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Best practices in implementing inpatient pediatric asthma pathways: a qualitative study

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ABSTRACT

Objective: Clinical pathways (operational versions of practice guidelines) can improve guideline adherence and quality of care for children hospitalized with asthma. However, there is limited guidance on how to implement pathways successfully. Our objective was to identify potential best practices in pathway implementation.

Methods: In a previous observational study, we identified higher and lower performing children's hospitals based on hospital-level changes in asthma patient length of stay after implementation of a pathway. In this qualitative study, we conducted semi-structured interviews with a purposive sample of healthcare providers involved in pathway implementation at these hospitals. We used constant comparative methods to develop a conceptual model of potential best practices in implementation.

Results: Healthcare providers ($n = 24$) from 6 higher performing and 2 lower performing hospitals were interviewed about pathway implementation. We identified several practices that addressed barriers and promoted successful pathway implementation: (1) utilizing quality improvement (QI) methodology and a data-driven approach helped overcome inertia of current practice; (2) getting teams to commit to shared goals around asthma care helped overcome disagreements in the implementation process; (3) integrating pathways into the electronic medical record decreased some burdens of implementation; (4) leveraging multi-disciplinary teams by developing protocols for nurses and/or respiratory therapists to titrate medications reduced variability in provider practice; and (5) engaging hospital leaders with pathway implementation teams helped secure crucial resources.

Conclusions: We identified several potential best practices to support pathway implementation. Hospitals implementing pathways should consider applying these strategies to better ensure success in improving quality of asthma care for children.

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Introduction

Asthma is a leading cause of pediatric hospitalizations (1). Clinical pathways are operational, bedside versions of evidence-based guidelines (2); they guide providers step-by-step in caring for patients by providing succinct guidance on the timing, indications, and details of recommended tests and treatments for managing a specific illness. Pediatric asthma pathways commonly include specific instructions on how to assess a child's clinical severity and titrate bronchodilator treatments. Pathways have been shown to improve quality of care for children hospitalized with asthma (3–12), and indeed, a national analysis showed the proportion of children's hospitals using inpatient

pediatric asthma pathways rose from 27% to 86% from 2005 to 2015 (13).

Although clinical pathways can improve the quality of inpatient pediatric asthma care, there is wide variability in the effects observed with pathway implementation. This variation in outcomes is likely reflective of variation in pathway implementation strategies. Developing setting- and population-specific strategies could facilitate more consistent, successful pathway implementation and widespread benefits for child health (14). Using the search strategy of a previous systematic review of pediatric asthma pathways (15), we found no prior studies that primarily focus on better understanding pathway implementation strategies.

One approach to understanding implementation strategies is the “positive deviance” approach, which proposes that examination of higher performing organizations can facilitate discovery of strategies to improve care (16). This approach recognizes that mixed methods are crucial for illuminating the real-life contextual understandings, multi-level perspectives, and cultural influences necessary for successful implementation (16). We determined hospital performance in a prior quantitative analysis that examined hospital-level changes in asthma patient length of stay after pathway implementation (6).

With this study, our objective was to identify potential best practices in asthma pathway implementation and develop a conceptual model of how these practices help overcome implementation barriers. Our positive deviance approach used qualitative methods to understand which practices higher performing hospitals employed during pathway implementation, and whether their practices differed from lower performing hospitals. Our analysis is meant to provide actionable guidance for healthcare providers, quality improvement leaders, hospital administrators, and policymakers seeking to improve implementation of evidence-based guidelines and quality of care for hospitalized children.

Methods

Study design and sample

In a previous observational study, we performed a hierarchical, multivariable regression analysis of 42 tertiary academic children’s hospitals in the Pediatric Health Information System database (6). This was the first national, multi-center analysis of pediatric asthma pathways. The analysis adjusted for case-mix differences as well as secular trends. We determined adjusted hospital-level changes in length of stay (LOS) following pathway implementation. Those hospitals with the largest decreases in LOS (range: 20–55%) were identified as higher performers. We selected length of stay because it is a patient-centered outcome that reflects time to recovery. Asthma is the top cause of chronic illness-related school absence for children and missed work for caregivers in the U.S. (17). Decreasing LOS can thus decrease missed school, missed work for caregivers, and health system costs. Other outcomes analyzed in the previous observational study included systemic steroid administration, bronchodilator administration, chest radiography utilization, antibiotic prescription, ipratropium bromide administration for >24 h, and 30-day hospital readmission.

