RESEARCH ARTICLE

Contextual Factors Influencing Implementation of Evidence-Based Care for Children Hospitalized With Asthma

Flory L. Nkoy, MD, MS, MPH,[a] Victoria L. Wilkins, MD, MPH,[a] Bernhard A. Fassl, MD,[a] Joseph M. Johnson, MD,[b] Derek A. Uchida, MD,[a] Justin B. Poll, PhD,[b] Tom H. Greene, PhD,[a] Karmella J. Koopmeiners, RN, MS,[b] Carolyn C. Reynolds, RN, MS,[b] Karen J. Valentine, MStat,[b] Lucy A. Savitz, PhD,[b] Christopher G. Maloney, MD, PhD,[c] Bryan L. Stone, MD, MS[a]

ABSTRACT

BACKGROUND AND OBJECTIVES: The translation of research findings into routine care remains slow and challenging. We previously reported successful implementation of an asthma evidence-based care process model (EB-CPM) at 8 (1 tertiary care and 7 community) hospitals, leading to a high health care provider (HCP) adherence with the EB-CPM and improved outcomes. In this study, we explore contextual factors perceived by HCPs to facilitate successful EB-CPM implementation.

METHODS: Structured and open-ended questions were used to survey HCPs ($n = 260$) including physicians, nurses, and respiratory therapists, about contextual factors perceived to facilitate EB-CPM implementation. Quantitative analysis was used to identify significant factors (correlation coefficient ≥ 0.5; $P \leq .05$) and qualitative analysis to assess additional facilitators.

RESULTS: Factors perceived by HCPs to facilitate EB-CPM implementation were related to (1) inner setting (leadership support, adequate resources, communication and/or collaboration, culture, and previous experience with guideline implementation), (2) intervention characteristics (relevant and applicable to the HCP's practice), (3) individuals (HCPs) targeted (agreement with the EB-CPM and knowledge of supporting evidence), and (4) implementation process (participation of HCPs in implementation activities, teamwork, implementation team with a mix of expertise and professional's input, and data feedback). Additional facilitators included (1) having appropriate preparation and (2) providing education and training.

CONCLUSIONS: Multiple factors were associated with successful EB-CPM implementation and may be used by others as a guide to facilitate implementation and dissemination of evidence-based interventions for pediatric asthma and other chronic diseases in the hospital setting.

www.hospitalpediatrics.org
DOI:https://doi.org/10.1542/hpeds.2019-0050

Address correspondence to Flory L. Nkoy, MD, MS, MPH, Division of Pediatric Inpatient Medicine, University of Utah School of Medicine, Primary Children's Hospital, 100 N Medical Dr, Salt Lake City, UT 84113. E-mail: flory.nkoy@hsc.utah.edu

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: Main author Dr Nkoy and coauthors (Drs Stone and Fassl and Ms Koopmeiners) received salary and travel support through the Agency of Healthcare Quality and Research grant; the other authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Supported by grant 1R18HS018166-01A1 (Organizational Factors Associated with Improved Inpatient Pediatric Asthma Care) from the Agency of Healthcare Quality and Research. The sponsors did not participate in the design and conduct of the study; collection, management, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript. Its contents are solely the responsibility of the authors and do not necessarily represent the official view of the Agency of Healthcare Quality and Research.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

[a]Department of Pediatrics University of Utah, Salt Lake City, Utah; [b]Intermountain Healthcare, Salt Lake City, Utah; and [c]Children's Hospital and Medical Center, Omaha, Nebraska

Dr Savitz's current affiliation is Kaiser Permanente Northwest, Center for Health Research.

Dr Nkoy conceptualized and designed the study and survey procedures, drafted the initial manuscript, and oversaw the analysis; Drs Wilkins, Fassl, Uchida, Johnson, Savitz, Maloney, and Stone and Mrs Koopmeiners, Ms Valentine, and Ms Reynolds participated in the concept and design, interpretation of data, and revising of the manuscript; Dr Poll participated in the concept and design, survey development and adaptation, survey procedures, data analysis and interpretation, and revising of the manuscript; Dr Greene participated in the concept and design and revising of the manuscript and oversaw data analysis and interpretation data; and all authors approved the final manuscript as submitted.

Pediatric asthma accounted for 640 000 emergency department (ED) visits and 157 000 hospitalizations in 2009[1–3] and ∼15.9 billion dollars in annual costs.[4,5] Despite substantial burden, gaps persist between the evidence and actual care children with asthma receive,[6–9] with low health care providers' (HCP) adherence with guideline recommendations.[10–12]

The Institute of Medicine has identified translation of research findings into improved patient care and safety as a priority.[13] However, the translation of research findings into routine practice remains slow, lags 15 to 20 years after discovery of effective treatments, and leads to suboptimal care.[14] One of the reasons for this lag is the difficulty of translating the complex content of guidelines into routine clinical practice.[15]

Implementation of evidence-based interventions (EBIs) via decision support tools (eg, care pathways, protocols, care process models, etc) is often used to accelerate the translation of research findings and guidelines into routine care and improve patient outcomes. Although single-center EBIs are commonly implemented at tertiary care hospitals,[16–18] efforts to disseminate successful EBIs to other hospitals are rare[19–23] and are not always successful.[24–26]

Researchers have reported the role of contextual factors in facilitating successful implementation (leading to a high HCP adherence) of EBIs in clinical practice.[27–38] Contextual factors have an indirect effect on HCP practice and patient care via various means, including the availability of resources, staffing, expertise, and via policies, rewards, sanctions, etc.[34] Yet, in existing studies for children hospitalized with asthma, authors focus primarily on assessing EBI impact on asthma outcomes and often fail to assess contextual factors. Strategies to successfully implement EBIs for children hospitalized with asthma are not well known. Better understanding of contextual factors will help promote broad implementation of EBIs for children with asthma and other conditions in the hospital setting.

