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A Case Study of Pediatric Asthma Alerts from the Beacon Community Program in Cincinnati: Technology is Just the First Step

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Methods: We interviewed key Beacon leaders as well as providers and office staff in selected practices. We also collected preliminary data from practices that reflected handling of alerts, including the number of asthma related alerts received and followed up.

Results: Regional alerts, supplied by the community-wide health information exchange, were a significant addition to the quality improvement effort in that they enabled practices to identify and follow up with additional children at risk. An important finding was the substantial effort at the practice level to integrate technology into ongoing patient care.

Conclusions: Developing the technology for community wide alerts represented a significant endeavor in the Cincinnati Beacon Community. However, the technology was just the first step. Despite extra effort and time required on the part of individual practices, they reported that the value of having alerts was high. Hospital and ED visits represent some of the most costly aspects of care, and an efficient process for intervening with children using these costly services was seen as of significant value.

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Keywords

Health Information Technology; Quality Improvement; Data Use and Quality

Disciplines

Health Information Technology | Health Services Research | Respiratory Tract Diseases

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eGEMs

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Introduction

Implementing an information technology solution for notifying primary care practices when patients were hospitalized or seen in the emergency department (ED) was a primary objective of the Greater Cincinnati Beacon Community Program (GCBC). The Cincinnati Beacon was one of 17 Beacon Community Programs nationwide[1] that received funding from the Health Information Technology for Economic and Clinical Health (HITECH) Act to test innovative approaches for aligning Health Information Technology (HIT) with quality improvement interventions and payment reform strategies to improve care delivery and outcomes at the population level.[2,3]

In Cincinnati, the Beacon funding was used, in part, to enhance the community-wide Health Information Exchange (HIE) infrastructure managed by *HealthBridge*.[4] This consisted of data on admissions and ED visits to hospitals in the region, and enabled the creation of an automated alerting system that electronically notified primary care practices when patients experienced a hospital admission or ED visit. This alerting is crucial to identifying patients who are most at risk and to pursuing interventions that reduce preventable hospitalizations, rehospitalizations, and return visits to the ED.

Decision support tools, including alerts, have been implemented and offered as a value added service by many entities, including Regional Health Information Organizations.[5-12] Existing literature, however, generally evaluates alerts within a single hospital or clinical practice setting, such as drug allergy or drug safety alerts,[11] or electronic health record (EHR) alerts linked to clinical decision support tools.[5] With the development of a community-wide HIE, cross-setting alerts are possible, such as alerts to a primary care practice indicating that a patient had an ED or hospital visit. There are few published studies of the effectiveness of such alerts but some evidence is beginning to be shared in abstracts and conference presentations.[13,14]

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This paper describes how alerts to primary care practices about region-wide ED and hospital use for their asthma patients were screened, triaged, and then used to trigger a bundle of interventions to improve patient care and asthma outcomes.

Methods

This is a comparative case study of two important initiatives that collectively represent nearly 20,000 children with asthma in the Cincinnati region. The study reviews the steps that occur when primary care practices receive alerts involving ED visits or hospital admissions for children with asthma and initiate related improvement interventions. This study was approved by the Institutional Review Board (IRB) at Cincinnati Children's Hospital and Medical Center (CCHMC) and the Western IRB.

Setting and Population

The Beacon Program in Cincinnati included two improvement initiatives focused on children with asthma, see Table 1. The first included three primary care practices (hereafter referred to as "practice") from Cincinnati Children's Hospital Medical Center (CCHMC) Division of General and Community Pediatrics (Gen Peds) sites with 5,400 children with asthma, and the second included 40 primary care practices from the Physician-Hospital Organization (PHO) affiliated with CCHMC with 13,000 children with asthma. The Gen Peds clinics primarily serve Medicaid-insured children, whereas the PHO generally serves privately insured children. One Gen Peds clinic is located on the CCHMC main hospital campus; the second is about 3 miles from the main hospital, on the west side of Cincinnati; and, the third is located about 15 miles north of the main hospital. The PHO practices are located in the eight-county region that covers greater Cincinnati, northern Kentucky, and southeast Indiana. The majority of admissions for the Gen Peds and PHO populations occur at CCHMC. The majority (about 85 percent) of ED visits for the Gen Peds population occur at CCHMC, whereas ED visit volume for the PHO population is split evenly between CCHMC and other hospitals in the region.