These outcomes were not selected for defining hospital-level performance for two reasons: (1) we were unable to identify adequate numbers of higher and lower performing hospitals based on these measures (due to heterogeneity in pathway interventions and limited sample sizes at the hospital level) and (2) most of these outcomes reflect guideline adherence/care processes rather than patient-centered outcomes.

In this qualitative study, we conducted individual semi-structured interviews designed to elicit a detailed understanding of organizational context and implementation processes (18,19). We conducted purposeful sampling of key personnel (e.g., physicians, nurses) involved in implementation of pediatric asthma pathways at higher and lower performing hospitals. We then used a snowball sampling method, in which participants identified and put our team in touch with additional key personnel that were involved in pathway implementation.

Our first phase involved identifying potential best practices through analysis of personnel from higher performing hospitals. Higher performing hospitals were enrolled sequentially until thematic saturation was reached. We also interviewed personnel from two hospitals that had published analyses documenting quality gains with pathway implementation, but could not be included in our database analysis due to pathway implementation before 2005.

In our next phase, we analyzed lower performing hospitals to understand any differences in use of the potential best practices identified in phase 1. Lower performing hospitals were defined as those with increases in LOS following pathway implementation. On the basis of prior positive deviance studies, we anticipated that data would be less rich in lower performing hospitals (18,19). We contacted two lower performing hospitals before reaching theoretical saturation. The institutional review board at the University of California, San Francisco, reviewed this qualitative study and exempted it as not human subjects research (due to lack of inquiry on sensitive topics or collection of personal identifiers).

Data collection

We used the constructs described in the Consolidated Framework for Implementation Research (CFIR (20)), and adapted those salient to inpatient pediatric asthma pathways to develop a semi-structured interview guide that was used with all study participants (Appendix 1). CFIR offers an overarching typology to understand what works where and why across

Table 1. Characteristics of included children's hospitals.

<i>Higher or lower performer</i>	<i>Geographic region</i>	<i>Number of pediatric beds</i>	<i>Academic affiliation</i>	<i>Freestanding</i>	<i>Year of pathway implementation</i>
Higher	Midwest	253	Yes	Yes	2008
Higher	South	248	Yes	Yes	2013
Higher	South	348	Yes	Yes	2013
Higher	Northeast	100	Yes	No	2014
Higher	West	254	Yes	Yes	Prior to 2005
Higher	Midwest	523	Yes	Yes	Prior to 2005
Lower	Midwest	264	Yes	Yes	2009
Lower	Northeast	404	Yes	Yes	2011

multiple contexts. CFIR is composed of five major domains that influence implementation: intervention characteristics, inner setting (hospital), outer setting (economic, political, and social context of the hospital), characteristics of the individuals involved, and the process of implementation (20). Data were collected across all five of these domains to inform our analysis of potential best practices in implementation and common implementation barriers. Our interview guide was peer-reviewed by a scientific review panel at the Agency for Healthcare Research and Quality.

Interviews were conducted in person and by phone from October 2016 to September 2017 (SVK). Participants were blinded to the hospital's performance with pathway implementation. We confirmed with all participants that they were involved in pathway implementation. Interviews lasted 30–60 min and were recorded and transcribed verbatim. Transcripts were edited for accuracy using audio recordings of the interviews. To ensure that multiple perspectives were represented from each hospital, we asked to interview personnel across a range of clinical positions that had been involved with pathway implementation. As we were collecting retrospective data, we used specific interviewing techniques to facilitate effective retrospective responses: (1) providing a clear anchor reference point to orient their experience (the pathway implementation date) and (2) asking clarifying questions about temporal relationships. This retrospective approach has been effective for qualitative data collection from hospital personnel in previous studies (18,19).