We previously reported successful implementation of an asthma evidence-based care process model (EB-CPM) at a tertiary care hospital and its subsequent dissemination to 7 community hospitals.[18,21] EB-CPM implementation and dissemination resulted in a high HCP adherence with asthma quality measures at all hospitals (25%–58% at baseline to 80%–99% postimplementation) and significant and sustained reductions in length of stay, hospital costs, and readmissions.[18,21]

The successful implementation of the EB-CPM at these hospitals provided a unique opportunity to evaluate contextual factors that led to successful implementation. Thus, the objective of the current study was to determine key contextual factors perceived by HCPs to facilitate successful EB-CPM implementation in participating hospitals.

METHODS

Setting

We involved 8 hospitals from Intermountain Healthcare (IH), an integrated health care system in Utah and southeastern Idaho, with 22 hospitals and 185 clinics and urgent care facilities.[39] Participating hospitals ranged from a 289-bed tertiary facility (Primary Children's Hospital [PCH]), staffed by pediatric subspecialists and located in a metropolitan area (Salt Lake City), to 7 rural and urban community facilities, staffed by family physicians, general pediatricians, and midlevel and ancillary staff, with limited pediatric-specific resources, including American Fork Hospital, Dixie Regional Medical Center, Logan Regional Hospital, McKay-Dee Hospital, Riverton Hospital, Utah Valley Hospital, and Cedar City Hospital.

Asthma EB-CPM Description

The EB-CPM was designed to standardize care of children age 2 to 17 years hospitalized for asthma[9,18,21] and improve hospital adherence with evidence-based inpatient asthma care quality measures.[9] The EB-CPM included decision support tools (admission and discharge orders), patient- and/or parent-oriented competency regarding asthma education, and an algorithm to guide step therapy.[40]

Asthma EB-CPM Implementation and Dissemination

EB-CPM implementation at PCH occurred between January 2008 and March 2009,[21] and its dissemination to 7 community hospitals occurred between January and June 2011.[18] We used facilitation[18] to implement the EB-CPM at PCH and the Replicating Effective Programs approach[41] combined with facilitation to disseminate it to community hospitals, including obtaining leadership support and clinical staff (physicians, nurses, and respiratory therapists [RTs]) buy-in, assembling a multidisciplinary team, providing education and/or training, supporting local physician champions and teams, and providing on-going assistance and data feedback.[9]

Study Design and Population

The cross-sectional survey, administered 1 year after completion of the implementation, involved HCPs (eg, physicians, nurses, and RTs) from participating hospitals who implemented and/or used the EB-CPM to deliver care to children hospitalized with asthma.

Survey Questionnaire and Conceptual Framework

The questionnaire was adapted from a previous study of contextual factors influencing chronic heart failure care in an integrated health care system[33] by changing chronic heart failure references to "asthma" and rewording a few questions (see Survey Procedures and Data Collection). The survey assessed 5 constructs of the Consolidated Framework for Implementation Research,[42] including (1) inner setting (eg, leadership support, resource availability, support staff, quality improvement [QI] commitment, previous QI experience and culture, relationship between hospital management and physicians, need for the intervention, staff empowerment, communication and/or collaboration within the organization, competing demands, and organizational readiness to change, etc); (2) outer setting or hospital structure variables (eg, size, type [tertiary and community], location [rural and urban], and HCP incentive); (3) intervention characteristics (eg, if it fits the

HCP's needs, was relevant or applicable to the HCP's practice, was perceived effective in improving the HCP's practice, and its clarity, ease of use, and understandability); (4) individuals involved (eg, the HCP's years of experience, previous QI or guideline implementation experience, personal involvement in EB-CPM implementation or with the implementation team, or whether they were knowledgeable about, complied, or agreed with the EB-CPM, whether they were resistant); and (5) implementation process (eg, QI professionals' participation in the implementation team, teamwork, team composition, use of a champion, if there were structural changes made to facilitate EB-CPM implementation, data feedback, feedback mechanisms, use of a brief EB-CPM summary [eg, pocket card, algorithm, etc], education and/or training of HCPs and approach used [eg, grand rounds, clinical meetings, etc], whether additional staff was used, and if there was a rearrangement of roles, change in workflow, and delegation of certain work).

Overall, the survey included 82 structured questions, with responses ranging from 1 to 6 (1 = not at all, 2 = very little, 3 = some, 4 = great, 5 = very great, and 6 = do not know). An open-ended question ("What do you feel were the most important factors that helped facilitate EB-CPM implementation?") was used to identify additional constructs missed in the structured survey.