Table 1. Cincinnati Beacon Asthma Improvement Initiatives

Asthma Improvement Initiatives	Primary Care Practices	# of Children with Asthma Served
Cincinnati Children's Hospital Medical Center (CCHMC) Division of General and Community Pediatrics (Gen Peds)	3	5,400
Physician-Hospital Organization (PHO) affiliated with CCHMC	40	13,000

Both initiatives had pre-existing alerting systems that notified practices when hospitalizations and ED visits occurred at CCHMC facilities only. The Beacon community-level alerts made the hospitalizations and ED visits occurring at any hospital in the Greater Cincinnati region highly visible to the practices. These alerts were then linked to a bundle of improvement interventions focused on children with asthma. At the time of this study, HealthBridge had just initiated alerts from community hospitals other than CCHMC.

Interviews and Descriptive Data on Handling Alerts

To better understand the impact of the alerting system on practices and patients, we conducted a total of eight semistructured interviews with key individuals (providers and administrative staff) from Gen Peds (three interviews) and the PHO (three interviews), as well as two group interviews with providers (physicians, nurses and medical assistants) from two practices. We also collected data on 86 pediatric asthma patients in Gen Peds and 21 pediatric asthma patients in the PHO between April and November 2012: total number of alerts routed to practices, percentage of alerts viewed, percentage of alerts linked to asthma exacerbations, percentage of alerts with a follow-up appointment occurring within 7 and 30 days of the ED visit or hospital discharge, percentage of alerts with the root cause analysis (RCA) process performed (PHO only), and percentage of high-risk asthma patients referred for care coordination (Gen Peds only). An independent company transcribed all interviews verbatim, and two independent coders used a priori and emerging codebooks to code the interviews using NVivo 10.0 software. Codes were used to analyze the data and to identify and report emerging themes.

Results

Based on interviews and descriptive data, findings related to the alert routing and follow-up process, value of alerts, and key informant perspectives regarding key challenges, improvement opportunities, and implications for the future are presented below.

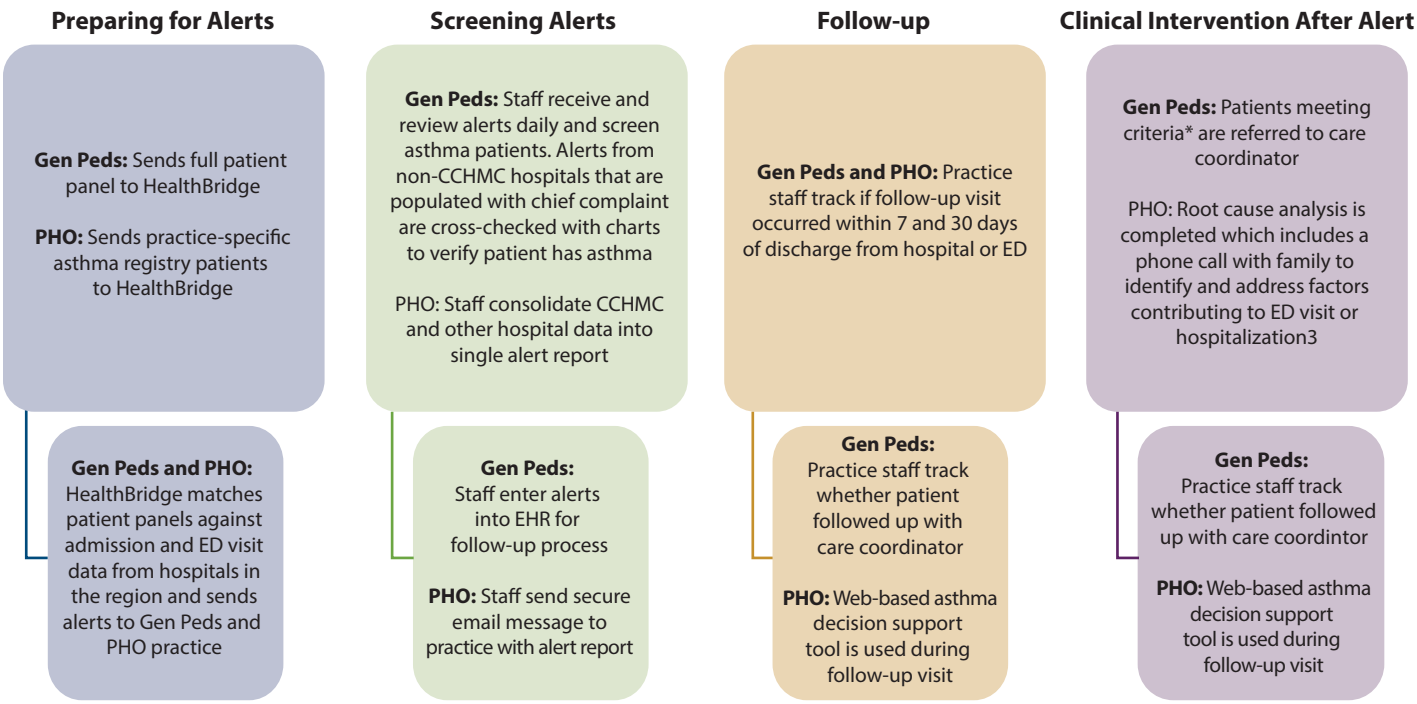
Using Alerts to Trigger Quality Improvement

