

Improving Pediatric Asthma Care Through Surveillance: The Illinois Emergency Department Asthma Collaborative

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ABSTRACT

OBJECTIVES. To better understand and improve the care of asthma patients who require emergency department (ED) care, the Illinois Emergency Department Asthma Collaborative (IEDAC) was created to develop, test, and disseminate an ED-based surveillance system. This report describes the development and testing of the pediatric IEDAC surveillance instruments and demonstrates how these instruments can be used to describe the health status, healthcare delivery, and outcome of children using ED services.

METHODS. A convenience sample of 128 children presenting to 5 EDs in Illinois for asthma care was the study base. Data were collected on monthly samples of children aged 2 through 17 years who presented to these EDs from May to November 2003. Three instruments were used to collect data regarding the children's pre-ED, ED, and post-ED experience.

RESULTS. At the ED visit, 73.4% of children met national guideline criteria for persistent-level asthma symptoms. Among this group, 53.2% were using inhaled corticosteroid (ICS) medications. At 1 month follow-up, 66.6% of the children met the criteria for persistent-level asthma symptoms, which was statistically unchanged from the ED visit. Among the latter group, 64.2% were using ICS medications, again statistically unchanged compared with the ED visit. At follow-up, 24.5% of children were reported to have returned to an ED or were subsequently hospitalized. The majority of children were noted at follow-up to have limitation of at least some activity.

CONCLUSIONS. Children who presented to IEDAC EDs were found to have a high level of asthma burden that continued at follow-up despite treatment. Moreover, a substantial proportion of children had returned to an ED or were subsequently hospitalized. Encouraging trends in medication use were observed, although sub-optimal medication use was also observed.

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Key Words

asthma surveillance, emergency department, children

Abbreviations

ED—emergency department
EPR-2—National Asthma Education and Prevention Program Expert Panel Report 2
IEDAC—Illinois Emergency Department Asthma Collaborative
ICS—inhaled corticosteroid
IQR—interquartile range
MDI—metered-dose inhaler

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EACH year emergency departments (EDs) in the United States receive numerous visits from children for asthma care.¹⁻³ In 2002, nearly 9 million children in the United States were told that they have asthma, and 4 million had asthma symptoms that same year.⁴ From 1980 to the late 1990s, asthma office visit, hospitalization, and death rates gradually increased in patients with asthma who were <18 years of age.¹ These data were reported by the Centers for Disease Control and Prevention's National Center for Health Statistics.

Although national aggregate health statistics are crucial for the public health perspective, such a view precludes detailed evaluation of risk factors, clinical management, outcomes, and the relationship among these clinical measures. Assessment of asthma care, as outlined by national guidelines, requires such detailed clinical measures. The National Asthma Education and Prevention Program Expert Panel Report 2 (EPR-2)⁵ recommends clinical goals for asthma care of individual patients. A surveillance system that collects detailed clinical measures in a sample of patients with asthma could be used to assess adherence with national guidelines and monitor important trends in factors that affect the aggregate burden of asthma.

Acute asthma requiring ED care identifies children at risk for hospitalization and relapse to the ED.⁶⁻¹⁰ Recurrent ED visits and hospitalizations are risk factors for fatal asthma.¹¹ After medication use, hospitalization-related costs accounted for the largest total direct cost for asthma care in 1994.¹² An enhanced asthma surveillance system that is ED-based could measure the relationships among clinical risk factors, processes of care, and patient outcomes in a group of patients at high risk for asthma morbidity. Such a surveillance system that is also responsive to continuous quality-improvement initiatives would have the advantage of enabling the effects of interventions to be measurable and the improvement processes to be continued.

This study was part of the Illinois Emergency Department Asthma Collaborative (IEDAC) study, which had 3 principal goals: (1) to develop and test an ED-based asthma surveillance system; (2) to implement a continuous quality-improvement initiative and test the surveillance system for responsiveness to interventions; and (3) to develop an Internet-based application that enables the surveillance system to be more broadly implemented. The current study describes the development of the surveillance system and presents descriptive results in children from baseline data collection before the intervention phase.