Survey Procedures and Data Collection

We pretested the survey on a sample of 6 participants, including 2 physicians, 2 nurses, and 2 RTs, ensuring questions were clearly worded and easily understood. We reworded unclear questions for clarity without changing the concepts. We contacted clinical program leaders at each hospital to identify individuals who were exposed to the EB-CPM through patient care or involvement with local implementation teams.

We obtained potential participants' names and e-mails and conducted the survey using SurveyGizmo. The survey packet included an introductory letter describing its purpose, a letter of support from clinical program leaders, consent form, confidentiality measures, and the questionnaire. All nonrespondents were contacted up to 3 times to optimize the response rate. The IH privacy and the University of Utah Institutional Review Boards approved the study.

Data Analysis

Quantitative Analysis

We used descriptive analysis and Pearson partial correlation, controlling for the hospital, to assess the association between the participant's response about the HCP's adherence with EB-CPM and individual factors. We used individual responses to the structured question ("… please indicate to what extent HCPs used or complied with the EB-CPM") as the dependent variable to determine factors associated with EB-CPM implementation (or the HCP's perceived adherence). We included responses 1 through 5, and excluded response 6 (do not know) and missing. Pearson correlations provide a single measure of the degree of linear association between responses on 1-to-5 Likert scales for each relationship investigated. Contextual factors for which the correlation coefficient (r) was high ($r \geq 0.50$)[43–48] with a P value $\leq .05$ were classified as significantly associated with EB-CPM implementation.

Qualitative Analysis (Open-ended Question)

Two authors (F.L.N. and J.B.P.) reviewed participants' responses independently and used thematic analysis to develop a preliminary coding scheme using constant comparison method and open coding principles. We created a nonhierarchical list of first-level codes describing responses. We then categorized the data, assessed relationships, and combined similar categories; then, the 2 authors met to discuss and refine the coding scheme. The discussions during coding sessions included reflections on previous literature, relevant theories, and the goals of the study. Any discrepancies between the 2 reviewers were resolved through consensus. Analysis was descriptive.

RESULTS

Quantitative Analysis Results

Of 523 individuals invited, 260 responded (50% response rate) to the survey, including 24 (of 82) physicians, 164 (of 300) nurses, and 72 (of 141) RTs. The majority of participants (65%) had >5 years of job experience, and 97% were familiar with the EB-CPM. Eight respondents unfamiliar with the EB-CPM were excluded, leaving 252 participants for analyses. Similar to our finding with objective measures of adherence from a previous study,[18] perceived HCPs' adherence (responses 3, 4, and 5 on the survey) was also high (96.8%) overall, by role (98.2% nurses, 95.2% RTs, and 91.7% physicians), hospital type (97.8% tertiary care and 95.6% community), and individual hospitals (Table 1).

Overall, no outer setting factor was associated with EB-CPM implementation. We found significant associations with factors related to inner setting, intervention characteristics, individuals involved, and implementation process (Table 2).

Inner Setting

EB-CPM implementation was positively associated with HCPs' perception that there was (1) leadership support, (2) effective collaboration between senior administration and physicians, (3) effective communication between physicians and nonphysician HCPs, (4) effective collaboration between departments involved, (5) previous hospital experience with guideline implementation, (6) data-driven decision-making organizational culture, and (7) sufficient resources, time, or personnel allocated to the effort.

Intervention Characteristics

EB-CPM implementation was positively associated with HCPs' perception that it was relevant and applicable to HCPs' practice.

Individuals Involved

EB-CPM implementation was positively associated with perception that HCPs (1) agreed with the EB-CPM and (2) were knowledgeable of evidence supporting the EB-CPM. Interestingly, the number of years individuals worked in the hospital was inversely associated with EB-CPM implementation.

Implementation Process

EB-CPM implementation was positively associated with HCPs' perception that there was (1) distribution of the EB-CPM to all

TABLE 1 Types of Participants by Hospital

Hospital	Type	Location	Participants, *n*	EB-CPM Adherence,[a] %
American Form Hospital	Community	Rural	15	93.3
Dixie Regional Medical Center	Community	Rural	15	93.3
Logan Regional Hospital	Community	Rural	15	100
McKay-Dee Hospital	Community	Urban	19	94.7
PCH	Tertiary care	Urban	138	97.8
Riverton Hospital	Community	Urban	12	91.7
Utah Valley Hospital	Community	Urban	38	97.4
Total	All hospitals	—	252	96.8

—, not applicable.
[a] Perceived adherence was calculated by combining responses no. 3 (some), no. 4 (great), and no. 5 (very great) to the question "…please indicate to what extent HCPs used or complied with the EB-CPM…."

physicians, (2) an implementation team with a mix of expertise and professional (physicians, nurses, and RTs) input, (3) teamwork, (4) HCPs' participation in implementation activities, (5) performance data shared with physicians, (6) frequent data feedback provided to physicians, (7) appropriate checkpoints and deadlines during implementation, and (8) organizational changes for EB-CPM implementation completed in a reasonable time frame.

Full results with questions and *r* and *P* values are provided in Supplemental Table 4.

Qualitative Analysis Results

Of 252 survey responders, 89 responded to the open-ended question. Providing education and training (not significant in quantitative analysis) was an additional and most commonly perceived facilitator of EB-CPM implementation reported, with responders stating, "Education ensured all parties became aware and familiar with the EB-CPM." Many recognized grand rounds and department meetings as venues for education. Respondents also reported having adequate preparation, resources, and supporting materials before implementation facilitated the process. The list of most common facilitators identified with exemplar quotes is included in Table 3.

