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The role of computerized order sets in pediatric inpatient asthma treatment

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Condition-specific order sets within computerized physician order entry (CPOE) systems are designed to decrease unnecessary practice variation and to promote evidence-based practice. This study quantitatively assessed the relationship between use of a computerized order set and processes of care in inpatient pediatric asthma treatment, and qualitatively assessed user attitudes toward order set use.

The study population included 790 patients with a primary diagnosis of asthma admitted to Columbus Children's Hospital between November 1, 2001 and November 30, 2003. Rates of systemic corticosteroid (SCS) use, metered-dose inhaler use, and pulse oximetry (PulseOx) were calculated for three patient groups: those admitted prior to order set implementation ('pre-set'); those admitted after implementation but without the order set used ('no set'); and those admitted after implementation with the order set used ('set'). Financial measures of length of stay, total charges, and pharmacy charges were also calculated. Focus groups exploring attitudes about order sets were held with physician users of order sets.

Order set patients were significantly more likely to receive SCS and PulseOx than 'pre-set' and 'no set' patients. 'No set' patients did not differ significantly from 'pre-set' patients. No significant differences were found in financial measures. Results from focus groups suggested that order set use would be optimized by promoting order set awareness and maximizing order set quality.

These results give further credence to policy-makers' calls for expanded use of CPOE systems with condition-specific order sets to facilitate provision of evidence-based care.

Deena J. Chisolm^{1,2}, Ann Scheck McAlearney^{2,3}, Sofia Veneris⁴, David Fisher², Melissa Holtzlander² and Karen S. McCoy²

¹Columbus Children's Research Institute, Columbus, OH, ²Department of Pediatrics, The Ohio State University College of Medicine and Public Health, Columbus, OH, ³Division of Health Services Management and Policy, School of Public Health, The Ohio State University, OH, ⁴Administrative Fellow, The Ohio State University Medical Center, Columbus, OH, USA

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Deena Chisolm, Office of Clinical Science, Columbus Children's Research Institute, 700 Children's Drive, Columbus, OH 43205, USA
Tel.: 614 722 6030
Fax: 614 722 3544
E-mail: chisolmd@ccri.net

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Acute exacerbation of asthma is one of the leading causes of US pediatric hospital admissions and results in 152,000 admissions per year at a total cost of \$835,006,000 (1). As a result, asthma treatment recommendations, which provide detailed guidelines about assessment and treatment of exacerbations, have been widely propagated by the National Heart Lung and Blood Institute and other organizations (2, 3). The challenge has been for healthcare providers to integrate this information within the treatment process so that they can provide truly evidence-based care.

For years, pediatric hospitals have promoted this integration through the use of standalone paper-based or computerized clinical pathways which make operational clinical practice guidelines (4). Such asthma pathways have been shown to improve compliance with practice guidelines (5) and improve outcomes (6, 7); however, they have also met with some resistance because they are not well integrated into regular processes of care (8, 9).

The expanding capabilities of clinical information technology have created new and promising tools that can help to integrate evidence-based

medicine with standard practice. One such tool is the computerized order set within a computerized physician order entry (CPOE) system. Computerized order sets are pre-constructed groups of orders, organized categorically and designed with a 'check-box' interface which amalgamate the evidence-based orders for a specific diagnosis or procedure into a concise, easy to use, easily accessible format. These systems have shown significant success in a number of clinical applications (10).

While a substantial body of research has shown that use of CPOE systems in adult hospitals reduces medication errors (11, 12) and lengths of stay (12), less research has been conducted to assess the impact of computerized order sets within CPOE on processes of care and financial outcomes. In addition, few computerized order set studies have been conducted in a pediatric hospital setting. In this study, we evaluated the relationship between computerized order set use and processes of care by studying the use of three generally recommended inpatient asthma treatments: use of systemic corticosteroids (SCS), use of pulse oximetry (PulseOx), and use of metered-dose inhalers (MDI). Order set association with financial outcomes was evaluated on the basis of lengths of stay and inpatient charges. We also conducted focus groups with house staff interns and residents, the physicians responsible for more than 80% of inpatient orders, to explore attitudes toward order sets and uncover determinants of order set use.

