Asthma Care Quality Measures at Children's Hospitals and Asthma-Related Outcomes

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Asthma is a leading cause of pediatric hospitalizations; to improve asthma care, the Joint Commission requires children's hospitals to submit process measure compliance data for hospital accreditation. The Children's Asthma Care (CAC) process measures include the use of relievers (CAC-1) and systemic corticosteroids (CAC-2) for asthma exacerbation, as well as the completion of a home management plan of care (CAC-3) for patients at discharge, outlining indications for medications, follow-up plan after discharge, and information on environmental triggers (Fassl et al., 2012). Since 2010, these data are publicly reportable on the website www.hospitalcompare. gov. (Data.Medicare.gov, 2012).

Recent literature is conflicted on whether performance on CAC process measures is related to improvements in asthma outcomes. In a study of 42 free-standing, tertiary care children's hospitals, there was no association between compliance with CAC measures and asthma-related outcomes such as subsequent emergency department visits and asthma-related readmissions among almost 40,000 children (Morse et al., 2011). Conversely, in a single-site study of almost 2,000 patients assessing the effect of increased compliance with the use of home management plans of care (CAC-3) in conjunction with an asthma clinical pathway, authors showed a reduction in readmissions from 17% to 12% (p = .01; Fassl et al., 2012).

Others have identified new metrics beyond CAC process metrics to measure asthma care. Nkoy and colleagues used a modified Rand appropriateness method to identify nine process measures that were tested for feasibility and reliability;

Abstract: Objective: The Joint Commission requires hospitals to report on Children's Asthma Care (CAC) measures, although their relationship to outcomes is not clear. The objective of this study was to (1) characterize metrics hospitals use for asthma, and to (2) determine if the number and type of metrics used is associated with readmission rates.
Study Design: Pediatric hospital quality leaders were asked to identify asthma metrics utilized by their respective organizations via an online survey. "Use" of metrics was defined as periodically measuring data regardless of performance. Linear regression was used to determine if the number or domain of metrics grouped by topic used was associated with 7-, 30-, and 90-day same-cause readmission rates obtained from the Pediatric Health Information System (PHIS).
Results: Among respondents (n = 27, 62.7%), the mean number of metrics used was 20.5 (SD = 9.1, range = 4–38). There was no association between the number or domain type of metrics used and 7-, 30-, or 90-day readmission rates.
Conclusions: Despite using a wide variety of asthma metrics, there was no association between use of any metric or domain of metrics and asthma-related readmission rates. Additional work should identify asthma process measures that are associated with meaningful outcomes.

these process measures included elements of the CAC process measures including the use of systemic corticosteroids and a written asthma action plan, but also included other process measures including documentation of asthma severity at admission and scheduling a follow-up appointment with a primary care provider at discharge (Nkoy et al., 2008). Despite this recent literature suggesting the heterogeneity in measures for asthma care, little is known about the specific types of quality metrics that hospitals currently use to measure and improve asthma care.

It is also unclear what the impact of heterogeneity in measurement for asthma

care is on performance improvement in individual hospitals and on quality of care provided to individual patients. Although some process measures may be directly tied to outcome measures, many process measures may be markers for other unmeasured but nevertheless important processes of care (Werner, Bradlow, & Asch, 2008). Furthermore, it has been suggested that the very act of performance measurement may have a positive impact on outcomes, due in part to the intense scrutiny placed on a whole system of care. This idea of a "Hawthorne strategy" takes the principles of the "Hawthorne effect," or the impact on behaviors that sometimes occurs as a consequence of subjects being observed by experimenters, and leverages its strength to change behaviors to achieve performance improvement. According to the "Hawthorne strategy," intense internal commitment as in the use of multiple measures for a given complex process may in fact drive performance on both process and outcome metrics, simply by measurement alone and the intense scrutiny involved in this (Lied & Kazandjian, 1998). This strategy has been credited in quality improvement projects related to increasing residents' assessments and documentation of patient pain, improving physician documentation of parental consent and technical performance of pediatric lumbar puncture, and in improving perioperative quality measures using a clinical pathway for kidney transplant patients (Gruber, Sharma, Daneschvar, & Estfan, 2003; Schwarzbach et al., 2010; Taitz et al., 2006). Despite the importance of asthma as a leading cause of pediatric hospitalization, little is known regarding the association between the number and type of measures used as a proxy for strategic focus and patient outcomes. Armed with this knowledge, hospitals would be more informed to craft efficient, meaningful quality measurement programs that take into consideration both the benefits and opportunity costs of measuring a wide array of asthma metrics.