DISCUSSION

We found that successful EB-CPM implementation was perceived to be influenced by key contextual factors, including having an appropriate preparation, obtaining leadership support, having adequate resources, providing education and training, having an intervention that was evidence-based and relevant to the HCP's practice, having teamwork and effective communication, and providing data feedback to HCPs, specifically physicians.

EBIs for children hospitalized with asthma are commonly implemented in single-center hospitals and rarely disseminated to other hospitals because of limited information on effective implementation strategies. Our findings may be used by others to guide implementation and dissemination of EBIs for children with asthma and other conditions in the hospital setting.

Specifically, our study highlights the importance of having adequate preparation before implementation activities as a facilitator of EB-CPM implementation. Our preimplementation strategies included obtaining leadership support, providing education and training to HCPs, and developing a mechanism for sharing feedback data with HCPs. Also, we had in our team individuals with previous experience of guideline implementation, which was found to facilitate implementation of new EBIs.[49,50]

Leadership support was a key driver of EB-CPM implementation because it helped participating hospitals obtain HCPs' buy-in and commitment, allocate resources and personnel time to support the project, and make organizational changes needed to facilitate EB-CPM integration and use by HCPs. In our study, we used the EB-CPM impact data when it was initially implemented at PCH to secure leadership support at other hospitals, creating a high expectation among leaders to see similar improvements when the EB-CPM would be implemented locally.

Our findings underscore the value of education and training as a facilitator of an EBI implementation. Education and training provided to HCPs before implementation activities increased their knowledge, shaped their attitudes toward the EB-CPM, and secured their buy-in. In our study, we used grand rounds and department meetings as venues to educate HCPs at participating facilities about the EB-CPM and supporting evidence.

Our results reveal that characteristics of the intervention, especially when supported by evidence, can influence HCPs' attitudes. In our study, we used decision support tools (admit and discharge order sets) to integrate and translate asthma evidence-based recommendations into routine hospital care. Because the development of these tools was informed by guidelines[51] and their contents were relevant and applicable to the HCP's practice,[50] HCPs were eager to use them.

We found teamwork (a well-functioning team) as another key facilitator of EB-CPM implementation, which we established by having an equal stakeholder (physicians and nonphysicians) representation and participation in decision-making and by promoting effective intraorganizational collaboration, communication, and coordination about the EB-CPM.

In addition, we found data feedback regarding hospital and physician performance a key facilitator.

We posted feedback data online in a dashboard accessible by all participants and discussed the data regularly with HCPs at participating hospitals during monthly conference calls, grand rounds, and other departmental meetings. Feedback data helped promote accountability, identify improvement opportunities, and support continued HCPs' engagement with the process.

Overall, our study corroborates findings of many non–asthma-related studies, often

TABLE 2 Contextual Factors Associated With Implementation of the EB-CPM in Clinical Practice

Variable Label	Correlation Coefficient	*P*
Inner setting		
Was senior administration supportive of physicians?	0.54	.00
Did senior administration support the pediatric asthma EB-CPM activities?	0.54	.00
Did senior administration support changes to improve quality of care?	0.60	<.001
Was there effective communication between physician and nonphysician providers (eg, nurses, RTs, pharmacists)?	0.70	<.001
Was there collaboration and/or cooperation between departments?	0.60	<.001
Was there collaboration and/or cooperation between physicians and senior administration?	0.58	<.001
Did the culture of your hospital support data-driven decision-making?	0.59	<.001
Was there sufficient financial or personnel support to implement the changes?	0.53	.00
Was there cooperation from other departments with your efforts to improve quality of care?	0.64	<.001
Did your hospital experience with guidelines facilitate implementation of the asthma EB-CPM?	0.54	.00
Intervention characteristics		
Providers (physicians, nurses, and RTs) feel this EB-CPM is relevant to their daily practice.	0.51	<.001
Did physicians believe that the pediatric asthma EB-CPM guidelines are applicable to their practice?	0.50	.01
Individuals targeted by the intervention		
Providers (physicians, nurses, and RTs) agree with this EB-CPM.	0.63	<.001
Providers (physicians, nurses, and RTs) are knowledgeable about this EB-CPM.	0.53	<.001
Did patient care providers (physicians, nurses, and RTs) consistently participate in activities to improve care quality?	0.50	.00
How long have you been working at (or with) this hospital?	−0.60	.02
Implementation process		
Were your hospital's asthma EB-CPM data distributed to all physicians?	0.63	.01
How often were pediatric asthma EB-CPM data (or feedback data) distributed to physicians in your hospital?	0.56	.04
Did teamwork exist at your hospital in implementing the EB-CPM?	0.63	.00
Appropriate checkpoints and deadlines were established.	0.58	<.001
Were changes intended to improve quality of care accomplished in a reasonable time frame?	0.60	<.001
Was there an appropriate mix of expertise?	0.54	.03
Was there an appropriate balance of input across professions?	0.61	.01

conducted in the ambulatory setting, supporting that similar factors are important in both the outpatient and hospital setting. Leadership support was found to foster EBI use, secure HCP commitment, promote accountability, and reduce resistance in ambulatory settings.[52–54] Likewise, implementation of diabetes and blood pressure control guidelines in primary care settings was successful when guidelines fit the needs of patients and HCPs.[55–57]