Materials and methods

Study setting

Our study was conducted at Columbus Children's Hospital, Inc. (CCHI) in Columbus, Ohio, an independent, not-for-profit pediatric institution affiliated with the Ohio State University. This large teaching hospital with 323 inpatient beds serves more than 14,000 admissions per year. In April of 2001, CCHI began implementation of Sunrise Clinical Manager (Eclipsys Corporation, Boca Raton, FL, USA), a windows-based CPOE system that interfaces with CCHI's financial, laboratory, radiology, and clinical documentation systems. Admissions are entered into the system, although a direct interface between the hospital's admitting system and the CPOE system. A single sign-on, using a combination of password and fingerprint security measures, permits entry of orders and access to all inpatient clinical information except images. Clinicians can access the system from designated

workstations provided on all clinical units and in other strategic locations throughout the hospital. Wireless access is not currently available. Orders for medications and monitoring are transmitted directly to the clinical documentation system allowing nursing staff to update the electronic medication administration record and to document patient monitoring.

Order set development. The Sunrise Clinical Manager CPOE system includes a configuration tool that allows the development of order sets. To date, CCHI has developed over 300 order sets, including the asthma order set studied here. The asthma order set in the CPOE system was developed by a team of pulmonology clinicians based on an existing paper-based order set in use in the hospital. In the development process, the clinician team worked with the IS staff to program the paper order set into the CPOE system. The clinical team then pre-tested the interface to identify problems and/or opportunities for improvement. Through an iterative process, concerns were addressed and a final version of the order set was approved by the clinical development team and 'made live' in the CPOE system. After the order set 'went live', all ordering clinicians in the hospital could access the set. This broader group of users also had the opportunity to recommend changes through an established feedback mechanism. Any recommended changes were discussed and acted upon by the original clinical development team.

Asthma order set. The asthma admission order set groups orders for pharmaceuticals, including SCS, albuterol, and MDIs; patient monitoring, including vital signs and PulseOx; respiratory care, including peak flow monitoring and oxygen; and other general care orders, including laboratory tests, dietary and activity instructions, and patient and parent education. The order set can be accessed at any CPOE terminal by entering the name of the order set, by entering key words into a search function, or by browsing the full selection of order sets organized by order type (e.g., pharmacy or nursing) or by clinical discipline (e.g., pediatric surgery or pulmonary). Clinicians can enter orders from one or multiple order sets and/or from the 'a la carte' lists as needed to provide appropriate patient-specific care. Fig. 1 presents sample screen shots from the asthma order set. Since the initial implementation of the asthma order set, it has been used for over 88% of patients with a primary diagnosis of asthma exacerbation.

Fig. 1. Sample screen shot for asthma order set. This screen shot of a segment of the asthma order set shows the standard format used for all order sets. Clinicians using order entry may check as many options as they deem necessary. Selected orders are pre-checked to insure that clinicians consider these orders for all patients. Clinician, however, maintain the option to un-check 'pre-checked' items.

Order Item	Ordered Dose	Frequency	Time	Priority	Route
☐ Methylprednisolone Inj - mg	IV q6h (06, 12, 18, 24)	(1-2mg/kg/DOSE)	T	Routine	
☐ Prednisolone Liq 3mg/1ml - mg	PO q6h (06, 12, 18, 24)	(1-2mg/kg/DOSE)	T	Routine	
☐ Prednisone Tab - mg	PO q12h (08, 20)	(1-2mg/kg/DOSE - q12h)	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q2h (08, 10, 12)	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q1h PRN - wheezing	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q1h	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q3h (09, 12, 15)	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q4h (08, 12, 16, 20, 24, 04)	T	Routine	
☒ Albuterol Inhalation 2.5mg/3ml	Ordered Dose: 2.5 mg	Aerosol q2h (08, 10, 12) PRN	T	Routine	
☒ Ipratropium Aerosol 0.5mg - indicated per pathway	Ordered Dose: 0.5 mg	Aerosol q6h (06, 12, 18, 24) as	T	Routine	
☐ Budesonide Respule 0.25mg -	Ordered Dose: 0.25 mg	Aerosol (qd or bid)	T	Routine	
☐ Budesonide Respule 0.5mg -	Ordered Dose: 0.5 mg	Aerosol (qd or bid)	T	Routine	
☐ Fluticasone Inhaler 44mcg -	Ordered Dose: 2 Puff (s)	Inhaled bid (08, 20)	T	Routine	

Training to use order sets. Residents, who are the primary users of the order entry system, receive 2 h of CPOE training during their initial orientation to CCHI. This hands-on training session covers accessing orders, retrieving results, entering orders, and responding to computer-generated alerts. Approximately 20–30 min of this class focuses specifically on the use of order sets. In this time, residents practice use of an order set appropriate to the area in which they will be working. They also learn about how to find other order sets and are encouraged to use them regularly. Attending physicians receive personalized training on the system.

