4 (1–14)	6 (2–10)	5 (1–24)	.03
Mean ± SD	6.3 ± 13	6.2 ± 3.6	7.5 ± 8.1	.68
Inpatient unit LOS				
Median (IQR)	8 (3–26)	8 (3–17)	6 (2–19)	.07
Mean ± SD	10.8 ± 13.4	12.4 ± 13.0	8.2 ± 9.6	.06
Duration of aspects of care				
Days to any enteral feeds				
Median (IQR)	4 (1–12)	5 (2–9)	3 (1–11)	.16
Mean ± SD	5.1 ± 3.6	4.9 ± 2.7	4.2 ± 3.0	.03
Parenteral nutrition days				
Median (IQR)	6 (0–25)	6 (0–14)	0 (0–17)	.0006
Mean ± SD	8.2 ± 13.6	5.9 ± 5.4	4.1 ± 6.0	.03
Foley catheter in place, days				
Median (IQR)	4 (1–14)	5 (2–11)	5 (2–16)	.14
Mean ± SD	6.0 ± 10.8	6 ± 3.9	6.2 ± 6.0	.99
Oxygen days				
Median (IQR)	5 (0–14)	5 (1–14)	6.5 (0–20)	.04
Mean ± SD	8.0 ± 19.3	6.9 ± 5.6	8.1 ± 8.4	.92
BiPAP days				
Median (IQR)	5 (0–14)	5 (1–14)	6.5 (0–20)	.04
Mean (SD)	1.6 ± 5.4	2.6 ± 8.9	2.2 ± 4.9	.48
Central line in place, days				
Median (IQR)	0 (0–0)	0 (0–7)	0 (0–14)	.04
Mean ± SD	14.0 ± 25.3	13.1 ± 5.2	12.0 ± 9.3	.13
Postoperative resource use				
Consults requested in PICU				
Median (IQR)	11 (0–30)	14 (7–20)	11 (0–33)	.92
Mean ± SD	1.7 ± 1.6)	1.9 ± 0.3	1.9 ± 0.3	.32
Consultations requested, inpatient unit				
Median (IQR)	2 (1–2)	2 (2–2)	2 (2–2)	.45
Mean ± SD	1.1 ± 1.5	1.7 ± 1.1	1.4 ± 0.8	.06
Sodium levels checked, inpatient unit				
Median (IQR)	1 (0–4)	1 (1–3)	1 (1–3)	.0004
Mean ± SD	6.4 ± 6.3	6.2 ± 6.1	3.6 ± 3.6	.0001
Postoperative complications, inpatient unit, Number				
Pancreatitis	33 (38)	19 (48)	35 (44)	.55
Pneumonia	2 (2.3)	2 (5.0)	5 (6.3)	.44
UTI	5 (5.7)	3 (7.5)	5 (6.3)	.93
Line infection rate/1000 d	12.1	9.8	8.0	.26
Emergent consultation	4 (4.6)	2 (5.0)	7 (8.8)	.51
Unplanned AED change	12/46 (26)	3/24 (13)	5/35 (14)	.26
Unplanned studies, inpatient unit	2 (0–8)	3 (0–13)	0 (0–8)	.0005
Return to PICU	6 (6.9)	3 (7.5)	2 (2.5)	.35
Return to operating room	7 (8.0)	4 (10)	1 (1.3)	.08
30-d readmission rate	14 (16.1)	8 (20)	10 (12.5)	.55

Data are presented as median (IQR), mean ± SD, or *n* (%). *P* values are for full intervention group versus preimplementation. Unplanned AED changes were analyzed only for patients taking seizure medications.

and assessments for statistically significant changes in risk are difficult. In this study, we used several data points such as parenteral nutrition days as proxies for clinical variation to better understand the impact of a hospitalist comanagement program among medically complex patients. There was a statistically significant association between

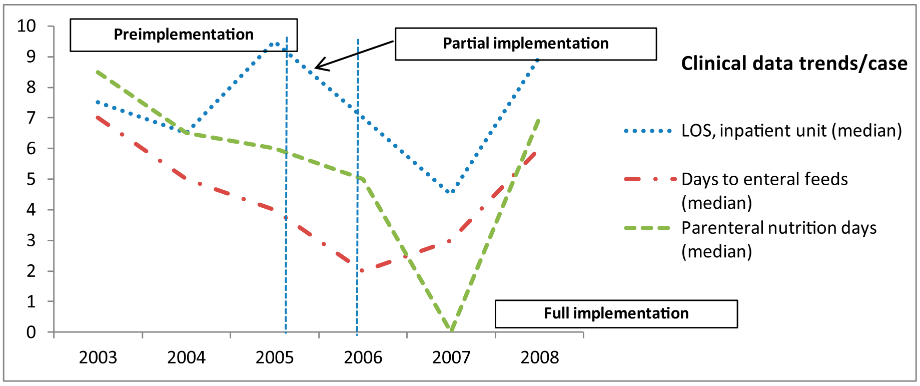

FIGURE 1 Trends in selected clinical variables per patient over time by year. Data are presented as medians. The year 2008 data included 10 patients only.

full comanagement and decreased use of parenteral nutrition and laboratory studies. We found no statistically significant change in medical/surgical unit LOS. We also found that costs associated with a comanagement program may increase.

The baseline differences between the intervention groups versus the preimplementation group are interesting. The longer anesthesia and surgery times suggest that these patients may have been more surgically complex. The longer PICU LOS and PICU nursing costs in the full implementation group are also interesting and may relate to increased surgical complexity. Limitations in financial accounting precluded our ability to distinguish total PICU costs from those on the medical/surgical unit, although PICU costs likely represented a significant portion of total hospital costs in this group. There were no significant changes in surgical or perioperative approaches to our knowledge during this time. Surgeries were performed by the same group of orthopedic surgeons in all 3 groups.

