RESEARCH ARTICLE

The Effect of Implementation of Standardized, Evidence-Based Order Sets on Efficiency and Quality Measures for Pediatric Respiratory Illnesses in a Community Hospital

Anuradha Dayal, MD,[a,b,c] Francisco Alvarez, MD[a,b,c]

ABSTRACT

OBJECTIVE: Standardization of evidence-based care, resource utilization, and cost efficiency are commonly used metrics to measure inpatient clinical care delivery. The aim of our project was to evaluate the effect of pediatric respiratory order sets and an asthma pathway on the efficiency and quality measures of pediatric patients treated with respiratory illnesses in an adult community hospital setting.

METHODS: We used a pre-post study to review pediatric patients admitted to the inpatient setting with the primary diagnoses of asthma, bronchiolitis, or pneumonia. Patients with concomitant chronic respiratory illnesses were excluded. After implementation of order sets and asthma pathway, we examined changes in respiratory medication use, hospital utilization cost, length of stay (LOS), and 30-day readmission rate. Statistical significance was measured via 2-tailed *t*-test and Fisher test.

RESULTS: After implementation of evidence-based order sets and asthma pathway, utilization of bronchodilators decreased and the hospital utilization cost of patients with asthma was reduced from $2010 per patient in 2009 to $1174 per patient in 2011 ($P < .05$). Asthma LOS decreased from 1.90 days to 1.45 days ($P < .05$), bronchiolitis LOS decreased from 2.37 days to 2.04 days ($P < .05$), and pneumonia LOS decreased from 2.3 days to 2.1 days ($P = .083$). Readmission rates were unchanged.

CONCLUSION: The use of order sets and an asthma pathway was associated with a reduction in respiratory treatment use as well as hospitalization utilization costs. Statistically significant decrease in LOS was achieved within the asthma and bronchiolitis populations but not in the pneumonia population. No statistically significant effect was found on the 30-day readmission rates.

[a]Division of Hospitalist Medicine, Children's National Medical Center, Washington, District of Columbia; [b]George Washington University School of Medicine Department of Pediatrics, Washington, District of Columbia; and [c]Mary Washington Hospital, Department of Pediatric Hospitalist Medicine, Fredericksburg, Virginia

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Address correspondence to Anuradha Dayal, MD, Division of Hospitalist Medicine, Children's National Medical Center, 111 Michigan Ave, NW, Suite M-4800, Washington, DC 20010. E-mail: adayal@childrensnational.org

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Hospitals and medical providers are facing increasing pressure from both public and private insurance groups to adhere to the standards of "best practice" while also remaining cost-efficient.[1] Consistency of these practices among providers has been identified as one of the obstacles limiting the successful implementation of these recently proposed health care improvement initiatives. Institution of order sets has been hypothesized to be an effective way to introduce standardized, evidence-based care while remaining medically current and fiscally lean.[2,3] The predominant literature examining the use of order sets and their effect on quality originates in the adult patient population, whereas most studies within the pediatric population have occurred at tertiary care children's hospitals.[4,5] Furthermore, most pediatric studies have focused on the implementation of order sets in the asthma or bronchiolitis population and its effect on clinical outcome or medication variances.[6–8] A recent study by Mittal et al[9] found that implementation of an inpatient bronchiolitis guideline reduced use of hospital utilization resources but did not specifically examine dollar amount reduction in cost per patient or hospital charges. Although Srivastava et al[10] examined the impact of implementation of a pediatric hospitalist system on cost and length of stay (LOS) for common conditions, such as asthma and dehydration, this study was also performed at a tertiary children's hospital. Studies focusing on standardization of pediatric care delivery in the setting of an adult community hospital that have also examined the effect of order sets on cost and clinical outcomes are rare.[11]

Mary Washington Hospital (MWH) is an adult community hospital in Fredericksburg, Virginia, which partnered with Children's National Health System (CNHS) in Washington, DC, with the goal of improving care of pediatric patients and reducing cost. Before the introduction of the CNHS pediatric hospitalist group, there was significant practice variation among the pediatric hospitalists for children treated with the inpatient diagnoses of asthma, bronchiolitis, and pneumonia. This may have been driven by residency graduation date, lack of consensus on diagnosis management, and lack of awareness of current best practices. For example, for the diagnoses of pneumonia and bronchiolitis, each provider would write orders on a blank order sheet, and the use of supplemental oxygen or adjunctive bronchodilators would be provider dependent. In patients admitted with asthma, the advancement of albuterol treatments occurred at varying interval weaning schedules, along with the use of either levalbuterol or albuterol as the main bronchodilator therapy. Practice variation combined with provider handoffs every 12 hours led to confusion among parents and nurses with regard to a consistent plan of care and continued necessity for hospital stay.