Study population

We studied asthma patients between the age of 2 and 20 yr who were admitted to CCHI between November 1, 2001 and November 30, 2003. This asthma population was defined as those with a primary ICD-9 diagnosis code of 493.xx and excluded those admitted to the pediatric intensive care unit. For our analyses, patients were divided into three categories. 'Pre-set' patients included those admitted between November 1, 2001 and August 30, 2002 prior to order set implementation. 'No set' patients were those admitted on or after the October 1, 2002 full implementation for whom the asthma order set was not used. 'Set' patients included those admitted after implementation for whom the order set was used. Patients admitted in September of 2002 were excluded because the month was

transitional and included both pre-implementation and post-implementation patients.

Analysis

Two primary sources of data were used in this project. First, study eligibility was determined using the hospital's Decision Support System (DSS), a data repository combining 'cleaned' data from billing and registration systems. This database provided all demographic, diagnostic, and utilization-related variables used in our analyses. Secondly, order set use data were obtained from the Eclipsys CPOE data system. Patients with only 'a la carte' orders and/or only orders from non-asthma pre-defined order sets were defined as 'no set' patients. A patient was considered to have had the order set used if at least one of his or her orders was selected from the asthma order set. This definition was selected because the asthma order set gives clinicians the opportunity to select from a number of potentially appropriate treatment and monitoring strategies so in no situation will all orders on the set be selected. In order to confirm that using the definition of 'at least one order from the set' would represent a clinically relevant use of the order set, we conducted an in-depth review of ordering patterns. This review found that, when clinicians selected at least one order from the asthma order set, they selected a median of 17 orders, and in more than 80% of cases they selected 10 or more orders. We also found that 100% of order set uses meeting the 'one order'

definition included medication orders and over 90% included nursing orders and diet/activity orders (13). Based on these findings, we believe that the use of one order from the set serves as an appropriate proxy for order set use. We studied three inpatient treatment indicators derived from the Institute for Clinical Science Improvement guideline: (i) use of SCS; (ii) use of MDIs of corticosteroids and/or long-acting β -agonists (MDIs); and (iii) PulseOx (2). Use of these services was determined using charge code data. A list of all charges accrued by asthma patients over the past 2 yr was reviewed by an administrative fellow to identify relevant charge codes for each indicator. The administrative fellow's code identification was reviewed and modified as needed by a pediatric pulmonary fellow to ensure development of an accurate, comprehensive code list.

We calculated univariate use rates for each treatment indicator by order set use and by a number of potential confounding variables. Univariate differences were tested using chi-squared analyses. Potential confounders tested fell into two primary categories: socio-demographic characteristics (age, race, and primary payer) and case severity proxies (short stay, number of comorbidities, and emergency admission). Multivariate logistic regression models were built for each treatment indicator controlling for confounders found to be significant in the univariate analysis in order to calculate odds ratios (OR) with confidence intervals (CI) for the impact of order set use on treatment frequency.

In order to assess financial outcomes, we examined length of stay, total charges, and pharmacy charges using data from the DSS system. We used ANOVA to test for significant differences between the three groups on each of the variables after trimming outliers at the 99th percentile. All analyses were conducted using (SAS®) Statistical Analysis Software.

Focus groups

We held two focus groups to supplement our quantitative analyses, and designed an open-ended focus group guide to explore physicians' perspectives about CPOE and computerized order set use. Our focus groups included 17 interns, residents, and fellows and explored issues including satisfaction, training, and system usability. Each focus group lasted 90 min, and was moderated by a study investigator (ASM, DJC). Focus groups were audiotaped and transcribed to permit qualitative data analysis, consistent with the standards of rigorous qualitative

research (14, 15). We used the qualitative data analysis software package ATLAS.TI (version 4.2) to facilitate our analyses (16).

Volunteer physician participants were recruited through e-mail solicitation and through announcements at resident meetings. Most of our 17 clinicians were part of the Children's Hospital Residency program including one chief resident, three interns, three second-year residents, and six third-year residents. These 13 participants represent 18% of the pediatric residency program. Four 'rotators' from other residency programs also participated.

All participants signed informed consent forms, which reviewed the focus group process and confirmed that individual responses would remain anonymous. Lunch was provided during the session, and participants received a \$15 bookstore gift certificate, in gratitude for their participation. The Internal Review Board at the study institution approved all elements of the focus group study.