The following key processes are involved when routing alerts to primary care practices (See Figure 1):

- Accurately assigning patients and routing related alerts to the correct practice,
- Viewing and triaging alerts,
- Contacting families to understand factors that contributed to the asthma exacerbation,
- Assuring timely follow-up visits, and Implementing clinical interventions that improve patient outcomes.

Due to the differences in the number of children served and resource constraints, Gen Peds and PHO practices adopted two different approaches to handling alerts; thus, these efforts are described separately.

Figure 1. Asthma Alert Processes for Gen Peds and the PHO



*Care Coordination Criteria: One hospitalization or two ED visits for asthma within the past 12 months.

Preparing for and Receiving Alerts: Identifying a Panel of Patients. The first step in accurately routing alerts is to link a panel of patients to the correct practice. All-cause utilizations linked to patient panels are sourced from HealthBridge, and asthma-related encounters are then identified by staff at the PHO and Gen Peds.

For Gen Peds, a query of the CCHMC EHR generates a list of all patients seen in the clinics over the past two years (this defines an "active" patient). Gen Peds decided to identify all patients, not just the 5,400 children within the asthma registry, to ensure that all asthma-related alerts were captured, even if the patient was not yet formally diagnosed with asthma. This patient panel is sent electronically to HealthBridge on a biweekly basis and is used to identify admissions and ED visits linked to these patients, based on admission, discharge, and transfer (ADT) data transmitted to HealthBridge from the 29 hospitals in the region. HealthBridge matches patient panels against admission and ED visit data and sends all-cause alerts data to Gen Peds; these alerts are screened by a Gen Peds staff member, with asthma-related events identified and routed to practice sites.

For the PHO, the alert reports are generated through two separate patient matching processes. First, the PHO team matches the panel of 210,000 children across the 40 primary care practices against admission and ED visit data sourced from CCHMC. Second, to identify admissions and ED visits occurring at other hospitals, the PHO transmits to HealthBridge the panel of 13,000 asthma patients across the 40 primary care practices sourced from the PHO web-based registry; HealthBridge matches these patients against ADT data received from hospitals across the region (excluding CCHMC) and transmits the data to the PHO, which then combines it with the data sourced from CCHMC to create a consolidated alert report that the PHO transmits to practices via secure email.

