

ORIGINAL RESEARCH

Pediatric Hospitalist Preoperative Evaluation of Children With Neuromuscular Scoliosis

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WHAT'S NEW: This is the first study of a pediatric hospitalist preoperative clinic. Pediatric hospitalists frequently make significant recommendations for patients with neuromuscular scoliosis prior to spinal surgery, especially those with medical complexity. Certain clinical criteria are statistically significantly associated with a hospitalist making a preoperative recommendation.

OBJECTIVE: To assess (1) how frequently pediatric hospitalists make recommendations when evaluating preoperative neuromuscular scoliosis patients in anticipation of spinal fusion surgery and (2) evaluate if any clinical characteristics are associated with a higher likelihood of hospitalists doing so.

METHODS: We performed a case series study using retrospective chart review of 214 patients scheduled for spinal fusion surgery for neuromuscular scoliosis from November 2009 through September 2012.

RESULTS: We analyzed data for 214 patients aged 1 to 20 years (median, 13 years), of whom 155 (72%) received at

least 1 specific preoperative recommendation, whereas 59 patients (28%) were cleared for surgery without specific recommendations. Underlying diagnosis ($P = 0.024$), nonambulatory status (odds ratio [OR]: 2.02, 95% confidence interval [CI]: 1.09-3.74), and increased number of preoperative medications (OR: 1.19, 95% CI: 1.06-1.34) were statistically significantly associated with an increased rate of receiving preoperative recommendations from the hospitalist. Comorbidities such as seizure disorder (OR: 2.68, 95% CI: 1.29-5.57) and gastrointestinal conditions (OR: 3.35, 95% CI: 1.74-6.45) were also statistically significantly associated with specific presurgical recommendations being made by the pediatric hospitalist.

CONCLUSION: A pediatric hospitalist preoperative program for children with neuromuscular scoliosis in anticipation of spinal fusion surgery is associated with a high rate of recommendations being made, especially in children with certain clinical characteristics. *Journal of Hospital Medicine* 2013;8:684-688. © 2013 Society of Hospital Medicine

Pediatric hospitalists are increasingly following their adult counterparts' lead in participating in comanagement programs with surgeons. In the 2011-2012 Society of Hospital Medicine survey of hospitalist practice models, 94% of adult hospitalists and 72% of pediatric hospitalists reported comanaging surgical patients.¹ Adult patients comanaged postoperatively have shown equivalent clinical outcomes with strong endorsement from nurses and surgeons in 1 study² and reduced morbidity, mortality, and length of stay in other studies.^{3,4}

One of the drivers of pediatric hospitalists comanaging surgical patients may be the increased complexity of hospitalized children.⁵⁻⁸ Two pediatric studies have assessed hospitalist-surgeon comanagement of medically complex children in the postoperative period. One study evaluating 14 patients undergoing spinal

fusion surgery for neuromuscular scoliosis showed an association between pediatric hospitalist comanagement and a decreased length of stay, with decreased variability in postoperative length of stay.⁹ A study of 207 medically complex children undergoing spinal fusion surgery for neuromuscular scoliosis suggested an association between comanagement and reduced laboratory studies and parenteral nutrition but an initial increase in costs.¹⁰

Pediatric hospitalist programs have also followed adult programs' lead in evaluating surgical patients preoperatively. Studies of preoperative medical evaluations for adult surgical patients have reported mixed results, with improved use of recommended medical therapies, length of stay, and mortality postoperatively in 1 study,¹¹ whereas other studies have reported longer lengths of stay and higher costs.^{12,13} One adult study described a protocol-based approach in which hospitalists coordinated pulmonary and cardiac evaluations for high-risk spine patients but did not report any outcomes.¹⁴ A pediatric study from the Netherlands described a multidisciplinary team approach to these patients, including both preoperative and postoperative evaluation, but did not include a hospitalist or general pediatrician nor present data on outcomes.¹⁵

In 2009, we began a hospitalist preoperative evaluation program for patients with neuromuscular

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scoliosis in anticipation of spinal fusion surgery. This program was established by the hospital administration in response to 2 sentinel events. Hospitalists, who had already begun comanaging surgical patients postoperatively, were required to see patients with neuromuscular scoliosis preoperatively. Hospitalists were felt to be knowledgeable about postoperative complications of spinal fusion surgery and were thought to perhaps be able to prevent certain postoperative complications.

In the current study, we sought to evaluate certain outcomes associated with this preoperative program. We hypothesized that evaluations for more complex patients would be more likely to be associated with preoperative changes. We evaluated how frequently hospitalists make recommendations for changes in patients' medical regimens or request further diagnostic evaluations and if any clinical characteristics were associated with hospitalists making these recommendations.