Results

Study population

The analysis population included a total of 790 patients distributed as 261 'pre-set' cases, 63 'no set' cases, and 466 'set' cases. Table 1 displays the demographic characteristics of the population. No significant differences were found in the demographic composition of the three study groups. The majority of patients was under the age of 12 yr (87.1%) and admitted through the emergency department (92.8%). More than half of the patients were insured by Medicaid. Non-white children were over-represented, making up 55% of the asthma study population, compared with only 27% of the Franklin County population, from which CCHI draws the majority of its patients.

Treatment and financial indicators

For each of the three treatment indicators, significant group differences were found, with order set patients more likely than 'pre-set' or 'no

Table 1. Study population characteristics

Variable (%)	Total	Pre-set	No set	Set
Under 12 yr	87.1	87.7	95.2	85.6
Non-white	54.7	51.3	47.6	57.5
Medicaid	55.1	51.3	47.6	58.1
W/comorbidity	40.0	42.9	61.9	35.4
Weekend admit	29.7	29.1	17.5	31.8
Emergency admit	92.8	88.9	87.3	95.7

set' patients to receive the recommended treatment (Table 2). For SCS use, patients with the asthma set used had the highest use rate (94.4%). The SCS use rates in 'pre-set' and 'no set' groups were similar with rates of 77.8% and 75.1%, respectively. Similarly, PulseOx was higher in the 'set' group (90.8%) than in the 'no set' or 'pre-set' groups (78.9% and 82.5% respectively), and MDI use (55.6%) was higher in the 'set' group than in the 'no set' or 'pre-set' groups (39.7% and 47.9% respectively).

The significance of socio-demographic and severity measures varied by treatment indicator. Use of SCS was not associated with any of the potential confounders, while PulseOx was only associated with admission through the emergency department. Use of MDIs, on the other hand, was associated with age, short length of stay, and number of comorbidities.

Multivariate logistic regression models (Table 3) showed that use of the order set remained strongly associated even after controlling for a number of potential confounders. For SCS, the adjusted OR for the 'set' group compared with the 'pre-set' group was 5.61 (95% CI: 3.46–9.11), indicating that the odds of having SCS used was nearly six times higher for order set patients than for 'pre-set' patients. No significant difference was found between the 'pre-set' and 'no set' groups. Because no potential confounders were found to be significant in the univariate analyses, no controls were used in this model.

The multivariate model for use of PulseOx also showed a significant 'set' effect with an OR of 2.45 (95% CI: 1.58–3.80). 'No set' and 'pre-set'

Table 3. Odds ratios (95% confidence intervals) from logistic regression models for use of systemic corticosteroids (SCS), metered-dose inhalers (MDI), and pulse oximetry (PulseOx)

Characteristic	SCS	MDI	PulseOx
Pre-set	Ref	Ref	Ref
No set	1.16 (0.60–2.23)	0.84 (0.47–1.49)	1.29 (0.63–2.66)
Set*	5.61 (3.46–9.11)	1.42 (1.04–1.94)	2.45 (1.58–3.80)

*p < 0.05.

patients did not differ significantly. Being admitted to the hospital through the emergency department was the only other significant variable in the model.

The smallest effect was seen in use of MDIs with an OR of 1.42 (95% CI: 1.04–1.94) after controlling for age, short length of stay, and number of comorbidities.

Total cost, pharmacy cost, and length of stay data are presented in Table 4. Analysis of variance found no significant differences in costs or lengths of stay among the three groups.

User attitudes

Two general themes emerged from our analysis of focus group transcripts that helped improve

Table 4. Mean values (s.d.) of total charges, pharmacy charges, and length of stay, by study group

Study group	Total charges	Pharmacy charges	LOS
No set	\$3620 (2011)	\$416 (404)	1.94 (1.45)
Pre-set	\$3567 (1692)	\$373 (307)	1.93 (1.12)
Set	\$3759 (1493)	\$429 (294)	1.77 (1.05)

Table 2. Use of systemic corticosteroids (SCS), metered-dose inhalers (MDI), and pulse oximetry (PulseOx), by study group