What Comes Back to Practices: Content of the Alerts. The content of alerts sourced from ADT data feeds flowing from regional hospitals to HealthBridge are the same for Gen Peds and the PHO. The report includes the patient's first name, last name, date of birth, date and time of the event, and chief complaint upon admission. As the International Classification of Diseases ninth revision (ICD-9) code is generally not available from the hospital ADT data (CCHMC data flowing into the PHO alert report includes ICD-9 code), admissions and ED visits are linked to an asthma exacerbation based on one of the following terms appearing in the chief complaint: *asthma, reactive airway disease (RAD), cough, difficulty breathing, wheeze,* or *chest pain*. The alert contains the chief complaint as entered by hospital staff on admission. The data are from a structured field entered as either free text or selected from a menu of choices, depending on the institution.

Screening and Triaging Alerts. The next step is to screen the alerts and confirm if they indeed are asthma-related, as relying on chief complaint alone is problematic. The screening process is similar for Gen Peds and the PHO. For Gen Peds, the alert is received by the clinic sites through an online portal based at HealthBridge. A designated person receives the alerts on a daily basis, and confirms admissions and ED visits occurring at CCHMC as

Figure 2. Root Cause Analysis Script

ED/Urgent Care/Admission
Interview Script for Follow-up with Family Member

(Date of follow-up appt. ____)

Hello my name is _____. I am working with Dr._____ and her/his practice to look at ways to improve care for children with asthma. I would like to ask you a few a questions about your child's <_____insert name> recent <_____ED visit/Admission on <_____insert date>. Is that okay with you? Is this an okay time? If not, is there another time I can call that will be better?

- When did you first get concerned about your child's asthma?
- How/who initially identified he/she was having trouble?
- What were the specific symptoms at that time?
- What do you think triggered this event?
- What did you do next?
  - (Prompt use/availability of inhaler and effectiveness. Specifically ask what color inhaler did you use?)
- What else did you consider doing?
  - Did you use your child's asthma management plan?
  - Was it helpful? Any confusion?
- At what point did you make the decision to take your child to the emergency department?
  - Did you call your pediatrician's office during this event?
  - If yes, ask about the conversation/experience.
  - If no, ask "Is there a reason you didn't call your pediatricians office?"
- Looking back, is there anything that could have been done to prevent you from taking your child to the emergency room?
- What advice would you provide to your doctor or other (e.g., school) that could prevent this from happening again?
- Anything else we didn't discuss that you think is important for us to know?

At end of call, verify appointment date and time and how the information will be shared with provider for pre-visit planning. If no appointment, encourage family to schedule a follow-up visit.

asthma-related by checking additional information contained in the CCHMC EHR system. This information is then routed to the appropriate Gen Peds clinic site. For the non–CCHMC alerts (about 15 percent of all alerts) with an asthma-related chief complaint, staff verify an asthma patient by checking the CCHMC EHR system for a diagnosis of asthma in the patient's problem list or a history of asthma-related encounters or medications.

The PHO sorts data by active asthma registry patients and non-registry patients and combines alert data received from CCHMC and HealthBridge into a single alert report. The alert information is then routed via secure email to designated personnel at each practice. Because the PHO is only receiving non–CCHMC alerts for confirmed asthma patients within the PHO registry, all of these alerts are followed up.

Follow-Up and Outreach to Patients. After it has been established that the alert was asthma related, both Gen Peds and the PHO clinic staff contact the patient's family to schedule a follow-up visit. The goal for both is to see the patient as soon as possible after the hospitalization or ED visit, and to track whether the follow-up visit occurred within 7 and 30 days.

Clinical Intervention after Alert. For Gen Peds, patients meeting criteria (one hospitalization or two ED visits for asthma within the past 12 months) are referred for care coordination. The care coordination intervention bundle includes assessing the reason for the ED visit or admission, and working with the family to understand and address barriers to optimal care. For non–care coordinated patients, they are contacted by a staff member to schedule a follow-up visit. If the patient attends a follow-up visit, the reasons for the utilization are typically discussed, though less formally than the care coordinator follow-up.

Within the PHO, four pilot practices tested the following alert response bundle: calling the family using a scripted dialogue (see Figure 2); placing information in the chart to support pre-visit planning; and ensuring a timely follow-up visit, during which an asthma decision support tool is used. The family dialogue is designed to elicit information, such as what precipitated the ED visit or admission; what the parents were noticing that caused them to take their child to the ED; when symptoms started; existence of a management plan; and factors driving the decision to go to the ED instead of their primary care provider.