Despite recent literature suggesting heterogeneity in asthma quality measures, little is known about the specific types of quality metrics that hospitals currently use to measure and improve asthma care and whether hospitals with a wide array of metrics for asthma care have improved asthma outcomes due to increased strategic focus on processes of care. In order to bridge this gap, we surveyed senior administrative leaders responsible for quality and patient safety initiatives at children's hospitals in order to (1) characterize the number and types of quality metrics hospitals are using to measure and improve asthma care and (2) determine if an association exists between the number and type of metrics used and hospital-specific readmission rates.

Study Design and Methods

Study Design
We conducted a cross-sectional, observational, online survey of quality leaders at children's hospitals associated with the Children's Hospital Association on their use of quality metrics related to asthma care from June to September 2012. An email link to the online survey (Survey-Monkey, Palo Alto, CA) was sent to quality and safety leaders via a list-serve hosted by the Children's Hospital Association. Nonresponders were contacted at 1-month intervals to complete the survey. The study was approved by the Columbia University Institutional Review Board (IRB-AAAJ9155).

Subjects
Subjects included hospital-identified quality leaders at the children's hospitals associated with the Children's Hospital Association whose hospitals submit data to the Pediatric Health Information System (PHIS). The Children's Hospital Association (CHA) represents more than 220 children's hospitals, of which 43 submit administrative data to PHIS. The CHA advances public policy, enabling hospitals to better serve children, and is a resource for pediatric data and analytics driving improved clinical and operational performance of member hospitals. Surveys were

emailed via a quality and safety leaders list-serve used for sharing information among members to the hospital-identified quality leader at each hospital who either completed the survey themselves or identified an appropriate designee or team to complete the survey. Quality leaders were identified by their respective hospitals as senior administrative leaders responsible for quality and patient safety initiatives.

Measurements/Variables

We developed a short, online survey asking quality leaders about their use of different quality metrics to measure and improve asthma care. The survey was based on existing literature regarding quality measures used for asthma care (National Asthma Education and Prevention Program, 1997; Nkoy et al., 2008). The survey was developed by consensus of the authors, which included a broad range of quality of care professionals, physicians and nonphysicians, and those with expertise in both hospital- and ambulatory-based pediatric healthcare delivery. There were 30 questions on the survey; of these 30 questions, 28 were dichotomous questions (Yes/No) and 2 asked for specific answers. There were no open-ended questions included in the survey. The survey was divided into three sections, each addressing a different care setting (inpatient, emergency room, and outpatient care). Questions asked whether each hospital "used" certain metrics to evaluate performance and/or guide improvement on asthma care. "Use" was defined as measuring and reviewing data on a periodic basis and using these data to evaluate performance and, when applicable, guide improvement projects. We did not collect information regarding how hospitals were performing on the individual metrics (Supporting Information).

Survey questions were further grouped into domains according to topic—domains included Clinical Complications, Clinical Outcomes, Resource Utilization, Health Maintenance after Discharge, Process of Care, Follow-up Care, and Patient Value. Each domain included a number of quality metrics relating to that topic. Additionally, subjects were asked to provide the zip code of their hospital in order to assure that each hospital only submitted one completed survey. All of the participating hospitals were located in separate discrete zip codes.