Analysis

Analysis was done using constant comparative methods (21). We used the approach of Charmaz: (1) collected interview data that focused on understanding the context and steps of the implementation process and how individuals experienced the process (SVK); (2) performed initial open-coding of the data (SVK and RL); (3) identified focused codes and categories

using CFIR as a resource (all investigators); (4) performed focused coding and categorizing of the data (SVK and RL); (5) developed a conceptual model that described the relationship between categories of potential best practices and common barriers described in the data (all investigators). CFIR was used at two stages of the study: (1) developing the interview guide and (2) cross-checking for any potentially important codes that were missing/needed to be explored further before focused coding. Thus, investigators maintained an inductive approach that was grounded in the data. Disagreements about focused codes, categories, and the conceptual model were resolved through review of primary data and iterative discussions among all study investigators. We used several strategies to assure study rigor, including investigator triangulation, peer analysis, respondent verification (with four participants that volunteered additional time to review our findings), and reflexivity (SVK [pediatric hospital medicine physician] and RL [research assistant]). Coding was performed using Atlas.ti 7.5 (Berlin, Germany).

Results

Participants

A total of 40 key personnel from 6 higher performing and 2 lower performing hospitals were approached for this study (Table 1). We were able to conduct interviews at all hospitals we approached. Sixteen potential participants declined and 24 participants were interviewed about pathway implementation (range: 2–6 participants per hospital). We interviewed 14 (58%) hospitalist physicians (one was also an information technology specialist), 4 (17%) respiratory therapists, 3 (13%) nurse practitioners, 2 (8%) nurses, and 1 (4%) pharmacist. The 16 participants who declined were similar in professional role distribution (68% physician, 13% respiratory therapists, 13% nurse practitioner, 6% nurse), and rate of declining to participate was similar in higher and lower performing hospitals (38% vs. 43%, respectively).

Potential best practices

We identified several potential best practices that participants reported were helpful to overcoming barriers and promoting successful pathway implementation. They are presented in order of frequency of occurrence within the data (e.g., most discussed practice presented first):

Using quality improvement (QI) and data-driven approach to implement pathways

All higher performing hospitals utilized QI methods and a data-driven approach to implement pathways. Participants described the importance of implementation team members having QI training and using QI methods to integrate pathways into clinical workflows. For example, participants described how teams conducted Plan-Do-Study-Act cycles of modifying workflows to promote higher rates of appropriate treatment selection by providers. Teams at higher performing hospitals also collected and used detailed data on process, outcome, and balancing measures throughout the implementation process (e.g., using baseline data to select project goals, modifying workflows using data on process measures, giving data reports of individual performance to providers). This practice strikingly differed between higher and lower performers. Lower performing hospitals had little QI expertise or methods supporting the process of integrating pathways into clinical workflows and had limited data to guide pathway implementation (only outcome measures collected routinely for public reporting).

Higher performer:

“The key is the ability to have the data, how are we doing with this, and then being able to identify where the processes break down. It is that rapid testing of things and having a group of people that can say, ‘Okay, we’re only at this level... what’s happening? What are the problems? What else can we test?’” (Physician)

Lower performer:

“No, we didn’t track any quality metrics or other data.” (Physician)

“It would have been really helpful if we had a data person who set up ahead of time to monitor [quality measures] as we went along.” (Nurse Practitioner)

Committing to shared goals

All higher performing hospitals described the importance of developing a commitment to shared goals. At

higher performing hospitals, implementation leaders developed consensus around shared goals for improving asthma care and outcomes early in the implementation process. They then worked with all hospital staff involved in care of children with asthma to collaboratively and efficiently implement pathways and achieve those goals. Participants described examples of how teams motivated by these shared goals quickly worked through differences in opinion, collaborated effectively to develop thoughtful implementation plans, and kept on track with an implementation schedule. This was facilitated by regular scheduled meetings and a formal process for resolving disagreements (e.g., having all voices/views heard and then voting). This practice differed markedly between higher and lower performers. Lower performers reported difficulty getting teams to effectively and efficiently develop shared goals and work together to implement pathways.