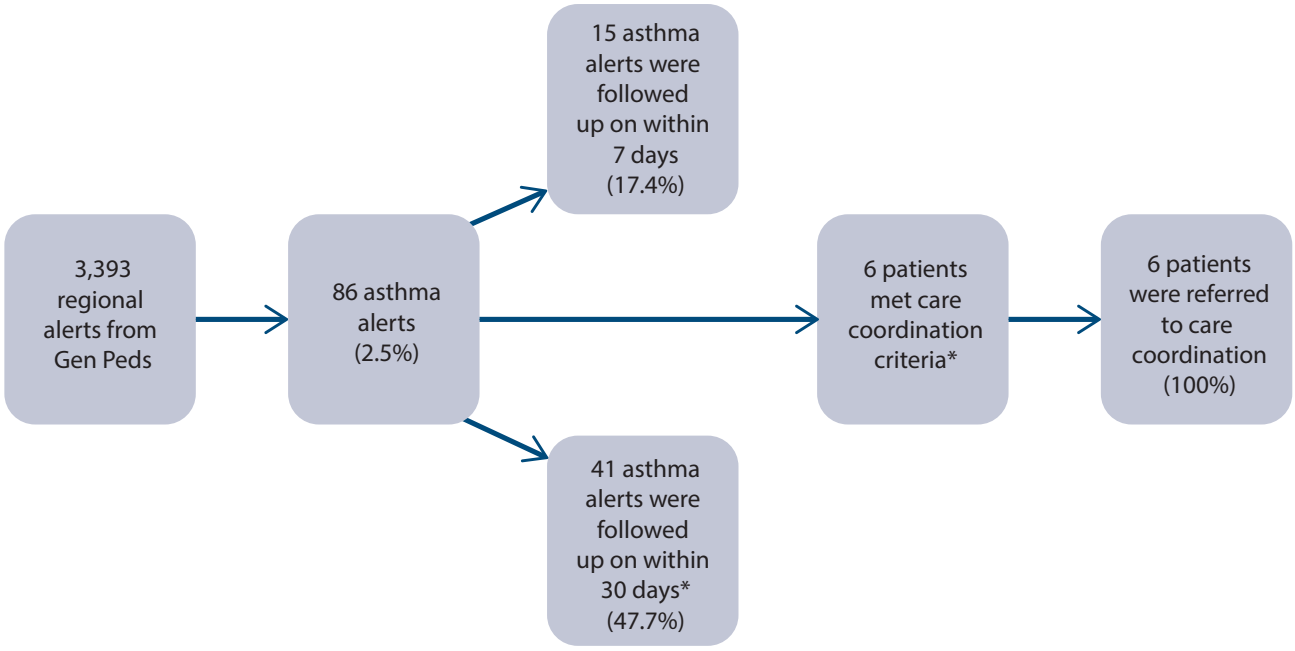
PHO staff combined information from the RCA script with registry data (e.g., asthma control ratings, severity classification, daytime and nighttime symptoms, activity limitation, ED visits, admissions) to support pre-visit planning. In preparation for the visit, staff share information from the family outreach call and broader RCA process with the provider who is seeing that patient, including recommended areas to address at the follow-up visit. During the follow-up visit, PHO practices utilize a web-based asthma decision support tool developed by the CCHMC Asthma Center that generates medication management recommendations based on the National Heart, Lung and Blood Institutes asthma guideline.

Preliminary Data from Pilot Practices

Staff collected preliminary data from the three Gen Peds practices and four PHO practices from mid-April 2012 to November 2012. For Gen Peds, there were 3,393 regional hospital (non–CCHMC) alerts for the entire primary care population, of which 2.5 percent (86) were asthma-related (see Figure 3). Of the regional asthma alerts, 17.4 percent (15/86) led to a follow-up visit within 7 calendar days of the utilization, and 47.7 percent (41/86) led to a follow-up visit within 30 calendar days of the utilization. All patients meeting criteria were referred for care coordination (6/6).