METHODS

Study Population

The study population consisted of patients who presented to 1 of 5 Illinois EDs for asthma care from May

through November 2003. Three of the EDs were located within the Chicago metropolitan area; of these, 2 were part of academic medical centers and 1 was part of a large community hospital. Two hospitals were located in smaller communities >60 miles from Chicago. All 5 of these EDs treated both pediatric and adult patients. A sixth ED, part of an academic medical center in Chicago, treated only adult patients; results from that ED are excluded from this study.

Each of the 5 EDs enrolled a convenience sample of 15 subjects, both children and adults, per month. Recruited subjects were enrolled when a trained research assistant was available, which was generally between 9:00 AM and 9:00 PM. Inclusion criteria were children who presented to the ED for asthma care, had a self-reported physician diagnosis of asthma, and were 2 through 17 years of age. Children who had been enrolled previously ($n = 3$) were excluded. The institutional review boards of all participating hospitals approved this study.

Development of Study Instruments

Three instruments were developed for the IEDAC study. The risk-assessment survey was designed to measure patient historical characteristics that may impact patient care and outcomes. The process-of-care survey was developed to measure pertinent clinical management details that are important in acute asthma management and that may affect patient outcomes. The outcome-assessment survey was designed to measure the burden of health imposed by asthma. Although data presented here pertain only to children, parallel child and adult versions were developed in that questionnaire items were worded similarly for children and adults, taking into account age status.

The instruments were developed in the first phase of the IEDAC study. The development process involved multiple iterations by local and national asthma and ED experts. Four groups of teams modified and reviewed the instruments, including the senior research study team, the site directors committee, the study advisory committee, and 2 ED physicians with a nationally recognized knowledge of asthma. The senior research team determined the final form of the instruments. Feedback from study personnel and subjects during field testing of the instruments was an integral part of the instrument revision process.

Development of the Risk-Assessment Survey

The risk-assessment survey items were initially based on previously validated studies on risk factors for acute morbidity associated with asthma.¹³⁻¹⁶ After modifications appropriate for the IEDAC study, a researcher-administered version of the survey was used to obtain surveillance data on 150 patients (including 33 children). This testing was used to verify face validity, pa-

tient acceptance, and repeat reliability; the latter was conducted by telephone follow-up 2 to 3 weeks after the ED visit. The next version, a parent/caregiver self-administered version, was tested for feasibility in a group of 151 and, later, 161 children and adults. The final instrument was parent/caregiver self-administered and contained 34 items (see Appendix 3). The content areas included (1) demographic information, (2) asthma symptoms, (3) medication use, (4) asthma care, and (5) physician contact.

Items on the risk-assessment survey queried parents/caregivers on the frequency of asthma symptoms and short-acting β -agonist use for the month before the start of the asthma exacerbation. Based on EPR-2, persistent-level asthma symptom status was determined for items pertaining to frequency of asthma symptoms and short-acting β -agonist use.⁵ EPR-2 recommends that the overall classification of asthma severity be determined by the symptom or short-acting β -agonist use with the greatest frequency. These concepts were used in dichotomizing children into the presence or absence of persistent-level asthma symptoms. Children were considered to be using a controller medication if they were using an inhaled corticosteroid (ICS), oral corticosteroid, cromolyn-class medication, long-acting β -agonist inhaler, leukotriene modifier, or theophylline.¹⁷ Persistent asthma status was determined by the presence of either persistent-level asthma symptoms or use of a controller medication.¹⁸ In determining appropriate use of ICS medications, children were considered to be using them appropriately if the response to the frequency of ICS-medication-use item was “every day” or “almost every day.”

Development of the Process-of-Care Survey

The process-of-care survey items were initially based on a chart-review instrument previously developed to assess ED asthma care processes in relation to national asthma guidelines (Appendix 4).¹⁹ The process-of-care survey was modified to enhance its validity in measuring surveillance and quality-improvement initiatives. Reliability of the survey was assessed by comparing results from medical charts with directly observed care in 51 patients. The final survey contained 30 items including (1) demographic information, (2) assessment, (3) treatment, (4) education, and (5) discharge practices.