Similar to our results, education and/or training was found to influence implementation of an EBI, increasing an HCP's knowledge about supporting evidence and allowing the HCP to be more comfortable and willing to use the EBI.[58] Also, effectiveness data (proof of benefit) were found to shape HCP attitudes.[59] Likewise, Bhatt et al[60] highlighted the importance of teamwork and collaboration and reported that an EBI is successful when all physicians and/or nonphysicians collaborate effectively. Teamwork improves communication and collaboration, allowing individuals of various disciplines to share expertise and skills to achieve a common goal.[61–63] Breakdown in teamwork is associated with poor communication and adverse patient outcomes.[64]

Some of our findings were similar to results reported in few asthma-related studies of contextual factors in the ED and ambulatory settings. Cabana et al[65] found awareness, familiarity, and agreement as facilitators to pediatricians' compliance with ED asthma guidelines. Also, perceived lack of benefits was found to impede adherence with the use of metered dose inhalers and spacers in pediatric EDs.[66] Teamwork was a recognized facilitator of an asthma self-management intervention in adult general practice.[67] Likewise, lack of appropriate preparation was a recognized barrier, resulting in low HCP adherence with an ED pediatric asthma protocol.[68]

Despite some similarities with non–asthma- and a few asthma-related studies, our study is unique in examining a broad range of contextual factors across multiple hospital settings, providing specific strategies that can be used to guide implementation of EBIs

TABLE 3 Perceived Facilitators of EB-CPM Implementation (Responses From Open-ended Questions)

Facilitators of EB-CPM Implementation	Example Quotes
Education and training to support CPM implementation	"Education…ensuring all parties were not only aware but familiar with the CPM" "Implementation using grand rounds to get things going. Updates in department meetings" "Continued education on pediatric asthma and the CPM" "We have tried to do a lot education on why we are doing what we are doing."
Appropriate preparation and adequate supporting materials and/or resources	"Having pre-made packets, we are able to see the paper work to be filled out. It also supplied you with a list of what to educate, so we were able to see what needed to be educated to educate patients and families." "Having written algorithms and other information about the steps available to providers."
Teamwork and effective communication between staff	"It was teamwork and better communication. Everyone worked together to implement the CPM." "Cooperation between nursing staff and physicians"
Clinical staff buy-in and commitment to the process	"Care provider (physician, respiratory therapist and nurse) commitment to improving asthma care"; "Buy in from all stakeholders." "I think that getting the doctors to buy in to the asthma CPM.
Providing data feedback	"On-going feedback with staff on our progress and implementation" "Shared baseline and outcomes data" "Importance of protocol with data collected from previous admits/patients" "Dissemination of information at physician meetings and updates as to progress at physician meetings."
Participation of care provider in the implementation process	"The involvement of committed nurses, respiratory therapists and physicians." "It was a methodical process that involved representatives from areas that care for asthma patients." "The respiratory therapy department was heavily invested in the success of the CPM. They were involved every step of the way, and were supportive of the efforts of the nursing staff, as well as helpful in teaching staff and patients/families." "Nurses and respiratory therapists made sure that everything was filled out." "The success of the CPM was made possible by respiratory therapy, nursing, and physicians."

CPM, care process model.

for children with asthma and accelerate the translation of research findings in the hospital setting. Our study adds evidence of the importance of implementation teams having a balanced mix of disciplines, setting deadlines and checkpoints to complete implementation activities in a reasonable time frame, and establishing effective collaboration among physicians and nonphysician HCPs. Lastly, we found a negative correlation between years worked at the hospital and EB-CPM implementation, suggesting experienced HCPs may be slow to adhere to a new EBI and underscoring the needs for targeted efforts to increase their buy-in and reduce resistance.

Our study is limited in that it only represents views of respondents. Nonrespondents may have different views. Because of our unique study setting, with a strong electronic medical record system, a culture of EB-CPM implementation, and a somewhat underrepresentation of physicians, our results may not capture the full array (eg, use of pocket cards) of factors that may influence EB-CPM implementation. Researchers of a study conducted in another location might identify additional important factors for EBI implementation success. Our surveys were conducted 1 year after the completion of implementation activities raising the possibility of recall bias. The contextual factors identified in our study are subjective ("perceived" by HCPs), as adherence with the EB-CPM was very high (>90%) overall across hospital type, location, HCP type, etc, rendering a comparison of high to low compliers impossible. Although the middle response is often considered neutral, we included "some" (Table 1) in the calculation of adherence because it was considered a positive response. This inclusion did not impact the analyses of contextual factors because adherence was used as a continuous variable. Nevertheless, we believe our study provides a foundation for advancing efforts for disseminating successful single-center EBIs (for asthma and other diseases) to other hospitals. Although we sample multiple HCP types (eg, nurses, RTs, and physicians), some of our qualitative findings stress the unique role of physicians as the most important driving force in influencing EBI implementation in clinical practice. Our analyses were exploratory and were performed without formal adjustment for multiple comparisons. Also, our outcome variable was assessed on the 1-to-5 Likert scale. This limited variability may have impacted our results. Therefore, further studies are needed to confirm our results. Finally, our study was conducted in an integrated health delivery system with an established QI culture and may not be applicable to other settings. However, we believe similarities with many non–asthma- and the few asthma-related studies conducted in ambulatory and ED settings support generalizability of our findings and underscore the importance of addressing

multilevel contextual factors when implementing EBIs in the inpatient settings.