Item	SCS use (%)	MDI use (%)	PulseOx use (%)
Order set use	$\chi^2 = 58.95$; $p \leq 0.001^*$	$\chi^2 = 7.97$; $p = 0.019^*$	$\chi^2 = 20.51$; $p < 0.001^*$
Pre-set	75.1	47.9	78.9
No set	77.8	39.7	82.5
Set	94.4	55.6	90.8
Age (yr)	$\chi^2 = 5.77$; $p = 0.06$	$\chi^2 = 21.65$; $p \leq 0.001^*$	$\chi^2 = 3.65$; $p = 0.16$
2–5	83.8	43.9	48.5
6–11	88.8	56.7	38.6
12+	91.2	66.7	12.9
Admit type	$\chi^2 = 0.33$; $p = 0.56$	$\chi^2 = 0.17$; $p = 0.68$	$\chi^2 = 13.27$; $p < 0.001^*$
Emergency	86.9	51.6	87.4
Non-emergency	84.2	54.4	70.2
Complexity	$\chi^2 = 1.24$; $p = 0.54$	$\chi^2 = 7.02$; $p = 0.03^*$	$\chi^2 = 0.33$; $p = 0.85$
No comorbid	87.8	54.8	86.1
1 comorbid	85.6	43.8	85.6
>1 comorbid	84.3	53.0	87.8
LOS (day)	$\chi^2 = 0.05$; $p = 0.81$	$\chi^2 = 12.86$; $p \leq 0.001^*$	$\chi^2 = 0.69$; $p = 0.41$
≤ 1	86.4	45.1	87.3
>1	87.0	57.9	85.2

*p < 0.05.

our understanding of asthma order set use and impact: social determinants and quality determinants.

Social determinants. As previously described, new residents at CCHI receive a 2-h training in use of CPOE and order sets; however, our focus group participants reported that they largely learned about the asthma order set and other order sets via word-of-mouth from other clinicians who had experience with the sets rather than from any formal training. For example, one resident, when asked how he learned about sets said, 'I remember them mentioning that there's order sets. And then when you get to the floor, someone will say "just do the asthma pathway or asthma admission"'. Another resident, in describing his formal training on order sets noted, 'After a point in the training, there's a whirlwind of stuff. And you just don't remember what they showed you until a resident on the floor showed me—oh yeah, there's an order set you can use instead of typing them all in individually'. In both focus groups, we observed physicians sharing information about the order sets with each other as the participants exchanged information about their experiences and provided tips about set use. Across groups physicians agreed that informal, social communication was key in fostering positive (or in some cases negative) attitudes toward the use of order sets.

Quality determinants. Our focus group participants consistently affirmed that the quality and completeness of an order set are most likely to influence actual use. Specifically, the relatively high use rate for the asthma order set was commonly attributed to high-perceived quality of that order set. As one participant noted, 'If it's an asthma admission, I can get my admit orders within literally a minute. Whereas if I had to type in all those albuterols, atavans, steroids – it would take probably at least 12–15 min'. When asked why they decided not to use an available order set for other conditions, one participant commented how, 'If there's things significantly absent... it's not even quicker. There's just too many things to add'. Participants identified several order sets that they do not use because of order set quality issues.

Discussion

Our study results show that when the asthma order set was used, patients were more likely to receive SCS, MDI, and PulseOx. This relationship was not purely explained by improvement

over time, demonstrated by the fact that SCS and PulseOx use rates in 'pre-set' patients did not differ significantly from those in post-implementation 'no set' patients. These results remained robust even after adjusting for a number of potential confounding variables.

No significant differences were found between set users and non-users with respect to length of stay, pharmacy cost, or total cost for patients. However, a number of issues may have hampered our ability to identify an effect, if one existed. First, our data collection did not include sufficient clinical data to permit us to risk adjust outcomes. Any underlying differences in costs or lengths of stay could be masked by severity differentials among the study groups. Secondly, the study may have been underpowered to detect differences if rare adverse events occurred (or were prevented). Thirdly, measurement of length of stay in days is imprecise because asthma stays are typically brief.

Our evidence supporting the role of order sets in improving use of evidence-based practices reinforces the importance of promoting computerized order set use in clinical practice. Interestingly, our finding that using evidence-based order sets makes clinicians more likely to use evidence-based practices is consistent with recent research on physician behavior. In an ethnographic study of primary care physicians, Gabbay and le May found that physicians rarely if ever go through the linear steps outlined in the evidence-based care model (17). When faced with uncertainty, physicians generally chose to ask a trusted colleague for advice rather than taking the time to conduct an extensive literature review or to read a lengthy clinical guideline. By implementing computerized evidence-based order sets that are designed by trusted colleagues, hospitals create a process of care in which the use of evidence does not entail extra steps and in which the contents are validated by locally respected clinical experts. As such, computerized order sets can seamlessly integrate evidence with accepted practice patterns.