Development of the Outcome-Assessment Survey

The outcome-assessment survey items were initially based on previously validated studies on acute asthma outcomes.^{13,16,20–23} After modifications to optimize the outcome-assessment survey for the IEDAC study, feasibility testing of the survey was conducted with 161 patients using either a telephone version only or a mailed version with telephone follow-up for nonresponders to the mailed version. Telephone administration was chosen for the final version based on optimal

survey completion and item-response rates. The final version of the outcome-assessment survey was completed by the parent/caregiver and consisted of 35 items. Content areas included (1) medical resource use, (2) symptoms, (3) medication use, and (4) health-related limitations.

For the outcome-assessment survey, persistent-level asthma symptom status was determined by using the same symptom and short-acting β -agonist use frequency criteria as for the risk-assessment survey. The response set for these items was identical in both surveys. The questions, however, varied in that the time window for the outcome-assessment survey items pertaining to frequency of asthma symptoms and short-acting β -agonist use was reduced to the 2 weeks before the completion of the survey. This was necessary because of the temporal proximity to the ED visit. Persistent asthma status at follow-up was determined by the same method as for the ED visit.

Data-Collection Protocol

While in the ED, potential enrollees were screened by trained research assistants for inclusion into the study. Informed consent as well as Health Insurance Portability and Accountability Act (HIPAA) consent were obtained from the parent/caregiver, and minor assent was obtained from the child when appropriate. The parent/caregiver and subject (when age-appropriate) were informed of the intent and composition of the study. After the parent/caregiver completed the self-administered risk-assessment survey, study personnel reviewed each item and assisted with completion of any missing or incomplete responses. Within 2 weeks of the subject's ED discharge, a member of the study team abstracted data for the process-of-care survey from the subject's ED medical chart.

During the ED visit, the parent/caregiver was asked to provide primary and alternative telephone numbers and indicate the optimal time during the week that the follow-up survey could be completed. At 3 and 21 days post-ED discharge, the parent/caregiver was sent a postcard with a reminder about the follow-up telephone survey. One month after the ED discharge, trained telephone staff interviewed the parent/caregiver using the outcome-assessment survey. If necessary, an alternative time for the interview was arranged. In the case of nonrespondents, the staff called repeatedly over 4 weeks before concluding that the parent/caregiver could not be reached.

Statistical Analysis

Survey response rates were >95% for all items in completed surveys. Missing data were excluded from the analyses. For count data, proportions based on percentages are shown. For continuous data, medians with interquartile range (IQR) are presented. Inferential testing

for count data used χ^2 or Fisher's exact test, where appropriate; inferential testing for paired data used McNemar's χ^2 or exact test, where appropriate; and inferential testing for unpaired continuous data used the Wilcoxon rank sum test. Two-tailed *P* values of $\leq .05$ were considered statistically significant. Data management and statistical testing were performed with Stata 8.1 (Stata Corp, College Station, TX).

RESULTS

Demographic Characteristics at ED Visit

As shown in Fig 1, 128 children were enrolled in the study; 82.8% were enrolled during weekdays, and 72.7% were enrolled between the hours of 9 AM and 9 PM. The median age was 7.9 years (Table 1). Overall, 60.9% of the children were male; among the children ≥ 5 years, 68.8% were male, whereas 47.9% of children < 5 years old were male. In terms of race/ethnicity, 68.7% of the children were black, 18.0% were white, and 13.3% were of another race/ethnicity. Based on parent/caregiver report, 87.4% of the children had medical insurance; this status was corroborated by chart insurance information. The primary reason for the ED visit was assessed in the process-of-care survey: 92.7% of children presented to the EDs primarily because of an asthma exacerbation, 3.2% because of unspecified respiratory complaints, 3.2% because of nonrespiratory conditions, and 0.8% for medication refill.

Children's Historical Characteristics at ED Visit

The risk-assessment survey provided data on each child's asthma history. Excluding the ED visit, 62.5% of children had at least 2 other ED visits or hospitalizations in the 12 previous months. Although 70.9% of parents/caregivers reported that their child had a physician whom they contact when their child's asthma worsens, these physicians were contacted in only 46.4% of in-

stances before visiting the ED; in 32.9% of the cases, no attempt was made to contact the physician, and in 20.4% the physician could not be contacted.