Lastly, we used the PHIS to determine 7-, 30-, and 90-day same-cause readmission rates for asthma for each hospital for the previous calendar year (2011). The PHIS database contains clinical and billing data from 43 freestanding children's hospitals and was used to identify all potential subjects and define readmissions through the use of a masked medical record number. Data quality and coding reliability are assured through a joint effort between the CHA and participating hospitals, as described previously (Mongelluzzo, Mohamad, Ten Have, & Shah, 2008). Asthma subjects were defined as children with a principal ICD-9 discharge diagnosis code of 493.xx in the inpatient or observational setting.

Data Analysis

Descriptive data were presented as counts and percentages. Linear regression was used to assess if any individual metric or any domain of metrics was associated with hospital-level readmission rates. All statistical analyses were performed using SAS 9.3 (SAS Institute, Inc., Cary, NC). For unadjusted comparisons, $p < .05$ was considered statistically significant. We powered our study based on moderate correlation (Spearman's correlation: .5–.6) between the total number of measure collected and the 90-day readmission rate. For a test of a correlation between two normal variables using Fisher's z statistic with a two-sided significance level of .05, a sample size of 27 has a power of .93 to detect a correlation of .6. For a correlation of .5, the test had a power of .78.

Results

Of the 43 hospitals approached to participate in the study, 27 (62.7%) of their respective representatives returned a completed survey. The characteristics of

the study hospitals are described in Table 1. Responding hospitals were on average larger, had more asthma-related emergency department visits, had more asthma-related discharges, and had slightly higher 7-day asthma-related re-admissions compared to nonresponding hospitals (Table 1).

There was variation regarding the number and types of metrics each hospital used to monitor and improve asthma care (Tables 2–4). The mean number of metrics used per hospital was 20.5 (*SD* = 9.1, range = 4–38). The median number of metrics used per hospital was 19 (IQR: 14–27).

Almost all hospitals used CAC metrics; these include use of relievers (92.6%), corticosteroids (92.6%), and use of the home management plan of care (96.3%). Beyond metrics in this domain, hospitals used a variety of other metrics to measure the quality of asthma care, including metrics in the clinical complication domain, clinical outcome domain, inpatient resource utilization domain, and health maintenance domain (Table 2). Fewer hospitals used emergency department (ED) metrics for asthma (Table 3). Similarly to inpatient metrics, ED metrics used were commonly in the health maintenance domain and clinical

Table 1. Characteristics of Study Hospitals

	Responders Median [IQR]	Nonresponders Median [IQR]	*p*
Hospital statistics			
N (%) hospitals	27 (62.8)	16 (37.2)	
Number of beds, median [IQR]	310 [259, 379]	250 [162, 282]	.00
Census region of hospital			.69
Northeast, *N* (%)	3 (11.1)	2 (12.5)	
South, *N* (%)	10 (37.0)	6 (37.5)	
North Central, *N* (%)	9 (33.3)	3 (18.8)	
West, *N* (%)	5 (18.5)	5 (31.3)	
All diagnosis-related statistics			
Annual all diagnosis ED visits, median [IQR]	65,642 [52,128, 88,212]	49,537 [42,793, 66,145]	.12
Percentage of all diagnosis patients admitted through ED, median [IQR]	10.0 [8.6, 14.0]	8.7 [7.3, 13.8]	.20
All diagnosis number of inpatient discharges, median [IQR]	15,727 [8,672, 16,957]	14,511 [13,010, 20,403]	.19
Case mix index (CMI) for all diagnosis inpatient, median [IQR] discharges	2.6 [2.2, 2.8]	2.5 [2.2, 2.8]	.72
Asthma-related visit statistics			
Annual asthma ED visits, median [IQR]	2,896 [1,664, 4,184]	1,677 [917, 2,454]	.02
Percentage of asthma patients admitted through the ED, median [IQR]	23.6 [16.2, 25.7]	23.9 [14.5, 61.1]	.71
Asthma number of inpatient discharges, median [IQR]	527 [398, 710]	342 [245, 539]	.02
CMI for all asthma inpatient discharges, median [IQR]	0.8 [0.7, 0.9]	0.8 [0.8, 0.9]	.13
7-day readmission rate for asthma, median [IQR]	0.81 [0.28, 1.26]	0.43 [0, 0.64]	.04
30-day readmission rate for asthma, median [IQR]	2.39 [1.75, 3.04]	2.13 [1.11, 2.61]	.46
90-day readmission rate for asthma, median [IQR]	5.63 [5.01, 8.46]	5.16 [3.94, 6.40]	.07