CONCLUSIONS

In our study, we provided a set of key facilitators of EBI implementation that can be used by others to facilitate broad implementation and dissemination of EBIs for childhood asthma in the hospital setting, which may be generalizable to other conditions and settings.

Acknowledgments

We acknowledge the medical, nursing, RT, and administrative staff at participating hospitals for their efforts and diligence during the implementation and dissemination of the EB-CPM. We also thank the Pediatric Clinical Program leadership at IH, including Dr Ed Clark, Ms Carolyn Reynolds, and Dr Brent James of the Intermountain Institute for Healthcare Delivery Research for their support for this project.

REFERENCES

1. Akinbami LJ, Moorman JE, Bailey C, et al. Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010. *NCHS Data Brief*. 2012;(94):1–8
2. Wang LY, Zhong Y, Wheeler L. Direct and indirect costs of asthma in school-age children. *Prev Chronic Dis*. 2005;2(1):A11
3. Zeiger RS, Yegin A, Simons FE, et al; TENOR Study Group. Evaluation of the National Heart, Lung, and Blood Institute guidelines impairment domain for classifying asthma control and predicting asthma exacerbations. *Ann Allergy Asthma Immunol*. 2012;108(2):81–87
4. Centers for Disease Control and Prevention (CDC). Asthma hospitalizations and readmissions among children and young adults--Wisconsin, 1991-1995. *MMWR Morb Mortal Wkly Rep*. 1997;46(31):726–729
5. Roemer M. *Health Care Expenditures for the Five Most Common Children's Conditions, 2008: Estimates for U.S. Civilian Noninstitutionalized Children, Ages 0-17 Statistical Brief #349*. Rockville, MD: Agency for Healthcare Research and Quality; 2011
6. Kattan M. Quality of inpatient care for asthma: challenges and opportunities. *Pediatrics*. 2008;122(6):1369–1370
7. Kattan M, Crain EF, Steinbach S, et al. A randomized clinical trial of clinician feedback to improve quality of care for inner-city children with asthma. *Pediatrics*. 2006;117(6). Available at: www.pediatrics.org/cgi/content/full/117/6/e1095
8. Lantner R, Brennan RA, Gray L, McElroy D. Inpatient management of asthma in the Chicago suburbs: the Suburban Asthma Management Initiative (SAMI). *J Asthma*. 2005;42(1):55–63
9. Nkoy FL, Fassl BA, Simon TD, et al. Quality of care for children hospitalized with asthma. *Pediatrics*. 2008;122(5):1055–1063
10. Barnett SB, Nurmagambetov TA. Costs of asthma in the United States: 2002-2007. *J Allergy Clin Immunol*. 2011;127(1):145–152
11. Chung HS, Hathaway DK, Lew DB. Risk factors associated with hospital readmission in pediatric asthma. *J Pediatr Nurs*. 2015;30(2):364–384
12. Kenyon CC, Melvin PR, Chiang VW, Elliott MN, Schuster MA, Berry JG. Rehospitalization for childhood asthma: timing, variation, and opportunities for intervention. *J Pediatr*. 2014;164(2):300–305
13. Leavitt M. Medscape's response to the Institute of Medicine Report: crossing the quality chasm: a new health system for the 21st century. *MedGenMed*. 2001;3(2):2
14. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academies Press; 2001
15. Brush JE Jr, Radford MJ, Krumholz HM. Integrating clinical practice guidelines into the routine of everyday practice. *Crit Pathw Cardiol*. 2005;4(3):161–167
16. Britto MT, Vockell AL, Munafo JK, et al. Improving outcomes for underserved adolescents with asthma. *Pediatrics*. 2014;133(2). Available at: www.pediatrics.org/cgi/content/full/133/2/e418
17. Kercsmar CM, Beck AF, Sauers-Ford H, et al. Association of an asthma improvement collaborative with health care utilization in Medicaid-insured pediatric patients in an urban community. *JAMA Pediatr*. 2017;171(11):1072–1080
18. Nkoy F, Fassl B, Stone B, et al. Improving pediatric asthma care and outcomes across multiple hospitals. *Pediatrics*. 2015;136(6). Available at: www.pediatrics.org/cgi/content/full/136/6/e1602
19. Andrews K, Esposito D, Taylor EF, et al. *Evaluation of the Business Case for Quality, Phase II: Cincinnati Children's Hospital Medical Center Case Study*. Princeton, NJ: Mathematica Policy Research; 2013
20. Bergert L, Patel SJ, Kimata C, Zhang G, Matthews WJ Jr. Linking patient-centered medical home and asthma measures reduces hospital readmission rates. *Pediatrics*. 2014;134(1). Available at: www.pediatrics.org/cgi/content/full/134/1/e249
21. Fassl BA, Nkoy FL, Stone BL, et al. The Joint Commission Children's Asthma Care quality measures and asthma readmissions. *Pediatrics*. 2012;130(3):482–491
22. McCarthy D, Cohen A. The Cincinnati Children's Hospital Medical Center's Asthma Improvement Collaborative: enhancing quality and coordination of care. *Commonwealth Fund*. 2013;7:1–20
23. Vernacchio L, Francis ME, Epstein DM, et al. Effectiveness of an asthma quality improvement program designed for maintenance of certification. *Pediatrics*. 2014;134(1). Available at: www.pediatrics.org/cgi/content/full/134/1/e242
24. Garcia-Cardenas V, Perez-Escamilla B, Fernandez-Llimos F, Benrimoj SI. The

complexity of implementation factors in professional pharmacy services. *Res Social Adm Pharm*. 2018;14(5):498–500