Parents/caregivers were queried regarding their child's frequency of asthma symptoms and medication use in the month before the onset of the asthma exacerbation (Table 2). Frequency of daytime and nighttime asthma symptoms and frequency of use of metered-dose inhalers (MDIs) and nebulized short-acting β -agonist medications were assessed. Based on each measure, 35.9% to 60.4% of the children were reported to have persistent-level asthma symptoms; based on having met any of the 4 symptom or medication-use criteria, 73.4% of the children had persistent-level asthma symptoms. A larger proportion, 83.6% of the children, met the criteria for persistent asthma; these children either had persistent-level asthma symptoms or were using a controller medication.

At the ED visit, children were reported to be using a variety of medications in the 4 weeks before the ED visit (Table 3). Most of the children in the study used inhaled short-acting β -agonist bronchodilators; 44.5% had used ICS medications before the ED visit. This was followed, in decreasing order of reported use, by oral β -agonist, oral-corticosteroid, and leukotriene-modifier medications. The remaining medications were rarely used. A controller medication was reportedly used by 56.2% of the children.

Of the children with persistent-level asthma symptoms based on any of the 4 criteria, 53.2% were using ICS medications before their ED visit (Table 2). A slightly larger proportion (62.7%) was using some type of controller medication before the ED visit. Parents/caregivers of children who were using ICS medications were queried on the frequency of use of those medications. Of 94 children with persistent-level asthma symptoms at the

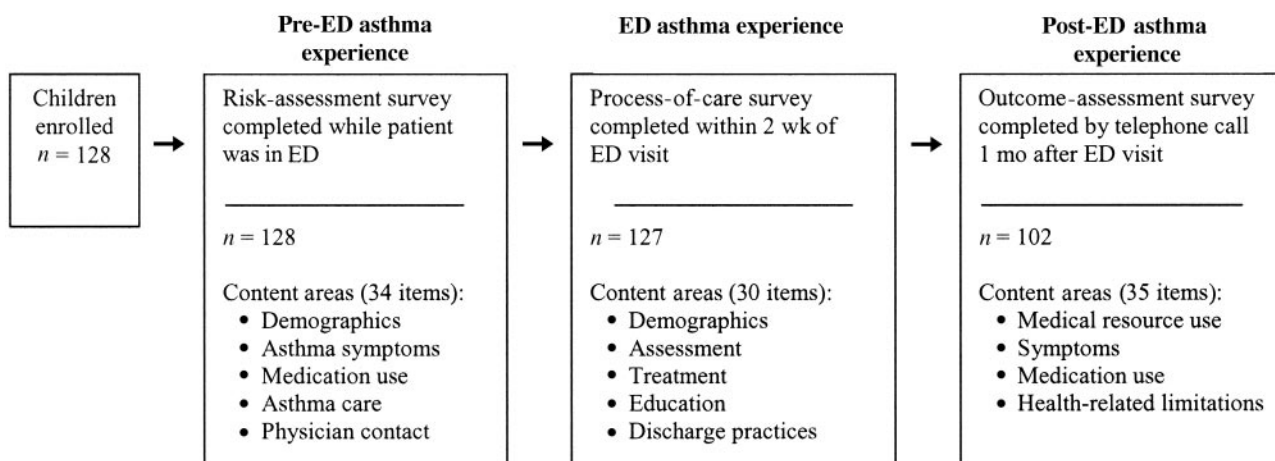


FIGURE 1
Diagram of IEDAC surveillance instruments in relation to patient ED experience.

TABLE 1 Demographic Characteristics of children at ED Visit (n = 128)

Age, y	
Median (IQR)	7.9 (3.8–11.4)
Range, minimum/maximum	2.0/17.6
Gender, % male	60.9
≥5 y old	68.8
<5 y old	47.9
Race/ethnicity, %	
Black	68.7
White	18.0
Other	13.3
Insurance status, %	
Self-report of having insurance	87.4
Chart status as having insurance	93.6

ED visit, 28.7% were both using ICS medications and using them with an appropriate frequency.

Clinical Management at ED Visit

Medical charts were reviewed for 127 of the 128 children enrolled (Fig 1). ED assessment and treatment practices were evaluated by using the process-of-care survey. Peak-flow measurements were obtained in 50.6% of children aged ≥5 years (Table 4). Essentially all of the children had a pulse oximetry measurement; 65.8% received >1 β-agonist treatments and 80.1% received systemic corticosteroids while in the ED.