outcome domain. Lastly, outpatient metrics were mostly in the health maintenance domain and clinical outcome domain (Table 4).

Mean readmission rates to the hospital for asthma were 0.75% (*SD* = 0.48) within 7 days, 2.45% (*SD* = 1.36) within 30 days, and 6.64% (*SD* = 2.61) within 90 days. There was no association between the use of any individual metric regardless of performance and 7-, 30-, or 90-day readmission rates to the hospital or emergency room. Similarly, there was no association between the number of metrics used in any clinical

domain in any setting and 7-, 30-, or 90-day readmission rates (Tables 2–4).

Discussion

In this study, we found that although almost all hospitals use the Joint Commission core measure CAC metrics, many hospitals use a wide variety of other metrics to measure and potentially improve the quality of asthma care. There is significant variability in what types of metrics hospitals use; metrics used include those relating to clinical complications, process

Table 2. Percentage of Hospitals That Use Metrics for Inpatient Asthma and Linear Regression Model Assessing Relationship Between the Number of Metrics in Each Inpatient Domain and 7-, 30-, and 90-Day Readmission Rates

Inpatient Quality Metrics for Asthma[a]	Percentage of Hospitals That Use Metric (*n*)	7-Day *p*- Value	30-Day *p*- Value	90-Day *p*- Value
All inpatient domains		.44	.18	.29
Clinical complication domain[b]		.32	.14	.23
Transfers to PICU	33.3% (9)			
Intubations	18.5% (5)			
Cardiopulmonary resuscitations	14.8% (4)			
Mortality rate	25.9% (7)			
Clinical outcome domain		.39	.19	.34
Readmissions to hospital	85.2% (23)			
Readmissions due to asthma	81.5% (22)			
Readmissions due to any cause	77.8% (21)			
Resource utilization domain[c]		.34	.97	.34
Antibiotics	11.1% (3)			
Receipt of other inpatient medications[d]	33.3% (9)			
Chest x-ray	22.2% (6)			
Pulmonary or asthma or allergy consult	14.8% (4)			
Health maintenance domain[e]		.60	.34	.35
Received influenza vaccination as inpatient	40.7% (11)			
Received environmental trigger information	81.5% (22)			
Discharged with controller medications	77.8% (21)			
Discharged with reliever medications	74.1% (20)			
Educated on how to use medications	77.8% (21)			
Provided with name/number of follow-up doctor	29.6% (8)			
Given appointment with follow-up doctor within one week of discharge	7.4% (2)			

(*Continued*)

Table 2. (*Continued*)

Inpatient Quality Metrics for Asthma[a]	Percentage of Hospitals That Use Metric (*n*)	7-Day *p*- Value	30-Day *p*- Value	90-Day *p*- Value
Core asthma care measures domain		.14	.12	.26
Use of relievers as inpatient	96.3% (26)			
Use of corticosteroids as inpatient	96.3% (26)			
Discharged with a home management plan of care	92.6% (25)			

[a]Use of no individual metric was found to be associated with 7-, 30-, or 90-day readmission rates.
[b]The metrics of patients who developed air-leak syndrome and patients who required extra-corporeal membrane oxygenation were removed from the table in this domain because no hospitals responded that they use these metrics.
[c]The metric of patients who received chest physiotherapy was removed from the table in this domain because no hospitals responded that they use this metric.
[d]Other inpatient medications include the following: Subcutaneous epinephrine; intravenous beta-agonist; inhaled ipratropium; nebulized ipratropium; levo-albuterol; inhaled steroid; nebulized steroid; oral corticosteroid; intravenous corticosteroid; intravenous magnesium.
[e]The metric-kept follow-up appointment with doctor was removed from the table in this domain because less than 5% of hospitals responded that they use this metric. This metric was included in the linear regression model.