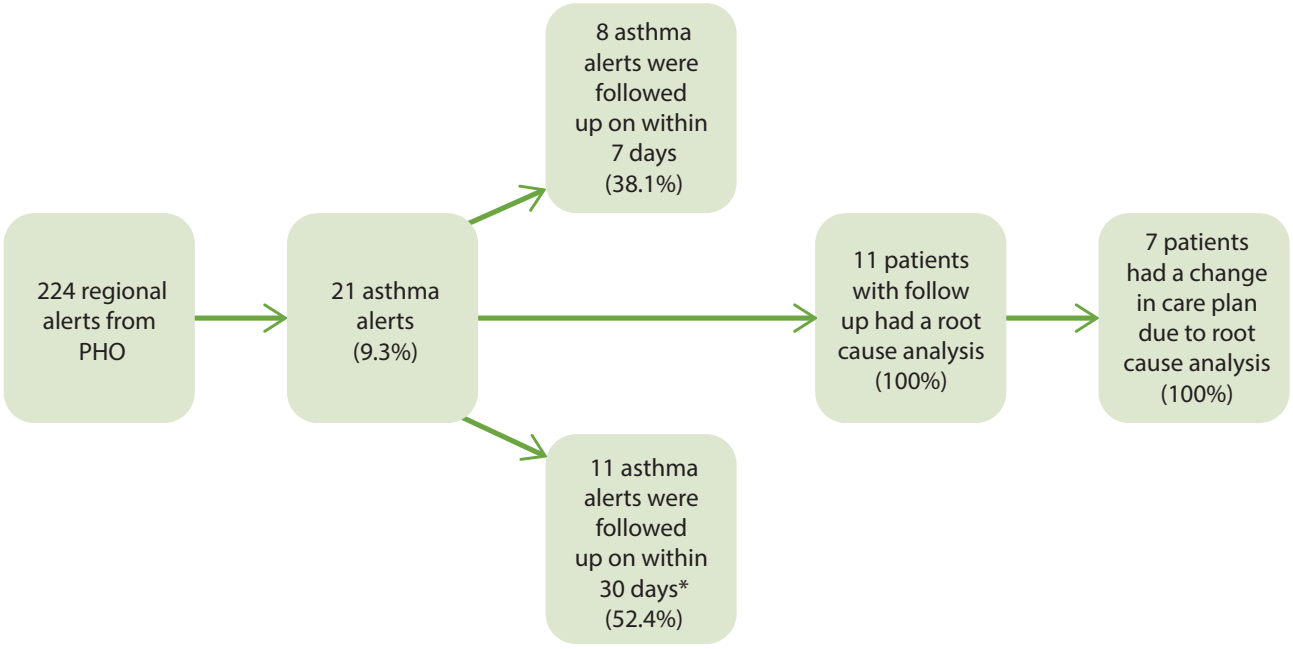
For the four pilot PHO practices, there were 224 alert reports (CCHMC and other hospital data combined) opened that contained 21 asthma alerts (see Figure 4). Of the asthma alerts, 38 percent (8/21) led to a follow-up visit within 7 calendar days of the utilization, and 52 percent (11/21) led to a follow-up visit within 30 calendar days of the utilization. Additionally, 52 percent (11/21) were linked to the RCA process, with 64 percent (7/11) leading to changes in the care plan. Since collecting this data, the process for managing alerts has been scaled up across the remaining 37 PHO practices.

Figure 3. Gen Peds Preliminary Data from Pilot Practices



*30-day follow-up includes 7-day follow-up

Figure 4. PHO Preliminary Data from Pilot Practices



*30-day follow-up includes 7-day follow-up

Value of Alerts

Alerts Were a Valuable Addition. There was general agreement from respondents that the alerts were valuable to ongoing efforts to improve quality and lower costs. This is noteworthy, given the time it took to process alerts before they are routed to the practice. One respondent in Gen Peds reported that in the fall, the peak asthma season, it took "at least two hours in the morning and then a couple more hours throughout the day" to screen the alerts, add clinical information from the EHR, and then forward the alert to the specific practice. This time is largely related to Gen Peds practices receiving alerts on all causes for admissions and ED visits for their population of over 33,000 patients.