Higher performers:

“The people that work here ... are on a mission. Their mission is to care for children ... to improve the lives of children ... Then by framing [that the specific asthma] outcome [we are targeting] is something that is doable, we get enthusiasm about it.” (Physician)

“We have great physician buy-in and we have great understanding that it’s a team effort. There were a lot of people making sure that they were working synergistically and not against each other. There’s very little ... ‘That’s not my job,’ or, ‘Why do I have to do that?’ It was very much a, ‘How do we make this better?’” (Nurse)

Lower performer:

“It’s so hard to explain because I’ve been here for 30 years, and I am a part of the dysfunction. But unfortunately, there [are] a lot of silos around here ... it’s just very difficult to get all of the different silos on the same page. It was meetings upon meetings upon meetings, making sure that you get one person up to date, [and] it took like a good couple of years [before they said] we literally can’t ignore [implementing this pathway] anymore ... It was push, push, push.” (Nurse Practitioner)

Integrating tools into the electronic medical record (EMR)

Implementation teams at higher performing hospitals were better supported in integrating pathways into the EMR. EMR-based order sets provided decision support by reminding providers of recommended tests and treatments. At higher performing hospitals, EMR

tools also enabled communication between providers, linked providers to more detailed evidence-based guidelines, facilitated screening of children's chronic asthma symptoms, and automated data collection on the implementation process (e.g., use of the pathway, clinical outcomes). Higher performing hospitals also often had information technology specialists on their implementation teams to help design EMR tools in user-friendly, effective ways.

Although some EMR integration was done at lower performing hospitals (e.g., order set development), these hospitals had less support for EMR integration (e.g., delays in order set development, no information technology specialist) and were not able to leverage the EMR to automatically collect data on the implementation process.

Higher performers:

"Working directly with clinicians in designing EMR tools better assures mutual gains with use. For example, I designed the order set so that it made it easier for them to do their work: 'Here's all the medications that you need in your usual defaulted doses, dose one, two and three.'" (Physician, Information Technology Specialist)

"There are all these links embedded within the pathway that take people to deeper levels of knowledge." (Physician, Information Technology Specialist)

Lower performer:

"I would say just getting... an order set built and embedded is always [a challenge]. You're depending on other people to do that and making sure it's user friendly; so that was probably another thing that was a [challenge to do quickly and successfully]." (Physician)

Leveraging multidisciplinary teams

Higher performing hospitals established protocols for nurses and/or respiratory therapists to autonomously assess clinical severity and titrate bronchodilator medication for children with asthma. This usually involved shifting responsibility from trainee and supervising physicians (who traditionally performed these tasks) to nurses/respiratory therapists. Participants described that this shift sometimes met with initial opposition rooted in concerns about nurses/respiratory therapists having inadequate training to perform these tasks, and physician trainees getting less training in these tasks. However, implementation teams were ultimately able to build consensus around the protocols, and the protocols facilitated improved care and outcomes for children.

Participants reported that once nurses/respiratory therapists were trained, the protocols facilitated more standardized and efficient weaning of medication and discharge of children home from the hospital.

One of the lower performing hospitals stopped allowing respiratory therapists to autonomously use the protocol, which may have affected their performance. Implementation leaders at this site reported that the protocol was discontinued several months after initiation due to physician concerns about respiratory therapists being inadequately trained to perform these tasks.

Higher performer:

"I think asthma is unique because [of the] nurse-driven protocol... that was probably a pretty big practice change when it originally went out. But now that's how we do things, and they were able to show us data that it decreased length of stay and didn't have any negative outcome." (Physician)

Lower performer:

"In the past, we had it where respiratory therapists could assess the patient and ... they could wean [medications] on their own. There were some physicians [who] didn't like it, and there were some disagreements between the respiratory therapists and the physicians. So we don't do that [protocol] anymore." (Nurse)

Engaging hospital leaders

All higher performing hospitals described collaboration between engaged hospital leaders and pathway implementation teams. Hospital leaders at higher performing hospitals recognized asthma as a high priority, stayed involved throughout implementation, and provided crucial resources to implementation teams. These resources included administrative support for scheduling meetings, technical support from a QI team to gather data and help guide the implementation process, financial support for implementation leaders' time, and technical support for integrating pathways into the EMR. This practice also differed markedly between higher and lower performers. Low performers reported lack of engagement between hospital leaders and implementation teams. They also reported difficulty securing essential resources for implementation.