At the end of the ED visit, 76.3% of the children were discharged from the hospital. Within this group, ICS medications were prescribed or encouraged to continue in 13.9% of children <5 years of age with persistent-level asthma symptoms, whereas this practice occurred in 34.4% of children ≥5 years of age ($P = .03$). For all discharged children, 77.3% were prescribed oral corticosteroid medications, and the median duration of treatment with this medication was 4 days. Follow-up with a physician was advised for 93.8% of discharged children, with the median time advised to follow-up being 2 days.

Of children discharged from the ED, 41.6% of parents/caregivers with children <5 years old were documented to have received some asthma education,

whereas a higher proportion (75.4%) of parents/caregivers with children ≥5 years old received such education ($P = .001$). The age disparity of asthma education was also apparent for instructions of what to do should the child's asthma worsen: 33.3% vs 73.8% of discharged children stratified by age, <5 or ≥5 years, were documented to have received such education ($P < .001$). Among the discharged children, 11.6% were recorded to have MDI technique observed as part of asthma education during their initial ED visit.

Outcomes at the Follow-up Telephone Survey

Of those enrolled, 102 (79.7%) parents/caregivers completed the outcome-assessment survey (Fig 1). The median time lapse between the ED visit and follow-up telephone survey was 30 days, with an IQR of 28 to 34 days. No differences were observed among children whose parents/caregivers completed the follow-up survey versus those whose parents did not in regards to the presence of persistent-level asthma symptoms (as measured at the ED visit), admission to hospital, and ICS and controller-medication use.

Presence of Persistent-Level Asthma Symptoms at Follow-up

During the telephone follow-up survey, parents/caregivers were queried regarding the frequency of their child's asthma symptoms and short-acting β-agonist use. Based on each of 4 criteria, persistent-level asthma symptoms were present in 43.5% to 73.2% of the children (Table 2). At follow-up, 66.6% of the children had persistent-level asthma symptoms based on the presence of any of the 4 criteria, a frequency that was unchanged when compared with the ED visit ($P = .25$). Also at follow-up, 83.2% of the children met the criteria for persistent asthma, which was unchanged compared with the ED visit ($P = .82$).

Medication Use at Follow-up

Children were found to be using a variety of medications in the 2 weeks before the telephone follow-up survey (Table 3). Most had used inhaled short-acting β-agonists; 72.5% of the children were using a controller

TABLE 2 Proportion of Children Who Met Criteria for Persistent-Level Asthma Symptoms and Use of ICS Medications Before ED Visit and Before Follow-up

Criteria for Persistent-Level Asthma Symptoms	% Who Met Criteria for Persistent-Level Asthma Symptoms			% Using ICS Medications Who Met Criteria for Persistent-Level Asthma Symptoms		
	At ED Visit (n = 128) ^a	At Follow-up (n = 102) ^b	<i>P</i> ^c	At ED Visit (n = 94) ^a	At Follow-up (n = 68) ^b	<i>P</i> ^c
Daytime symptoms	35.9	43.5	.13	56.5	67.4	.22
Nighttime symptoms	51.5	50.0	.87	51.5	69.4	.76
Frequency of MDI use	60.4	73.2	.45	62.1	64.7	.74
Frequency of nebulizer use	54.0	67.4	.34	60.0	76.7	.71
Any of above criteria met	73.4	66.6	.25	53.2	64.2	.65

^a Item frequency based on the 4 weeks before start of asthma exacerbation.

^b Item frequency based on the 2 weeks before administration of follow-up survey.

^c McNemar's χ^2 or exact test for paired data, where appropriate.

TABLE 3 Reported Medication Use Before the ED Visit and Follow-up

Medication Class	% Using Medication in the 4 wk Before ED Visit (n = 128)	% Using Medication in the 2 wk Before Follow-up (n = 102)	P ^a
Inhaled short-acting β -agonist	84.4	83.2	.53
Any controller	56.2	72.5	.0002
ICS	44.5	59.4	.01
Oral β -agonist	28.1	2.0	<.0001
Oral corticosteroid	25.0	32.3	.26
Leukotriene modifier	21.1	26.5	.04
Inhaled long-acting β -agonist	3.9	6.8	.25
Primatene oral or mist	3.1	Not assessed	—
Cromolyn inhaler	3.1	3.0	1.0
Theophylline	0.8	0.0	1.0

^a McNemar's χ^2 or exact test for paired data, where appropriate.