While many hospitals – including the one studied here – mandate the use of their CPOE system, use of standardized order sets within CPOE remains voluntary because of the variety and complexity of patients with any condition. This voluntary nature means that the potential quality impact of order sets can only be achieved if physicians choose to use them. Results from our focus groups suggest that the key factors in the decision to use an order set are the degree to which residents are aware of the order set and the perceived quality of the order set. These findings

are consistent with prior studies describing the importance of order set education, promotion, and quality in promoting order set use. The qualitative results from our study; however, provide two post-implementation 'lessons learned' that can inform the maintenance phase for a computerized order set system. Our first lesson is that education regarding order sets must be continuous and multimodal, including both formal and informal channels. Our respondents consistently noted that their awareness of order sets was often driven by informal communication between users rather than through more formal educational channels, and that their decision to use the asthma order set and other sets was based on interaction with other clinicians who had positive experiences using the set. Our finding expands upon other research studies that have described the importance of administrative and clinical leaders in implementing and promoting the use of new clinical information technologies (18, 19). This finding is also consistent with other research showing that physicians rely on trusted colleagues and opinion leaders when making practice decisions (17). However, given that the primary users of the CPOE system are physician residents, the issue of user turnover must also be addressed. Training programs should continually identify opinion leaders among senior residents and attending physicians and engage those individuals to promote order set use and share experiences with the CPOE system with incoming physicians-in-training.

One such training approach has been termed 'training for capability' (20). In this process, the expectation is not simply the development of competence, defined as knowledge or skill, but the development of the capability to adapt to change and continually improve performance. Having such a capability to adapt is of particular importance in the realm of CPOE and computerized order sets. Order sets are changed or added as new evidence becomes available, and underlying computer systems change as new technology becomes available. Simple, direct training will always be necessary to build basic competence in use of a clinical information system; however, the use of less traditional ongoing training methods including mentoring, case-based discussion, and networking will be required to give new clinicians the capability to not just use the system but to be able to make informed decisions regarding when and how the use of pre-defined order sets can enhance the care that they provide.

Our second lesson learned is that giving clinical areas ownership of order sets is necessary

but not sufficient for the creation of high-quality order sets that will be consistently used. The central importance of order set quality or 'good order sets', described by our participants as order sets which make ordering faster by including *all* of the *right* orders, has been noted in a number of studies (21, 22). Moreover, it is generally accepted that having clinical ownership of the development process is integral to the creation of an effective product. Yet in our implementation, although each clinical area was given ownership of the order set development process for the conditions and procedures for which they were responsible, not all areas were equally successful. This inconsistency in order set quality is likely caused by a combination of varying quality of available evidence and varying departmental commitment to standardization. Clearly, the pulmonology team, who had already made a commitment to improving and standardizing care through the development of a paper-based order set, had the commitment to create an appropriate computerized order set. They also had access to a well-accepted evidence base for the treatment of acute asthma exacerbation. This combination appears to be the driving force in the development of consistently used order sets that support high-quality care. In short, ownership must be combined with commitment to standardization and access to high-quality evidence for order sets to be deemed useful.

As with any study, several limitations must be mentioned. First, this is a single site study, which limits the generalizability of results. However, because the CCHI CPOE implementation is one of the first full implementations of CPOE in a pediatric specialty hospital, results from our study indicate substantial potential that may be realizable at institutions that serve similarly diverse pediatric populations. Secondly, this study is limited to one of the many order sets in use in our institution. It is possible that these results for the asthma order set may be atypical for the impact of order sets on evidence-based practice in general. Ongoing research is under way to examine a number of additional order sets to gain a broader understanding of the relationship between order set use and practice. Thirdly, our focus group was composed of self-selected volunteers from the house staff. Given that the incentives to participate were minimal (pizza and \$15 gift cards), it is possible that the persons who chose to participate did so because they wished to express strongly held opinions, positive or negative, regarding the system. These persons could differ significantly from those who chose not to participate, creating a bias in either direction. As

is standard with qualitative research, the qualitative results presented here should not necessarily be interpreted as normative but instead as individual opinions. Finally, our study is limited in its ability to relate improvements in quality to improvements in outcomes because we could not collect complete information to permit appropriate risk adjustment.

Conclusion

The integration of evidence-based treatment recommendations as computerized order sets within an inpatient CPOE system can improve compliance with evidence-based treatment recommendations. Our study provides further evidence to support the argument that expansion of the use of CPOE with integrated order sets can lead to general improvements in quality of care, consistency of care, and hopefully, outcomes.

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