Higher performer:

"[Before implementation,] we were really limited on what data collection tools we had. We didn't have a lot of electronic data collection and [hospital leaders'] investment in providing resources and making it a focus, so that we could see in real time what our outcomes were, made a huge difference." (Physician)

Lower performer:

"I have to admit that it is challenging and every once in a while I will go to my director and say, 'Is this still priority? Because I'm struggling with all my responsibilities.' It would be much better if there were somebody who had time dedicated to it, because it'd get easier to do." (Nurse Practitioner)

Additional practices

The potential best practices described above reflect codes that were frequently described in our data and differed when comparing higher and lower performing hospitals. Some additional codes that were less commonly described included "educating and training healthcare providers" in pathway content, "standardizing care across settings within the hospital" (e.g., emergency department, intensive care unit), and "providing asthma management education to care-takers of children with asthma."

Common implementation barriers

We identified several common barriers that participants reported during pathway implementation. They are presented in order of frequency of occurrence within the data (e.g., most discussed barrier presented first).

Disagreements during pathway implementation

Participants at both higher and lower performing hospitals commonly described facing difficulty getting staff to reach consensus during the pathway implementation process. However, at higher performing hospitals, disagreements were efficiently resolved through collaborative discussions focused on the goal of improving care. Thus, committing to shared goals helped overcome this barrier.

Higher performer:

"Sometimes [people think] anecdotal experience is more valuable than the true data. Sometimes we would say, 'We can see there's some conflict here and we will read some more and bring it back up.' Other times, we would say, 'We have to move on right now. Let's take a vote.' You have to keep people on task and work through those issues [efficiently to reach your goal]." (Physician)

Inertia of current practice

Participants at both higher and lower performing hospitals described difficulties getting providers to change his/her practice to follow the pathway recommendations.

At higher performing hospitals, teams shared data with providers that motivated them to change behavior. Thus, using a data-driven approach to implementation helped overcome this barrier.

Higher performer:

"We pull data and have shown people their [practice] relative to others and their outcomes relative to others. By giving people that data, we've seen [practice change] because people [see the data and] say, 'Oh, I will change my behavior.'" (Physician)

Variability in provider practice

Participants at both higher and lower performing hospitals tried to address and overcome inappropriate variability in provider practice. At higher performing hospitals, there was recognition of the value of protocols for nurses and/or respiratory therapists to titrate medications. These protocols helped standardize care and decrease variability.

Higher performer:

"I think what's great about the asthma pathway is that it gives nursing some autonomy into spacing patients, which improves timeliness of treatment... it's very predictable...it really helps to have a standard course for how things are going to go." (Nurse)

Competing priorities

Participants at both higher and lower performing hospitals described challenges due to competing institutional priorities. At higher performing hospitals, leaders recognized and maintained pediatric asthma care as a high priority. Thus, engaging hospital leaders and implementation teams helped overcome this barrier.

Higher performer:

"We have [had] a lot of other initiatives come up [over time], but we continued to have leadership support maintained [to prioritize asthma]." (Physician)

Burdens of implementation

Participants at both higher and lower performing hospitals described the time burdens of implementation. At higher performing hospitals, one strategy used to overcome some of this burden was automation of data collection through the EMR. Thus, integration of new EMR tools to collect data helped overcome some of the burdens of implementation.