25. Gravas S, Tzortzis V, Melekos MD. Translation of benign prostatic hyperplasia guidelines into clinical practice. *Curr Opin Urol*. 2008;18(1): 56–60
26. Van Spall HG, Shanbhag D, Gabizon I, et al. Effectiveness of implementation strategies in improving physician adherence to guideline recommendations in heart failure: a systematic review protocol. *BMJ Open*. 2016;6(3):e009364
27. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA*. 1999;282(15): 1458–1465
28. Curry SJ. Organizational interventions to encourage guideline implementation. *Chest*. 2000;118(suppl 2):40S–46S
29. Lieu TA, Finkelstein JA, Lozano P, et al. Cultural competence policies and other predictors of asthma care quality for Medicaid-insured children. *Pediatrics*. 2004;114(1). Available at: www.pediatrics.org/cgi/content/full/114/1/e102
30. Sisk JE. How are health care organizations using clinical guidelines? *Health Aff (Millwood)*. 1998;17(5):91–109
31. Sonnad SS. Organizational tactics for the successful assimilation of medical practice guidelines. *Health Care Manage Rev*. 1998;23(3):30–37
32. Soumerai SB, McLaughlin TJ, Gurwitz JH, et al. Effect of local medical opinion leaders on quality of care for acute myocardial infarction: a randomized controlled trial. *JAMA*. 1998;279(17): 1358–1363
33. Subramanian U, Sutherland J, McCoy KD, Welke KF, Vaughn TE, Doebbeling BN. Facility-level factors influencing chronic heart failure care process performance in a national integrated health delivery system. *Med Care*. 2007;45(1):28–45
34. Vaughn TE, McCoy KD, BootsMiller BJ, et al. Organizational predictors of adherence to ambulatory care screening guidelines. *Med Care*. 2002;40(12): 1172–1185
35. Vaughn TE, Ward MM, Doebbeling BN, Uden-Holman T, Clarke WT, Woolson RF. Organizational and provider characteristics fostering smoking cessation practice guideline adherence: an empirical look. *J Ambul Care Manage*. 2002;25(2):17–31
36. Ward MM, Yankey JW, Vaughn TE, et al. Provider adherence to COPD guidelines: relationship to organizational factors. *J Eval Clin Pract*. 2005;11(4): 379–387
37. Welke KF, BootsMiller BJ, McCoy KD, et al. What factors influence provider knowledge of a congestive heart failure guideline in a national health care system? *Am J Med Qual*. 2003;18(3): 122–127
38. Wiener-Ogilvie S, Huby G, Pinnock H, Gillies J, Sheikh A. Practice organisational characteristics can impact on compliance with the BTS/SIGN asthma guideline: qualitative comparative case study in primary care. *BMC Fam Pract*. 2008;9:32
39. James BC, Savitz LA. How intermountain trimmed health care costs through robust quality improvement efforts. *Health Aff (Millwood)*. 2011;30(6): 1185–1191
40. National heart, Lung, and Blood Institute. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma*. Washington, DC: US Department of Health and Human Services; 2007
41. Kilbourne AM, Neumann MS, Pincus HA, Bauer MS, Stall R. Implementing evidence-based interventions in health care: application of the replicating effective programs framework. *Implement Sci*. 2007;2:42
42. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci*. 2009;4:50
43. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates; 1988
44. Flosadottir V, Roos EM, Ageberg E. Muscle function is associated with future patient-reported outcomes in young adults with ACL injury. *BMJ Open Sport Exerc Med*. 2016;2(1):e000154
45. Haws BE, Khechen B, Guntin JA, Cardinal KL, Bohl DD, Singh K. Validity of PROMIS in minimally invasive transforaminal lumbar interbody fusion: a preliminary evaluation. *J Neurosurg Spine*. 2018; 29(1):28–33
46. Portney L, Watkins M. *Foundations of Clinical Research. Applications to Practice*. 3rd ed. Upper Saddle River, NJ: Pearson Prentice Hall; 2009
47. Rodriguez-Martinez CE, Melo-Rojas A, Restrepo-Gualteros SM, Sossa-Briceño MP, Nino G. Validation of the Spanish version of the Childhood Asthma Control Test (cACT) in a population of Hispanic children. *J Asthma*. 2014;51(8):855–862
48. Vodanovich DA, Bicknell TJ, Holland AE, et al. Validity and reliability of the chronic respiratory disease questionnaire in elderly individuals with mild to moderate non-cystic fibrosis bronchiectasis. *Respiration*. 2015;90(2): 89–96
49. Lugtenberg M, van Beurden KM, Brouwers EP, et al. Occupational physicians' perceived barriers and suggested solutions to improve adherence to a guideline on mental health problems: analysis of a peer group training. *BMC Health Serv Res*. 2016;16:271
50. Lau R, Stevenson F, Ong BN, et al. Achieving change in primary care–causes of the evidence to practice gap: systematic reviews of reviews. *Implement Sci*. 2016;11:40
51. National Asthma Education and Prevention Program. Expert panel report 3 (EPR-3): guidelines for the diagnosis and management of asthma-summary report 2007. *J Allergy Clin Immunol*. 2007;120(suppl 5):S94–S138