METHODS

Setting/Program Structure

We conducted a retrospective chart review of all 214 patients with the diagnosis of neuromuscular scoliosis who were seen for a preoperative evaluation by a pediatric hospitalist at our institution from November 2009 through September 2012. Nemours/AI duPont Hospital for Children is a 200-bed freestanding children's hospital with 11 pediatric orthopedic surgeons, 5 of whom perform spinal fusion surgery on patients with neuromuscular scoliosis. Our hospitalist group consists of 6 hospitalists, all of whom rotate on the medically complex comanagement service for 1 week at a time. The hospitalist who was assigned to the medically complex comanagement service for the week saw both postoperative patients and an average of 1 to 2 preoperative patients that week. All patients with neuromuscular scoliosis who were scheduled for spinal fusion surgery were seen preoperatively by a hospitalist. These patients included any with an underlying diagnosis of cerebral palsy, myopathy, skeletal dysplasia, or syndrome such as neurofibromatosis. Patients who were scheduled for spinal fusion surgery were referred to the hospitalists via the orthopedic scheduling department or perioperative services. These patients were typically seen in the general pediatrics outpatient area or in the outpatient orthopedics area of the hospital 1 to 2 months prior to surgery. The goal of the preoperative visit was to ensure patients were evaluated thoroughly before surgery. Hospitalists were given authority to delay or even cancel surgery, though in no case in this study was surgery cancelled. Hospitalists were responsible for following up on consultations and further studies obtained before surgery. Patients with a Cobb angle of more than 90° were by policy referred to pulmonology and cardiology for a preoperative evaluation.

Further testing in those domains, such as pulmonary function testing or echocardiograms, was at the discretion of the appropriate specialist.

Study Procedure

After receiving approval from the hospital institutional review board, we performed a case series study. Three investigators (D.R., S.C., and D.P.) reviewed the preoperative visit note for each patient. We identified all patients who had spinal fusion surgery for neuromuscular scoliosis via International Classification of Diseases, 9th Revision (ICD-9) codes, including that for neuromuscular scoliosis, and reviewed the patients' charts for preoperative visits. We used the preoperative note from the hospitalist as the definitive source for clinical information about the patient such as underlying diagnosis or etiology of the neuromuscular scoliosis. We used a structured data abstraction form to collect data regarding patient demographics, date of visit, time to surgery, type of surgery, number of standing daily (not as-needed) preoperative prescription medications, and dependence on medical technology. We defined seizure disorder as present when a patient was taking standing prescription medication for seizures or had been recommended to take standing medication for seizures.

We recorded patient comorbidities related to the gastrointestinal, cardiac, and pulmonary systems. Prior to chart review, we agreed on standard definitions for significant problems in these arenas. We defined a significant problem as one in which a standing prescription medication was required, medical technology was required, or a subspecialist was consulted on a regular basis. To establish inter-rater reliability using this definition, the 3 investigators independently reviewed an initial series of 5 charts. Inter-rater reliability was established at 90%.

Main Outcome Measures

We recorded whether the hospitalist made any preoperative recommendations. Recommendations were categorized as: change in medication, changes in nutrition, laboratory or imaging studies, other diagnostic tests, or subspecialty referral. We defined a medication change as any change that involved a new prescription medication to be used on a standing basis, a change in dosing to a standing prescription medication, or the discontinuing of a standing prescription medication. We did not include changes in medications used on an as-needed basis. We also recorded whether the hospitalist made any recommendations regarding further preoperative evaluation such as laboratory studies, imaging studies, other studies, or consultation with a subspecialist. We did not include laboratory studies that are routinely obtained preoperatively such as coagulation studies or blood count. We then recorded whether the hospitalist contacted a subspecialist or

TABLE 1. Types of Preoperative Recommendations Made by the Hospitalist

Type of Recommendation	n (%)
Changes in regimen	
Medication change (start new, discontinue, change dose)	82 (38%)
Nutrition modification	46 (21%)
Further diagnostic evaluation	
Laboratory studies	41 (19%)
Imaging studies	11 (5%)
Pulmonary function tests	6 (3%)
Electrocardiograms	6 (3%)
Referral to or contacted subspecialist	76 (36%)

NOTE: Some patients received multiple recommendations.

requested that an evaluation be done by that subspecialist prior to surgery.

Analysis

We used Stata 12 software (StataCorp, College Station, TX) to conduct all analyses. We used frequencies to describe categorical variables. Linear variables were not normally distributed and were therefore described using median and interquartile range. We calculated the simple, unadjusted odds ratio (OR) (95% confidence interval [CI]) of the hospitalist making a recommendation during the preoperative visit based on each variable. We defined statistical significance as a *P* value <0.05.

RESULTS

Overall, 214 patients were included in our study. Typical patients included those with cerebral palsy scheduled to undergo posterior spinal fusion surgery. Many had significant comorbidities, including seizures and gastrointestinal (GI) disease, and were dependent on medical technology.