Potential Best Practice	Description	Illustrative Quote/Barrier Addressed
1 Using QI & Data-driven Approach	Teams used QI methods (e.g., Plan-Do-Study-Act cycles) to integrate pathways into clinical workflows and reviewed detailed data on process, outcome, and balancing measures	"We pull data and have shown people their practice relative to others and their outcomes relative to others. By giving people that data, we've seen practice change because people see the data and say, 'Oh, I will change my behavior.'" (BARRIER: Inertia of Current Practice)
2 Committing to Shared Goals	Teams developed consensus around shared goals for improving asthma care and outcomes early in the implementation process	"Sometimes [people think] anecdotal experience is more valuable than the true data. Sometimes we would say, 'We can see there's some conflict here and we will read some more and bring it back up.' Other times, we would say, 'We have to move on right now. Let's take a vote.' You have to keep people on task and work through those issues [efficiently to reach your goal]." (BARRIER: Disagreements during Pathway Implementation)
3 Integrating Tools into the Electronic Medical Record (EMR)	EMR-based tools were used in many ways including providing clinical decision support (e.g., order sets), enabling communication between providers, and automating data collection on the implementation process	"We can query [the EMR] and have a report run. It unloads some of the work so [providers] can actually be taking care of patients and doing what's needed for [pathway implementation] instead of collecting mindless data." (BARRIER: Burdens of Implementation)
4 Leveraging Multidisciplinary Teams	Teams developed protocols for nurses and/or respiratory therapists to autonomously assess clinical severity and titrate bronchodilator medication for children hospitalized with asthma	"I think what's great about the asthma pathway is that it gives nursing some autonomy into spacing patients, which improves timeliness of treatment... it's very predictable...it really helps to have a standard course for how things are going to go." (BARRIER: Variability in Provider Practice)
5 Engaging Hospital Leaders	Teams engaged with hospital leaders and those leaders recognized asthma care as a high priority, stayed involved throughout implementation, and provided critical resources	"We have [had] a lot of other initiatives come up [over time], but we continued to have leadership support maintained [to prioritize asthma]." (BARRIER: Competing Priorities)

Figure 1. Conceptual model of potential best practices in pathway implementation. The leftmost column identifies the potential best practices in pathway implementation. The middle column contains the descriptions of these potential best practices. The rightmost column provides a quote that illustrates how these practices helped overcome common implementation barriers.

Higher performer:

"We can query [the EMR] and have a report run. It unloads some of the work so [providers] can actually be taking care of patients and doing what's needed for [pathway implementation] instead of collecting mindless data." (Physician, Information Technology Specialist)

Conceptual model

We developed a conceptual model that illustrates the potential best practices we identified and how these practices helped overcome common implementation barriers (Figure 1).

Discussion

This multi-center, national study is the first to our knowledge to provide detailed, targeted guidance for the successful implementation of inpatient pediatric asthma pathways. Prior studies of the effectiveness of pathways have not provided detailed guidance on implementation (3–12), and prior reviews and conceptual frameworks of implementation have not provided

targeted information specific to pediatric asthma pathways (22,23). We identified several potential best practices that helped overcome common implementation barriers. Few prior studies of inpatient pediatric asthma pathways have described use of QI methods or a data-driven process (3,10), but our key informants pointed to these practices as crucial to successful implementation at high-performing hospitals. We also found higher performing hospitals had greater support for integrating pathways into the EMR and using protocols for nurses/respiratory therapists to titrate bronchodilator therapy. In addition, we found collaboration between engaged hospital leaders and pathway implementation teams facilitated provision of crucial resources (e.g., data collection support). Those seeking to improve implementation of evidence-based guidelines and quality of pediatric asthma care could consider incorporating these practices into local pathway implementation efforts to ensure success. Given asthma is a top cause of childhood hospitalization across all types of hospitals (e.g., children's, community), our findings have broad potential impact.