The primary aim of our improvement project was to implement standardized, evidence-based order sets for the common respiratory illnesses of asthma, bronchiolitis, and pneumonia, as well as implement an asthma clinical care pathway. Our primary research aim was to evaluate the association of our intervention on the average hospital cost per patient with asthma and the total quantity of bronchodilator treatments prescribed. The secondary research aim was to evaluate the effects of our intervention on LOS and 30-day readmission rate.

METHODS

Setting

MWH has a 30-bed pediatric inpatient unit within the 437-bed hospital. The original MWH pediatric hospitalist group consisted of 4 core physicians who were overseen by the MWH chief of pediatrics. On initiation of the CNHS pediatric hospitalist program on September 2009, all 4 core physicians were absorbed into the new CNHS pediatric hospitalist program with the only addition being a CNHS pediatric hospitalist director. On February 2010, 50% of core staff (ie, 2 physicians) were transitioned out of program and replaced with rotating CNHS pediatric hospitalist physicians. On April 2011, the remaining previous core MWH pediatric hospitalist physicians (ie, 2 physicians) were also transitioned out of program and replaced with rotating CNHS pediatric hospitalist physicians. Total staffing for the program was 4 onsite physicians and 1 site director.

The MWH pediatric unit consists of a team of 24 hours/7 days a week pediatric hospitalist physicians, respiratory therapists (RTs), and nursing staff. The pediatric unit consists of a setting in which the nursing and respiratory therapy staff had limited exposure to pediatric care except for what they learn while caring for patients within the MWH pediatric unit.

Planning the Intervention

New evidence-based, standardized order sets for the diagnoses of pneumonia, bronchiolitis, and asthma, as well as an asthma clinical care pathway were presented as part of the care practices that would be implemented with the new CNHS pediatric hospitalist program. This was a multidisciplinary initiative that involved pediatric hospitalists, RTs, pharmacy, and nursing. The resources for implementing this policy change were limited to the MWH pediatric unit nurse manager, respiratory therapy educator, and the CNHS pediatric hospitalist director. Order sets were based on current best practice guidelines from the National Heart, Lung, and Blood Institute, *Pediatrics,* along with an asthma clinical care pathway and asthma respiratory acuity scoring system currently used at CNHS in Washington, DC[12–16] (Appendix 1). Levalbuterol was not part of the asthma clinical pathway and was considered a variance if used. The asthma order set and pathway was only used for patients who did not have any other concurrent active diagnoses such as pneumonia. Discharge criteria for patients with asthma were based on clinical parameters and asthma score within the asthma clinical care pathway. These were also built into the asthma admission order set. Standardized discharge criteria for the diagnoses of pneumonia and bronchiolitis were built into their own respective admission order sets as well.

Pediatric hospitalist physicians, RTs, and nursing staff were educated about new order sets and pathways 45 days before implementation (September 2009) and were implemented for use mid-October 2009.

Education was provided by using various modalities: lecture series during staff meetings, handouts, case examples of asthma scoring, and individualized discussion with staff during patient encounters. All providers were also given laminated asthma score cards to attach to their badges as a quick reference. After implementation, documentation for reasons in divergence in frequency of bronchodilator that did not correlate with patients given asthma score was required. This was reviewed to make improvements or reeducate.

Study Population

Inclusion criteria included all children age 1 month to 17 years with a primary diagnosis of asthma, bronchiolitis, or pneumonia admitted under both inpatient and observation status. Exclusion criteria included children with other chronic respiratory illness, such as bronchopulmonary dysplasia, tracheostomy, or restrictive lung disease. Patient-specific diagnosis and comorbid conditions where based on *International Classification of Diseases, Ninth Revision* codes.

Study Design and Duration

This study used a pre-post study design. Preimplementation period was from January 2008 to December 2009 and postimplementation period was from January 2010 to December 2011. Institutional review board approval was not required for this study per the MWH institutional review board.