TABLE 4 ED Asthma Assessment, Treatment, Education, and Discharge Practices

Characteristic	All children (N = 127), %	Children <5 y old (N = 48), %	Children \geq 5 y old (N = 79), %	P ^a
ED assessment and medications (n = 127)				
Peak flow documented	40.1	0.0	50.6	<.001
Oxygen saturation documented	97.6	95.8	98.7	.56
>1 β -agonist treatment	65.8	64.6	66.6	.81
Systemic corticosteroids received in ED	80.1	75.0	83.3	.25
Discharged to home (n = 97)				
ICS medication prescribed/continued	28.8	13.9	37.7	.01
ICS medication prescribed/continued in patients with persistent-level asthma symptoms	27.8	13.9	34.4	.03
Oral corticosteroid medication prescribed	77.3	75.0	78.7	.68
No. of days oral corticosteroid medication prescribed, median (IQR)	4 (4–5)	4 (4–5)	4 (4–5)	.68 ^b
Patient advised to follow-up	93.8	88.9	96.7	.19
No. of days to follow-up was documented	73.6	80.6	69.6	.32
No. of days advised to follow-up, median (IQR)	2 (2–4)	3 (2–5)	2 (2–3)	.33 ^b
Asthma education				
Any asthma education	62.8	41.6	75.4	.001
Instructed on what to do if asthma worsens	58.7	33.3	73.8	<.001
MDI use observed as part of MDI teaching	11.6	7.7	12.8	1.0

^a Fisher's exact or χ^2 test where appropriate.

^b Two-sample Wilcoxon rank-sum test.

agent, which was increased from the ED visit. Compared with the ED visit, an increased proportion (59.4%) of the children were using ICS medications. At follow-up, 2.0% of the children were using oral β -agonists, a substantial decrease compared with the ED visit. The frequency of oral corticosteroid use was unchanged across the 2 surveys. The proportion of those using leukotriene-modifier agents increased slightly (to 26.5%) in the follow-up survey. The remaining medications were sparsely used if at all. A majority of the caregivers/parents (93.6%) reported filling prescriptions for their child's asthma medication within 24 hours of the ED visit.

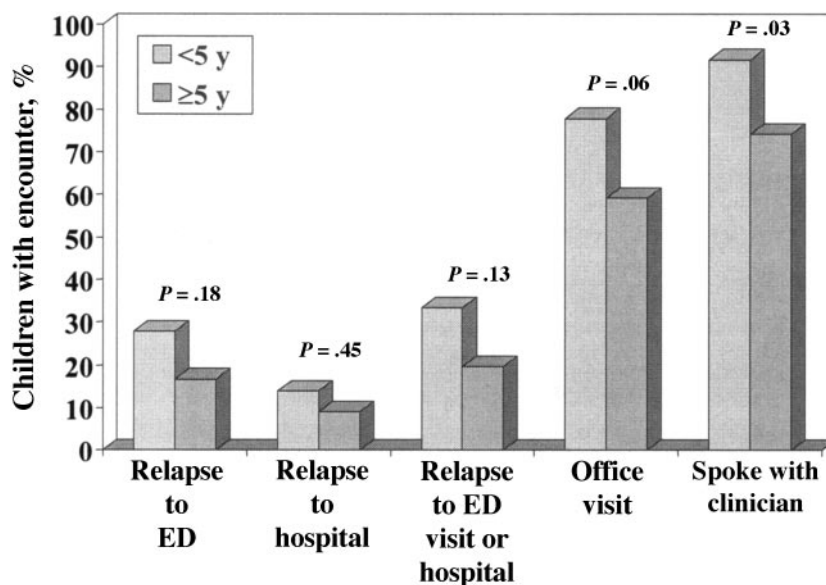
Of children with persistent-level asthma symptoms

based on any of the 4 criteria, 64.2% were using ICS medications before the follow-up telephone survey, which was unchanged compared with the ED visit (Table 2; $P = .65$). At follow-up, 77.9% of the children were using a controller medication, again unchanged compared with the ED visit ($P = .40$). Of the 68 children with persistent-level asthma symptoms at follow-up, 54.4% were both using ICS medications and using them with an appropriate frequency, which was increased compared with the ED visit ($P = .004$).