Our data expand the findings of Simon et al,[15] who first studied pediatric hospitalist comanagement in this population. When compared with the data of Simon et al, our population's longer LOS suggests differences in our patient population or our delivery system. Our results also suggest that a comanagement program may exert its impact differently over time. The partial implementation group showed no changes in clinical outcomes and was associated with increased costs. When measured over time, however, resources such as laboratory studies and LOS showed decreasing trends; yet, in a limited number of patients in 2008, these trends seemed to reverse somewhat ($n = 10$). The impact of hospitalist comanagement on returns to the operating room is uncertain. Perhaps comanagement improves antimcrobial management or patients' nutritional status. Our data also suggest that variation in inpatient LOS was reduced (Table 2), which suggests that hospitalist comanagement may lead to a more standardized approach.

TABLE 3

Financial Outcome	Pre-Intervention ($n = 90$)		Partial Implementation ($n = 46$)		Full Implementation ($n = 89$)		*P* value
	Mean	SD	Mean	SD	Mean	SD	
Hospital Costs							
OR Cost	18 117	3240	20 887	10 546	13 770	7415	<.00001
Anesthesia Cost	988	134	1131	341	685	350	<.00001
PICU RN Cost	13 411	2727	15 881	27	10 508	5868	<.00001
Floor RN Cost	9875	3403	13 887	886	8367	3978	.007
Lab (Total) Cost	7512	811	9273	236	2882	4871	<.00001
Radiology Cost	1645	297	1635	185	979	488	<.00001
Pharmacy Cost	5781	2335	8398	2762	4327	2415	.0001
Total Hospital Cost/Admission	57 969	5270	74 593	11 523	44 890	25 390	<.00001
Physician Costs							
Anesthesiology	3330	2184	3781	732	2312	1075	.0001
Critical care	1494	532	2126	504	1140	596	<.00001
Orthopedics	10 162	346	12 139	2320	7609	3457	<.00001
Radiologist	165	118	318	115	153	88	.44
General Pediatrics	250	80	571	229	821	190	<.00001
Total Subspecialty Cost	1509	702	1488	976	612	383	<.00001
Total MD Cost/Admission	17 150	2610	21 526	2390	13 403	5823	<.00001

The types of costs that hospitalists might be expected to directly impact (such as medical/surgical nursing costs and pharmacy costs) showed no significant change in the full implementation group compared with the preimplementation group, despite the former requiring more operative and PICU resources. The fact that subspecialty costs did not significantly change in contrast to other physician costs (except critical care), suggests that hospitalists may have performed some roles previously played by subspecialists. Laboratory costs, however, showed a statistically significant increase between preimplementation patients and full implementation patients. We did not include costs associated with readmissions in our analysis. Net costs of the hospitalist program itself have been estimated at $133 760 per year (Appendix).

We surmise that costs may initially increase due to hospitalists' inexperience, nurses and families' unfamiliarity with a new care paradigm, and/or inadequate staffing. Hospitalist experience has been shown to be important in improving care of general medical inpatients.[19] Appropriate staffing ensures that a hospitalist has sufficient time to manage these complex patients. Hospitalists and other providers must become familiar with these patients' unique management issues and develop strong working relationships.[18]

Several limitations of this study deserve note. It was performed at 1 institution with 1 group of orthopedic surgeons and 1 group of hospitalists. The same hospitalists involved in the clinical program performed data analysis. It was retrospective and nonrandomized. We also did not test post hoc interrater reliability. The study's retrospective nature precluded our ability to study patient or family satisfaction. Despite this being the largest study of pediatric comanagement of medically complex patients, our sample size remained relatively small, and results may be skewed by extreme values. Small sample sizes limited our power to detect the observed difference in LOS on the medical/surgical unit as statistically significant (76% power). We believe that this type of program has not been well studied partly because of these complexities.

Since this study's completion, hospitalists at our institution have begun preoperative evaluations of medically complex surgical patients. Future studies will hopefully assess this intervention's impact.

CONCLUSIONS

A pediatric hospitalist comanagement program for medically complex patients may be associated with reduced variation in certain clinical outcomes. Physician and hospital costs could initially increase.

APPENDIX: ANNUAL PROGRAM COSTS

Comanagement hospitalist annual salary = $125 000/full time hospitalist × 1.2[a] = $150 000

Nurse practitioner annual salary[b] = $75,000 × 0.8 time = $60 000

Liability costs = $7300 per full-time hospitalist × 1.2 = $8760

Estimated administrative costs + benefits = $10,000

Total costs = $228 760

Annual Program Revenue

Estimated revenue for hospitalists seeing medically complex patients = $95 000

Net annual program cost to hospital = $133 760

[a] Hospitalist salaries and administrative costs were paid for by the Department of Pediatrics. Coverage for medically complex patients was calculated as follows. A full-time hospitalist works 47 weeks per year and 14 weekends per year (or 2000 hours per year):

- Weekdays: 52 weeks/47 weeks per hospitalist = 1.1 full-time equivalent for weekdays
- Weekends: 4 hours/weekend spent on medically complex patients × 38 weekends = 152 hours/2000 = 0.1 full-time equivalent
- Total = 1.2 full-time hospitalists

[b] The nurse practitioner salary was split between the Department of Orthopedics and the Department of Pediatrics. The nurse practitioner cared for medically complex patients ~80% of the time and general orthopedics patients ~20% of the time.

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