Data Collection

A retrospective pre-post study of LOS and readmission rate was obtained by using a hospital-based administrative database (MIDAS+). We used *International Classification of Diseases, Ninth Revision* codes and principal diagnosis at time of discharge for patient selection. Hospital cost per patient with asthma was determined by using a hospital financial management database (Siemens Soarian Financials, Siemens Medical Solutions, Malvern, PA) that looked at hospital utilization cost. Hospital utilization costs included nursing staffing, medications, laboratories, radiologic studies, and all other ancillary staffing costs (eg, phlebotomy, respiratory) from January 2009 to December 2009 and compared with January 2011 to December 2011. Physician service costs were not included in the utilization cost review. Finally, medication utilization data were obtained from pharmacy inventory reports, which were available only for the dates of October 2008 to October 2010.

New process reinforcement, availability of order sets, pharmacy medication dosage adjustments, staffing workflow adjustments, and weekly monitoring of compliance were done from October 2009 to December 2009. As this was part of initial quality improvement preparation, it was decided to include this time period as a preimplementation period because individual physician practices and workflow were still being adjusted. Also, to accommodate for seasonal variations and have a more direct comparison, the preimplementation date ended on December 2009, even though order set implementation was initiated on October 2009, so as to compare with similar time periods.

Data Analysis

The primary outcomes included medication utilization and asthma population hospitalization cost per patient. The secondary outcomes included the average LOS and 30-day readmission rate. LOS statistical significance was tested via 2-tailed *t*-test and 30-day readmission rate via 2-tailed Fisher exact test. Data collected through MIDAS+ and Soarian Financials were analyzed by using Excel (Microsoft, Redmond, WA) and SPSS (IBM SPSS Statistics, IBM Corporation, Chicago, IL).

RESULTS

We identified a cohort of 870 pediatric patients with respiratory diagnosis from January 2008 to December 2009 and compared with 688 pediatric patients from January 2010 to December 2011. Implementation of order sets and asthma clinical care pathway was associated with a reduction in overall respiratory LOS as well as within the subcategory of patients with asthma and bronchiolitis (Table 1).

Pharmacy inventory data between October 2008 and September 2010 for all patients admitted with a respiratory illness who received a bronchodilator treatment showed a reduction in bronchodilator use over time. Before implementation of order sets between October 2008 and September 2009, pediatric respiratory patients ($n = 457$) were given 4900 albuterol nebulizer treatments and 911 levalbuterol treatments,

TABLE 1 Efficiency and Quality Measures Pre and Post Intervention

All Primary Respiratory Illness	Pre (Jan 2008–Dec 2009)	Post (Jan 2010–Dec 2011)	% Change	*P*
Asthma + Bronchiolitis + Pneumonia				
Total encounters	870	688		
LOS, d	2.19	1.86	−15	<.05
30-d readmission, %	3.0	2.2	−27	.344
Asthma				
Total encounters	314	232		
LOS, d	1.90	1.45	−24	<.05
30-d readmission, %	0.03	0.02	−33	.571
Bronchiolitis				
Total encounters	190	179		
LOS, d	2.37	2.04	−14	<.05
30-d readmission, %	4.8	2.8	−42	.420
Pneumonia				
Total encounters	366	277		
LOS, d	2.30	2.10	−9	.083
30-d readmission, %	2.5	2.2	−12	.807

which is an average of 10.7 albuterol nebulizer treatments and 1.99 levalbuterol treatments per respiratory patient. After implementation, between October 2009 and September 2010 ($n = 439$), patients were given 2257 albuterol nebulizer treatments and 86 levalbuterol treatments, an average of 5.14 albuterol nebulizer treatments and 0.19 levalbuterol treatments per respiratory patient.

Before the initiation of the asthma order set and clinical care pathway (January 2009 –December 2009), the average total hospital utilization cost per patient with asthma was $2010. After implementation (January 2011–December 2011), the average total hospital utilization cost per patient with asthma decreased to $1174. This represents a reduction of total hospital utilization cost of patients with asthma of $836.00 per patient or 41% ($P < .05$).

During the course of the study, the case-mix index of the overall pediatric population was 0.741 in 2008, 0.754 in 2009, 0.766 in 2010, and 1.088 in 2011.