52. Hughes R. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville, MD: Agency for Healthcare Research and Quality; 2008

53. Aarons GA, Ehrhart MG, Farahnak LR, Sklar M. Aligning leadership across systems and organizations to develop a strategic climate for evidence-based practice implementation. *Annu Rev Public Health*. 2014;35:255–274

54. Sharma S, Pandit A, Tabassum F. Potential facilitators and barriers to adopting standard treatment guidelines in clinical practice. *Int J Health Care Qual Assur*. 2017;30(3):285–298

55. Alexander PE, Li SA, Tonelli M, Guyatt G. Canadian primary care physicians' attitudes toward understanding clinical practice guidelines for diabetes screening. *Can J Diabetes*. 2016;40(6):580–585

56. Kastner M, Estey E, Hayden L, et al. The development of a guideline implementability tool (GUIDE-IT): a qualitative study of family physician perspectives. *BMC Fam Pract*. 2014;15:19

57. Robins LS, Jackson JE, Green BB, Korngiebel D, Force RW, Baldwin LM. Barriers and facilitators to evidence-based blood pressure control in community practice. *J Am Board Fam Med*. 2013;26(5):539–557

58. Majid S, Foo S, Luyt B, et al. Adopting evidence-based practice in clinical decision making: nurses' perceptions, knowledge, and barriers. *J Med Libr Assoc*. 2011;99(3):229–236

59. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and strategies in guideline implementation-a scoping review. *Healthcare (Basel)*. 2016;4(3):E36

60. Bhatt J, Swick M. *Focusing on Teamwork and Communication to Improve Patient Safety*. Chicago, IL: American Hospital Association, Advancing Health in America; 2017

61. Keller KB, Eggenberger TL, Belkowitz J, Sarsekeyeva M, Zito AR. Implementing successful interprofessional communication opportunities in health care education: a qualitative analysis. *Int J Med Educ*. 2013;4:253–259

62. King HB, Battles J, Baker DP, et al. TeamSTEPPS: team strategies and tools to enhance performance and patient safety. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. *Advances in Patient Safety: New Directions and Alternative Approaches*. Vol 3. Rockville, MD: Performance and Tools; 2008

63. Nancarrow SA, Booth A, Ariss S, Smith T, Enderby P, Roots A. Ten principles of good interdisciplinary team work. *Hum Resour Health*. 2013;11:19

64. Baker DP, Day R, Salas E. Teamwork as an essential component of high-reliability organizations. *Health Serv Res*. 2006;41(4 pt 2):1576–1598

65. Cabana MD, Ebel BE, Cooper-Patrick L, Powe NR, Rubin HR, Rand CS. Barriers pediatricians face when using asthma practice guidelines. *Arch Pediatr Adolesc Med*. 2000;154(7):685–693

66. Scott SD, Osmond MH, O'Leary KA, Graham ID, Grimshaw J, Klassen T; Pediatric Emergency Research Canada (PERC) MDI/spacer Study Group. Barriers and supports to implementation of MDI/spacer use in nine Canadian pediatric emergency departments: a qualitative study. *Implement Sci*. 2009;4:65

67. Morrow S, Daines L, Wiener-Ogilvie S, et al. Exploring the perspectives of clinical professionals and support staff on implementing supported self-management for asthma in UK general practice: an IMP^{2}ART qualitative study. *NPJ Prim Care Respir Med*. 2017;27(1):45

68. Wahabi HA, Alziedan RA. Reasons behind non-adherence of healthcare practitioners to pediatric asthma guidelines in an emergency department in Saudi Arabia. *BMC Health Serv Res*. 2012;12:226

Contextual Factors Influencing Implementation of Evidence-Based Care for Children Hospitalized With Asthma

Flory L. Nkoy, Victoria L. Wilkins, Bernhard A. Fassl, Joseph M. Johnson, Derek A. Uchida, Justin B. Poll, Tom H. Greene, Karmella J. Koopmeiners, Carolyn C. Reynolds, Karen J. Valentine, Lucy A. Savitz, Christopher G. Maloney and Bryan L. Stone

Hospital Pediatrics 2019;9;949
DOI: 10.1542/hpeds.2019-0050 originally published online November 6, 2019;

Hospital Pediatrics®

AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Contextual Factors Influencing Implementation of Evidence-Based Care for Children Hospitalized With Asthma

Flory L. Nkoy, Victoria L. Wilkins, Bernhard A. Fassl, Joseph M. Johnson, Derek A. Uchida, Justin B. Poll, Tom H. Greene, Karmella J. Koopmeiners, Carolyn C. Reynolds, Karen J. Valentine, Lucy A. Savitz, Christopher G. Maloney and Bryan L. Stone

Hospital Pediatrics 2019;9;949
DOI: 10.1542/hpeds.2019-0050 originally published online November 6, 2019;