Respondents discussed the value of the RCA in the PHO practices. One respondent from the PHO said that failure to recognize early symptoms was one of the most frequently identified causes of an ED visit or hospital admission. Other reasons had to do with misuse of medication, transportation issues and patients' families not connecting with the practice. A respondent gave an example of an RCA that uncovered several issues that were then addressed by the practice. She said, "One child had an exacerbation at home and waited with his mother until his father got home because they did not have transportation to go to the doctor's office. They ended up having to go to the ED because the office was closed by the time his father arrived." In response, this practice communicated with all of their patients and reinforced contacting the office as soon as a child has signs of an asthma exacerbation so that the primary care providers can provide advice on managing such situations.

Providers Are Finding New Uses for Alerts. Interestingly, respondents reported that they are identifying other uses for the alert reports, beyond quality improvement for asthma. For example, the PHO is using alerts to improve the asthma registry. If the alert, combined with chart review, shows that an asthma event happened, but that child is not in the registry, an opportunity to update the registry is presented. This gives the practices a "much better handle on an accurate population for this chronic condition." In addition, practices are not just limiting follow-up efforts to asthma. Respondents said that there were "any number of events that they choose to follow-up with" based on the report, which contains all-cause alerts for the entire population across PHO practices.

Providers in Gen Peds are using alerts to understand where patients are seeking care, regardless of diagnosis, as it is important to know patients presented to an ED or were hospitalized so interventions to prevent future utilizations can be implemented. One provider said, "You want to know whether it was something that could have been mitigated by doing something different in the medical home." Tracking the day and time of ED visits is also helpful; if patients utilize the ED after office hours or on days the office is closed, this could help inform practice decisions to extend office hours or increase capacity.

Issues and Improvements

Although respondents reported that alerts were a valuable tool for patient management, there were ways respondents hoped the alerts could be improved. This included knowing the ICD-9 diagnosis rather than a chief complaint, matching the full panel of patients against regional hospital ADT feeds to HealthBridge (for the PHO), and utilizing staff at the highest level of their license.

Diagnosis Versus Chief Complaint. A primary issue involves having the chief complaint rather than the actual discharge diagnosis on the alert report, as additional verification is required to accurately discern asthma-related events. One respondent said, "It would be more efficient to have the discharge summary that has more specific diagnosis information that would help eliminate the second step of verifying in the chart." Another respondent added that "feedback from the providers is that the chief complaint criteria, no matter how good you attempt to develop text strings for matching, is not as effective a tool as the discharge diagnosis."

Value of Using Full Panel of Patients. The PHO used a patient panel limited to children in the asthma registry when matching against ADT data submitted by regional hospitals to HealthBridge, but respondents reported interest in receiving alerts for their entire panel. One said, "We are [getting] a strong push [from the providers] to transmit the rest." The next step would be to share the entire panel with HealthBridge so that all children within the practice, not just those with asthma, who present to any hospital in the region will flow into the alert report.

Lessons Evolved on Appropriate Use of Staff. The question of which staff members are best positioned to handle alerts was also addressed. At first, practices in Gen Peds thought that a registered nurse would be needed to contact families, clinically assess the patient's current asthma status, and address the family's questions. It turned out that most outreach involved repeated calls to families, with less time spent conveying medical information; for this reason, practices are in the process of reassigning outreach calls from nurses to other staff members, thus allowing nurses to focus more time on clinical tasks.

Many Attempts Are Often Needed to Schedule Follow-Up. Respondents indicated that the main issues around follow-up of patients are difficulty connecting with families and patients' need to reschedule appointments. Often it takes many attempts and messages to schedule a follow-up appointment. Respondents reported that once an appointment is scheduled, the family is often unable to complete the appointment, and the process of outreach begins again.