Regarding hospitalist recommendations, overall 155 patients (72%) received at least 1 recommendation. Types of recommendations are listed in Table 1. The most common type of recommendation regarding the patient's current regimen was medication change (82 patients, 38%). Recommendations for changes in nutrition were made in 46 patients (21%). Subspecialist input was elicited in 76 patients (36%); a subspecialist appointment was suggested most commonly (36 patients, 17%), whereas a telephone consultation occurred in 15 patients (7%). Hospitalists also frequently requested further diagnostic evaluation, especially laboratory studies (41 patients, 19%). Imaging studies were requested less frequently (11 patients, 5.1%) as were other studies such as electrocardiograms and pulmonary function tests (6 patients, 2.8%, each). No patient received a preoperative hospitalist recommendation to cancel or postpone surgery.

Certain patient characteristics were associated with a statistically significant increase in likelihood of a

preoperative intervention by the pediatric hospitalist (Table 2). These included type of surgery (OR: 2.70, 95% CI: 1.22-5.97 for posterior spinal fusion), number of preoperative prescription medications (OR: 1.19, 95% CI: 1.06-1.34), and nonambulatory status (OR: 2.02, 95% CI: 1.09-3.74). Underlying disease also showed a statistically significant association with recommendations being made; patients were more likely to receive recommendations if they had cerebral palsy (OR: 2.01, 95% CI: 1.03-3.92), spina bifida (OR: 2.33, 95% CI: 1.90-3.48), and neuropathy (all had recommendations). An underlying diagnosis of skeletal dysplasia was statistically significantly associated with a decreased rate of recommendations being made (OR: 0.29, 95% CI: 0.14-0.61). Patients with seizures (OR: 2.68, 95% CI: 1.29-5.57) or GI comorbidity were more likely to receive a preoperative recommendation made by the hospitalist (OR: 3.35, 95% CI: 1.74-6.45), but patients with cardiac and pulmonary comorbidities were not.

DISCUSSION

This is the first large study to examine the role of the pediatric hospitalist in preoperative evaluation of complex surgical patients. Our program developed as an evolution of a postoperative program that we have described previously.¹⁰ The postoperative component of our comanagement program began in 2003, and the preoperative aspect was added in 2009. We believe that the preoperative component to our program contributed in some degree to the decrease in utilization of certain aspects of postoperative care over time such as parenteral nutrition. This change may have occurred because of improved bowel management perioperatively, for instance. Although the preoperative hospitalist evaluation program was instituted by our hospital administration, we felt a preoperative hospitalist evaluation represented a standardized, comprehensive way to evaluate patients before surgery. By 2009, the hospitalists at our hospital had already developed some expertise in managing patients after undergoing spinal fusion surgery.

The fact that hospitalists made recommendations for changes in medications, nutritional management, or diagnostic tests at such a high rate (72%) is interesting. We were not surprised by this finding based on anecdotal evidence because we feel that many of these patients may receive somewhat fragmented care because they often see multiple medical specialists. The high rate of interventions noted in our study may result from the fact that hospitalists who comanage these patients frequently after spinal fusion surgery were attempting to prevent postoperative complications that they see after this type of surgery. Many pediatric hospitalists have developed significant experience in caring for medically complex children and thus may feel more comfortable making preoperative recommendations than other general pediatricians.

TABLE 2. Relationship Between Baseline Characteristics and Unadjusted Odds of a Recommendation for Patients Who Were Seen by a Hospitalist Preoperatively in Anticipation of Spinal Fusion Surgery (N = 214)