of care, follow-up care, clinical outcomes, resource utilization, health maintenance, and patient value. Despite the plethora of metrics used, no individual metric used and no domain of metrics used were associated with better readmission rates to the hospital suggesting that hospitals using a more robust array of asthma metrics may not necessarily have better asthma-related outcomes. Despite these negative findings, this is a first step in identifying other process measures that may be more sensitive indicators of the quality of asthma care.

Most hospitals are using large numbers of process measures beyond the sole pediatric specific CAC core measures (Fassl et al., 2012). As accountability measures, or measures used for accreditation, public reporting, or pay-for-performance (Chassin, Loeb, Schmaltz, & Wachter, 2010), recent literature has called into question the use of CAC measures, especially the use of the home management plan of care, as a sensitive process measure (Morse et al., 2011). Perhaps as a result of this, we found that many hospitals used a wide array of metrics beyond the CAC measures to improve asthma care, identifying a need for more uniformity and evaluation

regarding whether the measurement of any of these other metrics is associated with improved outcomes, and therefore are better candidates for accountability measures.

In addition to heterogeneity of process metrics used, we found no association between the number or type of metrics used and outcomes. There are two possible explanations for this: (1) that measurement itself does not affect outcomes and (2) the lack of a clear association between the process and outcome. The model for improvement suggests there are three critical questions to drive meaningful improvement: (1) what are we trying to accomplish; (2) how will we know change is an improvement; and (3) what changes can we make that will result in improvement (Langley et al., 2009). These three questions feed the improvement team into Plan-Do-Study-Act cycles to trial, document, measure, and subsequently act upon improvement. Measurement is a critical component of this, but by itself likely does not guarantee improved performance. Processes have to be reliably implemented and improved upon to truly affect outcomes. Although this study did not assess

Table 3. **Percentage of Hospitals That Use Metrics for Emergency Department Asthma and Linear Regression Model Assessing Relationship Between the Number of Metrics in Each Inpatient Domain and 7-, 30-, and 90-Day Readmission Rates**

Emergency Department Quality Metrics for Asthma[a]	Percentage of Hospitals That Use Metric (n)	7-Day p-Value	30-Day p-Value	90-Day p-Value
All ED domains		.07	.40	.74
Process of care domain		.05	.64	.85
Time to first reliever treatment	18.5% (5)			
Time to first steroid treatment	29.6% (8)			
Resource utilization domain		.26	.24	.80
Antibiotics	11.1% (3)			
Chest x-ray	14.8% (4)			
Health maintenance domain[b]		.67	.64	.74
Discharged from ED with home management plan of care	37.0% (10)			
Given follow-up appointment with doctor	7.4% (2)			
Kept follow-up appointment with doctor	22.2% (6)			
Clinical outcome domain		.38	.44	.71
Readmissions to ED	63.0% (17)			

[a]Use of no individual metric was found to be associated with 7-, 30-, or 90-day readmission rates.

[b]The metric-kept follow-up appointment with asthma specialist was removed from the table in this domain because less than 5% of hospitals responded that they use this metric. This metric was included in the linear regression model.

how well individual hospitals performed in specific process measures or how hospitals used the measures to drive improvement in outcomes, it is a preliminary look at the wide number and types of process metrics children's hospitals are using to measure asthma care.