There are no prior studies to our knowledge that primarily focus on better understanding pediatric

asthma pathway implementation. However, our findings (1) build upon prior studies that provided some limited data on pediatric asthma pathway implementation and (2) align with studies of adult pathway implementation. A study by Kaiser et al. characterizing overall utilization of inpatient pediatric asthma pathways collected brief, survey free-text responses on “factors important for pathway implementation” as a secondary objective and did not correlate these findings with performance (13). A single-site randomized trial of inpatient pediatric asthma pathway implementation collected qualitative interview data from providers on overall satisfaction, but not specifically on implementation practices (11). Our study provides a more in-depth, detailed understanding that builds upon implementation practices noted in these studies, including committing to shared goals, using QI and a data-driven approach, integrating pathways into EMRs, and using nurse/respiratory therapist bronchodilator protocols. Our results also align with studies of adult clinical pathway implementation (22,24), but our analysis provides setting- and population-specific strategies for hospitals focused on improving pediatric asthma care. Reviews of practices important to implementation of adult pathways and guidelines reported committing to shared goals, using QI and a data-driven approach, and integrating pathways into EMRs to be important to success (22,24). These studies did not emphasize engaging hospital leaders. In addition, these studies did not highlight practices specific to pediatric asthma, such as development of nurse/respiratory therapist bronchodilator protocols or providing asthma management education to caretakers.

We also found that utilizing QI and a data-driven approach was crucial to successful pathway implementation. At higher performing hospitals, QI methods were used to integrate pathways into clinical workflows and data were used at every stage of implementation to identify gaps in practice, prompt hospital leaders to invest resources in pathway implementation, motivate providers to change behavior, and guide integration of pathways into clinical workflows. Although our findings indicate these practices are important for successful implementation, they require substantial resources. National QI collaboratives have provided external QI support to promote successful pathway implementation for other pediatric respiratory illnesses (25,26). Hospitals with fewer internal resources for pediatric pathway implementation might consider harnessing such external supports.

Our analysis reinforces evidence in favor of instituting protocols for nurses/respiratory therapists to

titrate bronchodilator therapy. These protocols have been shown in multiple quantitative analyses to correlate with decreased LOS (5,7–12). Our analysis demonstrates that providers also perceive great value in these protocols. Our participants reported that the protocols promoted more standardized, efficient care, because nurses/respiratory therapists were able to assess patients in a timelier manner than physicians. Additionally, Pound et al. reported that providers felt these protocols “provided nurses with more time to interact with and educate families, which led to better patient/family-centered care (11).” Both the higher and lower performing hospitals in our analysis used these protocols; however, one lower performing hospital stopped permitting nurses and respiratory therapists to autonomously use the protocol. We suspect this affected this hospitals’ performance and want to emphasize the evidence in favor of hospitals instituting these protocols.

We found that engaging hospital leaders with implementation teams was critical to successful implementation. At higher performing hospitals, this collaboration led to discussion of how pathway implementation aligned with institutional goals, sponsorship and prioritization of pathways on the institutional agenda, and provision of key resources (administrative support, QI support, support of implementation leaders’ time, and technical support to integrate pathways into the EMR). Other analyses of pathway/guideline implementation have reinforced the importance of having needed resources for implementation (24). Additionally, Ralston et al. found lack of these resources (e.g., technical support) to be an important barrier to pediatric inpatient pathway implementation in bronchiolitis (27). Hospitals considering pathway implementation should facilitate collaboration of hospitals leaders and implementation teams to ensure needed resources are available and promote pathway success.

This study has several strengths. We used a theory-informed approach, involved study sites across the country, and promoted the rigor of our findings through multiple methods (e.g., reflexivity, triangulation of investigators, and participant categories). However, there are several limitations to our analysis. First, we defined high versus low performance based on LOS, because this patient-centered outcome has most consistently been shown to improve with inpatient pediatric asthma pathway implementation (5–12). However, other ways of defining hospital performance with pathway implementation could be considered. Moreover, the identification of higher and

lower performing hospitals was not based on absolute performance but relative performance compared to peers. The lower performing hospitals were not necessarily poorly performing hospitals and the higher performing hospitals may still have room to improve. Second, our sample only focused on children's hospitals, so may have limited generalizability to general hospitals (that provide care for both children and adults). However, our findings align with studies from other hospital settings, and our future work will test the applicability of our findings to general hospitals (28). Third, although we consistently probed about processes, contextual factors, and cultural influences that might have affected pathway implementation, additional practices that did not come up regularly in our interviews may also play a role in pathway implementation. Our future work across a broad array of hospital settings will continue to explore potential additional best practices (28). Fourth, some practices we identified may depend on preexisting organizational capacity (e.g., QI expertise). However, our results could still be used to identify areas where hospitals should focus on capacity building. Fifth, participants were recalling events that occurred in the past (>12 years ago in some cases), and as such, may be subject to recall bias. Finally, this qualitative analysis is not able to draw conclusions regarding causality.