Looking to the Future

In Cincinnati, practices are moving toward becoming Patient-Centered Medical Homes (PCMH) and health systems are creating Accountable Care Organizations (ACO), thus raising the importance of alerts when admissions and ED visits occur across the community. As one respondent said, "the vision for the medical home is to have a total picture of all health care that is being provided to an individual so they can make the most informed clinical decisions." The respondent added, "as we move towards a model of accountable care organizations, 'accountable' means you are taking risk ownership for the health care being provided to this patient no matter where it occurs."

Discussion

Regional alerts supplied by the community-wide HIE were a valuable addition to quality improvement efforts, enabling practices to identify hospital and ED use region-wide for children with asthma in their practices. Developing a bundle of interventions to improve asthma care and outcomes was a significant achievement of the Beacon program in Cincinnati.

It is important to note that technology was just the first step leading to care improvements. An important finding from this study was the substantial effort at the practice level to make optimal use of the technology and to integrate it into ongoing patient care workflows. Practices needed not only to define protocols for handling alerts, but also needed to design the care coordination and follow-up protocols to prevent rehospitalizations or revisits to the ED. For example, handling the alerts, particularly during high volume asthma seasons, required additional personnel and reprioritizing of staff duties. Additional personnel were required to perform the RCA process and schedule follow-up appointments.

This is one of the first studies, to our knowledge, that has assessed the effect of alerts sourced from multiple hospitals in a region, and how alerts were integrated with clinical improvement interventions, such as family outreach and follow-up visits to primary care practices. Prior literature, for the most part, examined effects of notification about such problems as drug safety and drug-drug interactions or allergy warnings that could be acted upon immediately in the clinical setting.[7,8,11] Studies that examine the effect of clinical decision support for other "push" information exchange, such as automated laboratory or test result delivery is also pertinent,[5] but the level of effort and protocols for responding are not as extensive.

There are no currently published articles, to our knowledge, of the effects of either automated alerts such as these or of alerts received through emails as part of the Direct Project.[15] There are, however, a few recent abstracts on alerts to providers caring for patients ages 65 years and older.[13,14] One of these showed no improvement in hospitalizations for older patients in practices that received alerts compared with older patients in practices that did not receive these alerts.[13] It is important to note that the "intervention" being evaluated involves the *combination* of alerts with improvement protocols that practices implement after receiving alerts; it is likely that results will vary depending on content of improvement bundles and reliability of implementation.

A key contribution of this study is not only the results, but also the issues that it has surfaced. Related to the issue mentioned above—that the improvement bundle affects the outcome as much as the fact that an alert was sent—are the findings about the level of effort needed to process the alerts at the practice level, particularly due to the challenges involving chief complaint versus ICD-9 diagnosis populating the alert. Diagnoses are much easier to work with electronically, but if practices want to know about hospital use immediately, they will need to rely on chief complaint. In our study, there were far more chief complaints where the child did not have an asthma diagnosis (false positives) than there were for children with asthma, and where it took significant time to verify.

Despite extra effort and time required, practices placed high value on having alerts. As hospitalizations and ED visits represent some of the most costly aspects of care, intervening is of significant importance. Further, some respondents asserted that the value would grow as practices became PCMHs and were expected to manage (and thus know about) care received by patients no matter where it took place. The move to ACOs raises the value of alerts in terms of identifying and addressing overutilization of hospitals, thus reducing costs. Finally, practices are looking to use alerts as signals to intervene on children other than those with asthma diagnoses. As use of alerts expands, so does their value, even beyond asthma care.

This study had several limitations. It includes just six months of data that was collected early in the alert implementation process. Further, although the informants in this study represented the administrators and staff involved in the program, an overall small number were interviewed. Finally, this study was not designed to examine the effects of alerts on hospital and ED use.

Conclusions

This study is significant in that it describes how technology can be effectively integrated with care delivery redesign involving processes for receiving and triaging hospital admission and ED alerts, reaching out to families, and implementing interventions that address underlying issues identified. It demonstrated that much effort is needed at the practice level to integrate the alert technology with clinical improvement interventions. Additional research on the most cost-effective approaches by which practices can maximize the impact of alerts on patient and population-level outcomes is recommended.

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