Characteristics	Number (%) or Median (IQR)	Recommendations?		
		Yes, n = 155	No, n = 59	Odds of Recommendation, OR (95% CI)
Demographics				
Gender, female	106 (50%)	77 (60%)	29 (49%)	0.97 (0.53-1.78)
Age, y	13 (10-16)	13 (10-16)	12 (10-16)	1.05 (0.98-1.12)
Year of visit				
2009	41 (19%)	32 (21%)	9 (15%)	Ref
2010	65 (30%)	47 (30%)	18 (30%)	0.73 (0.29-1.84)
2011	64 (30%)	43 (28%)	21 (36%)	0.58 (0.23-1.42)
2012	44 (21%)	33 (21%)	11 (19%)	0.84 (0.31-2.31)
Days from visit to surgery	34 (14-45)	35 (17-47)	27 (8-41)	1.02 (1.00-1.03)
Type of surgery*				
PSF	184 (86%)	139 (90%)	45 (76%)	2.70 (1.22-5.97)
Growing rod	9 (4.7%)	6 (4%)	3 (5%)	0.75 (0.18-3.11)
Cervical fusion	17 (7.9%)	9 (6%)	8 (13%)	0.39 (0.14-1.07)
Halo, then PSF	4 (1.9%)	1 (0.6%)	3 (5%)	0.12 (0.01-1.19)
Underlying disease*				
Cerebral palsy	78 (36%)	63 (41%)	15 (25%)	2.01 (1.03-3.92)
Neuropathy	4 (2%)	4 (3%)	0 (0%)	All had recommendations
Myopathy	19 (9%)	16 (10%)	3 (5%)	2.14 (0.60-7.66)
Metabolic disorder	6 (3%)	4 (3%)	2 (3%)	0.75 (0.13-4.23)
Skeletal dysplasia	38 (18%)	19 (12%)	19 (32%)	0.29 (0.14-0.61)
Spina bifida	7 (3%)	6 (4%)	1 (2%)	2.33 (1.90-3.48)
Genetic disorder (including osteogenesis imperfecta)	40 (19%)	28 (18%)	12 (20%)	0.86 (0.41-1.84)
Other	22 (10%)	15 (10%)	7 (12%)	0.79 (0.31-2.06)
Number of preoperative prescription medications				
Institutionalized	9 (4.2%)	6 (4%)	3 (5%)	0.75 (0.18-3.11)
Nonambulatory	114 (54%)	90 (59%)	24 (41%)	2.02 (1.09-3.74)
Dependence on technology*				
Feeding tube	89 (41.6%)	66 (43%)	23 (39%)	1.16 (0.63-2.14)
Baclofen pump	20 (9.3%)	18 (12%)	2 (3%)	3.74 (0.84-16.67)
Ventriculoperitoneal shunt	24 (11.2%)	18 (12%)	6 (10%)	1.16 (0.44-3.08)
Vagal nerve stimulator/deep brain stimulator	8 (3.7%)	6 (4%)	2 (3%)	1.15 (0.22-5.85)
Tracheostomy	13 (6.1%)	9 (6%)	4 (7%)	0.85 (0.25-2.86)
Home mechanical ventilation (not BiPAP)	6 (2.8%)	5 (3%)	1 (2%)	1.93 (0.22-16.90)
Home oxygen, BiPAP, or CPAP	25 (11.7%)	22 (14%)	3 (5%)	3.09 (0.89-10.73)
Seizure disorder	70 (33%)	59 (38%)	11 (19%)	2.68 (1.29-5.57)
Significant GI comorbidity	102 (48%)	86 (55%)	16 (27%)	3.35 (1.74-6.45)
Significant cardiac comorbidity	37 (17.3%)	26 (17%)	11 (19%)	0.88 (0.40-1.92)
Significant pulmonary comorbidity	78 (36.4%)	57 (37%)	21 (36%)	1.05 (0.56-1.97)

NOTE: Abbreviations: BiPAP, bilevel positive airways pressure; CI, confidence interval; CPAP, continuous positive airway pressure; GI, gastrointestinal; IQR, interquartile range; OR, odds ratio; PSF, posterior spinal fusion.

*Simple, unadjusted OR is presented for the odds of recommendation for the presence versus absence of each individual condition.

We were not surprised to find that hospitalists made preoperative recommendations more frequently in children who had seizures, significant GI comorbidity, and who were nonambulatory. We also noted a statistically significant increased rate of recommendations when patients were on more preoperative medications. We believe that these variables suggest a population that is more medically complex. The importance of selecting medically complex patients for hospitalist comanagement has been noted previously.¹⁶ Therefore, comanagement programs looking to maximize patient benefit for a preoperative hospitalist evaluation program might limit these visits to those who are most medically complex. We found a particularly low yield in evaluation of patients with skeletal dysplasia for example and may discontinue seeing these patients preoperatively.

We found the lack of statistically significant change in rate of hospitalist recommendations among patients with cardiac and pulmonary comorbidities interesting. Whether this was related to the mandatory preoperative pulmonology and cardiology visits is not certain. We hope to study the impact of these preoperative visits in the future as we continue to evaluate our perioperative program.

Several limitations of this study deserve note. This study was performed at 1 institution with 1 group of hospitalists and 1 group of orthopedic surgeons. Two of the study authors (D.R. and D.P.) were among the hospitalists involved with the clinical program. The study was retrospective and nonrandomized. We did not contact primary care physicians as a rule for further information about these patients. In this study, we did not specifically study the impact of hospitalist

preoperative evaluations on postoperative outcomes, although the preoperative component represented an important aspect of the more systematic intervention described elsewhere.¹⁰

CONCLUSIONS

A preoperative program for pediatric hospitalists to see children in anticipation of spinal surgery for neuromuscular scoliosis leads to a high rate of recommendations for changes in medical management or diagnostic evaluation. Certain patient characteristics are more highly associated with hospitalists making these recommendations prior to surgery.

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