We found a lack of relationship between the number and type of process metrics used and outcomes. Other studies have shown related findings; although CAC measures such as use of corticosteroids and beta-agonists are considered standards of care, there has been mixed evidence regarding the effectiveness of the use of the home management plan of care for asthma patients at the time of discharge (DeNicola, Gayle, & Blake, 2001; Morse et al., 2011). This lack of relationship between process and outcome is not isolated to pediatric asthma; studies looking at process measures for other diagnoses such as heart failure have shown that

process measures have not been shown to be associated with outcomes of interest such as morbidity and mortality (Fonarow et al., 2007). Nevertheless, these process measures persist as publicly reportable quality metrics for inpatient exacerbations of these chronic diseases.

Although we focused on readmission rates as our outcome measure, there are other outcome measures that may be more clinically significant. Reducing hospital readmissions has become a focus for inpatient quality of care, especially in the Medicare population (Goldfield et al., 2008), despite evidence that preventable readmissions may be reduced by interventions outside the control of the hospital (Bhalla & Kalkut, 2010). In pediatrics, recent literature has shown that although readmission rates are generally low, only a fraction could be considered preventable (Hain et al., 2013). Other outcome measures may be more appropriate measures of

Table 4. Percentage of Hospitals That Use Metrics for Outpatient Asthma and Linear Regression Model Assessing Relationship Between the Number of Metrics in Each Inpatient Domain and 7-, 30-, and 90-Day Readmission Rates

Outpatient Quality Metrics for Asthma[a]	Percentage of Hospitals That Use Metric (n)	7-Day p-Value	30-Day p-Value	90-Day p-Value
All outpatient domains		.83	.47	.76
Health maintenance domain[b]		.59	.66	.93
Home management plan of care	63.0% (17)			
Controller medications	44.4% (12)			
Influenza vaccine	40.7% (11)			
Smoking exposure assessment	22.2% (6)			
Smoking cessation offered	22.2% (6)			
Asthma severity class assigned	44.4% (12)			
Assessment of control	40.7% (11)			
Receipt pulmonary function test	22.2% (6)			
Clinical outcome domain		.19	.09	.22
Outpatient admission rate	37.0% (10)			
Given appointment with follow-up doctor within 1 week of discharge	7.4% (2)			
Patient value domain		.88	.38	.38
Average missed days of school	12.0% (3)			
Average missed days of caregiver work	8.0% (2)			
Smoking exposure assessment	23.1% (6)			

[a]Use of no individual metric was found to be associated with 7-, 30-, or 90-day readmission rates.
[b]The metrics average yearly albuterol canisters used and average yearly corticosteroids used were removed from the table in this domain because less than 5% of hospitals responded that they use these metrics. This metric was included in the linear regression model.

asthma quality such as health-related quality of life, parental or patient understanding of home management, symptom control, school or work attendance, or health care utilization. However, as our findings indicate, these measures are not routinely used; hence data are lacking regarding how hospitals perform on these measures.

There are several limitations inherent in this study. We asked a small sample of hospitals to report on what quality metrics they used to measure and improve asthma care; we did not collect data on how each hospital performed on each metric. This could possibly explain why we did not find an association between the number of metrics used and readmission rates. Second, data were self-reported by a quality leader or that person's designee, whose roles may have been different at each

hospital, which may have affected their responses and introduced bias. Others at the same institution may have reported different results, and we did dot measure interrater reliability of reporting at individual institutions. However, a self-identified leader would presumably best estimate what measures are being used rather than underestimate metrics being monitored. And, lastly, the survey was sent out in 2012 and asked about metrics that were "currently" used; we used these data to correlate with readmissions data from 2011.

The discrepancies between use of metrics and asthma-related outcomes such as readmissions highlight the need for continued research in developing process measures and validating true outcome measures. Process measures must be evidence-based, accurately represent what is being measured, be proximal to the

outcome it represents, and have few or no unintended consequences (Chassin et al., 2010). Furthermore, process measures must be tied to meaningful outcome measures that are specific to the pediatric population. As the field of quality measurement grows, future study should aim at defining these types of process and outcome measures in order to create efficient, meaningful quality programs.