DISCUSSION

There have been limited studies that have specifically looked at the effect of standardization of care within pediatric units in an adult hospital setting. In our study, statistically significant decrease in LOS was achieved within the asthma and bronchiolitis population. We did not observe a statistically significant change in the LOS in the pneumonia population. We believe that this was because the standard of care for pneumonia is dependent on antibiotic selection, rather than bronchodilator selection or frequency. Implementation of order sets and an asthma clinical care pathway was associated with a decrease in total respiratory medication utilization, as well as hospital utilization cost per patient with asthma. Specifically within the asthma population, we believe that the decreased use of levalbuterol as part of the regular asthma management plan greatly reduced the cost per patient with asthma. We did not observe any statistically significant changes in readmission rate within our study group.

A limitation to this study is that hospital cost utilization analysis for bronchiolitis and pneumonia was not tracked or performed. This was because the main goal of the CNHS pediatric hospitalist program was to reduce pediatric asthma cost of care. In addition, we did not link changes in medication utilization within a specific respiratory diagnosis. Although the data presented for bronchodilator utilization was among all patients with a respiratory illness, we believe that standardization of care of the most common pediatric respiratory illnesses (asthma, bronchiolitis, and pneumonia) extended into a culture change of bronchodilator selection within the unit. This is reflected in the overall decrease of bronchodilator utilization during this time period despite increasing case-mix index. Finally, we did not observe any changes in readmission rate after instituting our order sets, but this is assuming that patients would return to the same hospital and be admitted. This does not include patients who might have returned to the emergency department or urgent care centers, or were readmitted at a different hospital in the area.

Current and future changes in reimbursement patterns have led to studies in both the adult and pediatric literature to look at effective ways to standardize practices and decrease resource utilization.[17–21] Unlike pediatric tertiary care centers, challenges to establishing evidence-based pediatric care in adult community hospitals include having limited resources to implement change, ancillary providers who are not familiar with pediatric evidence-based care practices, and an environment that does not specifically focus on the unique needs of a pediatric population.[22] We have demonstrated that despite these challenges, through the use of order sets, we were able to see similar results in the reduction in LOS as studies performed in larger tertiary care pediatric hospitals. Previous studies within tertiary care pediatric centers have based cost reduction on LOS multiplied by a standard hospital cost coefficient. Our study is unique in that cost assessment was based on the actual expenses for the asthma population and reduction was likely due to decreased use of levalbuterol. In general, levalbuterol has been restricted within many academic tertiary care centers due to increased cost-benefit ratio when compared with albuterol. Other possibilities for lower cost may be due to less variability in staffing, versus frequent rotation of residents and attending physicians in pediatric tertiary care centers who may not all be educated on new initiatives. Future studies could look at the impact of order sets on reduction of cost and resource utilization within the pediatric pneumonia and bronchiolitis populations along with sustainability of cost reduction over several years.

CONCLUSIONS

Pediatric evidence-based order sets can add value to pediatric units within adult community hospitals by decreasing the use of unnecessary therapies and lowering LOS while having minimal effect on 30-day readmission rates.[23] This is the first article to our knowledge to specifically look at the impact of order sets and pathways on several pediatric respiratory diagnoses within that setting. Within the current environment in which community hospitals face increased pressure to improve quality while concurrently being tasked to reduce resource utilization, order sets and pathways can streamline work processes to optimize effectiveness, quality, and cost-efficient care delivery.[24,25]

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APPENDIX 1 Asthma Scoring System

Value	0	1	2
Accessory muscle use	Absent or mild retraction	Moderate retractions	Severe retractions with nasal flaring
Respiratory Rate			
1–3 y	≤34	35–39	>39
4–5 y	≤30	31–34	>34
6–12 y	≤26	27–30	>30
>12 y	≤23	24–27	>27
O2 (on room air)	>93%	89%–93%	≤88%
Auscultation	Normal	Expiratory wheezes	Inspiratory and expiratory wheezes, diminished breath sounds
Dyspnea	Speaks full sentences, playful, no difficulty eating/drinking	Partial sentences, short cry, eating/drinking poorly	Short phases, grunting, unable to eat/drink

Weaning Guidelines: Wean from continuous albuterol to every 2 hours albuterol treatments if asthma score is <4; Wean from every 2 hours albuterol treatments to every 4 hours albuterol treatments if asthma score is <2.

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