Conclusions

We identified several potential best practices to support successful inpatient pediatric asthma pathway implementation. These practices were reflective of the experience of children's hospitals, but may also be relevant to broader settings. Hospitals implementing pathways should consider applying QI methods and using data to drive the implementation process, getting implementation teams to commit to shared goals, integrating pathways into EMRs, leveraging multidisciplinary teams by instituting protocols for nurses/respiratory therapists to titrate medications, and facilitating engagement of hospital leaders with implementation teams.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Appendix 1. Semi-structured interview guide on implementation of inpatient pediatric asthma pathways.

Open-ended question	Potential semi-structured probes (chosen based on responses to open-ended questions and evolving theory)
Intervention characteristics Think about when you first learned about the inpatient asthma pathway tool. What were your initial thoughts about the tool?	• Did you think the pathway was based on high-quality evidence? • Was the pathway developed at your hospital or somewhere else? • Did you think that implementing the pathway was the best way to improve quality of care, or did you feel other methods would be better? • Did you adapt the pathway for use in your setting? How did that go? • Did you test/trial the pathway before implementation? How did that go? • How complex was the pathway to use while providing care? • How well do you feel the pathway was designed and packaged? • Did you think the costs of implementing the pathway were lower than expected, reasonable, or too high?
Outer setting Can you describe any pressure the hospital may have faced that influenced the decision to implement an inpatient pediatric asthma pathway?	• Were patient needs and preferences integrated in pathway implementation? Can you describe how? • If your hospital is part of a larger network, was there pressure to implement pathways at your hospital because other hospitals within your network used them? Can you give an example? • Did any external policies or incentives (e.g., government policies, public reporting of quality metrics, insurance payment policies) play a role in pathway implementation? Can you give an example? • Was there pressure to implement pathways at your hospital because other similar institutions used them? Can you give an example?
Inner setting What characteristics or resources of your hospital do you think made pathway implementation successful?	• What is the size and general organization of your hospital (e.g., number of departments/units, how different types of providers are managed)? • How stable are the teams of providers that use the pathway? Can you describe how staff turnover affected implementation? • How would you describe the communication patterns between hospital staff (e.g., strong vs. weak, formal vs. informal, tangible vs. intangible, collaborative vs. hierarchical)? How did these communication patterns affect pathway implementation? • How did the culture/climate of the hospital affect implementation (i.e., tension for change, compatibility of pathway with hospital culture, goals/incentives for implementation, engagement of hospital leaders)?
Individuals Why were individual providers able to successfully implement and utilize pathways?	• Did providers think the pathway was a valuable tool? Can you give me an example of when a provider found the pathway valuable? • Did providers have the necessary skills to implement pathways? Can you give me an example of a skill that had to be learned to use it? • Did providers believe they were capable of using pathways? • How did providers feel about whether the pathway should be implemented (e.g., unsure, excited)? • How strongly do you feel different types of providers identify with and are committed to the goals of the hospital? Can you give an example of when you observed a provider's commitment to the hospital's goals?
Implementation What aspects of the implementation process made it successful?	• During the planning of pathway implementation, did the following happen: (1) engaging stakeholders, (2) developing implementation strategies for different groups/providers, (3) using effective communication, (4) tracking of progress toward goals, (5) developing strategies to simplify implementation? Can you give examples? • Who led the implementation process (e.g., opinion leaders, internal vs. external staff)? Can you describe interactions with these leaders? • Were there opportunities for reflecting and evaluating implementation? Can you describe one example? • Was compliance with the pathway or patient outcomes monitored? If not, do you have ideas on how it could be done?