Conclusions

Children's hospitals in this cohort use a wide variety of process metrics across multiple topic domains to measure asthma care. Despite the number of different metrics used, there is little association between the number and type of metrics used and asthma-related outcomes such as readmission rates. Children's hospitals should attempt to define process measures that are tied to validated outcome measures in order to create efficient quality programs.

Conflict of Interest

The authors have indicated they have no specific financial interests, relationships, or affiliations relevant to the subject of this manuscript. The authors have indicated that they do not have any conflict of interest to disclose as it relates to (1) study design; (2) the collection, analysis, and interpretation of data; (3) writing of the report; and (4) decision to submit the paper for publication. The first draft of the manuscript was written by Anupama Subramony, MD, MBA. No honorarium, grant, or other form of payment was given to anyone to produce the manuscript.

We attest that all authors have made substantive intellectual contributions to this study and meet the following criteria: (1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published. Furthermore, each author listed on the manuscript has seen and approved the submission of this version of the manu-script and takes full responsibility for the manuscript.

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Appendix A: Supplemental Digital Content 1, http://links.lww.com/JHQ/A10.

Authors' Biographies

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Matt Hall, PhD, provides statistical support to all divisions of the Children's Hospital Association (CHA) with a particular focus on health services research and policy. His responsibilities include data mining CHA's Pediatric Health Information System (PHIS) to provide owner hospitals with pre-scriptive analytics and to determine ways in which data residing at CHA can be integrated and used for clinical, operational, and financial improvement by member hospitals and policy makers.

Cherie Thomas, MBA, RHIA, is Director of the Children's Hospital Association, Overland Park, KS. She provides strategic and operational leadership and direction for the comparative benchmarking program Whole System Measures (WSM) designed to measure performance of the participating members' entire healthcare system over time (including ambulatory and inpatient services). She also leads implementation of the nationally recognized Children's Hospital Association Pediatric Quality Award.

Vincent W. Chiang, MD, is Chief of Inpatient Services and Vice Chair for finance for the Department of Medicine at Boston Children's Hospital. He is also an Associate Professor of Pediatrics at Harvard Medical School.

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Charles Macias, MD, MPH, is an Associate Professor of Pediatrics and Director of the Evidence Based Outcomes Center and Center for Clinical Effectiveness for Texas Children's Hospital and Baylor College of Medicine in Houston, Texas. He coleads several care process improvement initiatives, including a national collaborative to improve the care of pediatric septic shock recognition and treatment for the American Academy of Pediatrics Section on Emergency Medicine.

Keith J. Mann, MD, Med, is the Associate Executive Medical Director and Chief Medical Quality and Safety Officer for Children's Mercy Hospitals and Clinics in Kansas City, Missouri, and Associate Professor of Pediatrics at the University of Missouri—Kansas City

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Gary Frank, MD, MS, is Medical Director for Quality and Medical Management for Children's Healthcare of Atlanta, a hospitalist with Scottish Rite Pediatric and Adolescent Consultants, and an Adjunct Assistant Professor of Pediatrics at Emory University School of Medicine. Dr. Frank's professional interests include the effects of health information systems on patient safety, measure of value and quality in pediatrics, and the cause and effect of medication errors.

Harold K. Simon, MD, MBA, is Professor of Pediatrics and Emergency Medicine and an MBA with more than 20 years of clinical, administrative, and academic experience. He serves as Vice Chair for Faculty, Department of Pediatrics, Emory University, Children's Healthcare of Atlanta. Research interests include resource utilization and process and quality improvement.

Rustin B. Morse, MD, MMM, is Chief Quality Officer at Children's Medical Center and an Associate Professor at the University of Texas Southwestern in Dallas, Texas. As Chief Quality Officer, he serves as the senior-most physician responsible for overseeing the development and implementation of strategic initiatives designed to improve quality and patient safety. In addition to administrative responsibilities, Dr. Morse practices clinically as a pediatric emergency medicine specialist.

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The authors declare no conflict of interest.