Medical Encounters and Health Limitations at Follow-up

During the telephone follow-up, parents/caregivers were queried regarding medical encounters (Fig 2). After

FIGURE 2
Health care encounters after the ED.



the ED visit, 20.6% of the children returned to an ED before the follow-up telephone survey. After discharge from the ED visit, 10.7% of the children were admitted overnight to a hospital on another day, and 24.5% returned to an ED or were admitted to a hospital overnight (on another day). Between the time of the ED visit and follow-up, 65.6% of the children had visited with an office clinician; 77.8% of those <5 years had such office visits compared with 59.1% of older children ($P = .06$). After the ED visit, 80.4% of parents/caregivers spoke with a clinician; 91.7% of parents/caregivers with children less than <5 years of age spoke with the child's clinician compared with 74.2% of parents/caregivers with children ≥ 5 years of age ($P = .03$). Of the parents/caregivers who spoke with a clinician, 46.3% did so <3 days after the ED visit.

The parent/caregiver was queried at follow-up about the child's ability to perform activities (Table 5). Depending on the strenuousness of the activity, 14.8% to 54.1% of the children were reported to have at least some activity-related limitations. For 23.0% of the children, parents/caregivers reported that these limitations were related to physical health, whereas for 15.0%, the limitations were related to the children's emotional health.

TABLE 5 Limitations of Activities and Health at Follow-up ($n = 102$)

Activities or Health Domain	% With at Least Some Limitation
Activities	
High energy: playing soccer or running	54.1
Moderate energy: biking or skating	38.1
Low energy: bending, lifting, stooping	14.8
Limitation with school or daily activities	
Due to physical health	23.0
Due to emotional health	15.0

DISCUSSION

Results from this study demonstrate that an ED-based surveillance system that collects and analyzes data from children seeking asthma care is achievable. Furthermore, important patterns emerge that provide insight into the clinical characteristics and outcomes of these children. Notably, 73.4% of the children at the ED visit met EPR-2 criteria for persistent-level asthma symptoms. Of those children, 53.2% were using ICS medications. Although the use of EPR-2 criteria of persistent-level asthma symptoms has limitations, we believe that these concepts, as implemented in this study, would be considered useful by clinicians. Limitations of the EPR-2 criteria for persistent-level asthma symptoms include lack of validation studies in the setting of acute asthma and for comparative purposes in longitudinal follow-up.²⁴

International guidelines view children who are already using asthma-controller medications as having persistent asthma.¹⁸ For the ED visit, and taking into account use of controller medications, 83.6% of the children in our study met the criteria for persistent asthma. Scribano et al²⁵ reported that 51% of children with acute asthma presenting to an ED had persistent asthma, whereas Khan et al²⁶ noted that 13% of children discharged to home from an ED had persistent asthma. Our finding of a higher frequency of persistent asthma may be accounted for by regional differences, acute asthma severity, and different interpretations of national guidelines.²⁷

The surveillance system described in this study enables assessment of ED practices that can affect patient outcomes and could be considered targets for quality-improvement initiatives. The median duration of oral corticosteroid medication prescription was for 4 days. In

the setting of a high rate of undertreated persistent asthma, this places many children at risk for having persistent-level asthma symptoms without additional oral- or ICS-medication coverage. At the ED visit, 27.8% of children with persistent-level asthma symptoms were prescribed or encouraged to continue the use of ICS medications. This result was lower for younger compared with older children.

Some have suggested that ED visits for asthma often occur because patients use the ED when they do not have access to primary care, whereas others have suggested that such visits are a result of asthma exacerbations requiring emergency care.²⁸ Children in this study were treated extensively for an exacerbation of their asthma, as suggested by the high proportions who received ≥ 2 β -agonist treatments, systemic corticosteroids while in the ED, and a prescription for oral corticosteroids at discharge. In addition, review of the medical charts revealed that nearly all the children presented to the EDs primarily for an asthma exacerbation.

The third component of this ED-based surveillance system involved obtaining outcome data. The outcome-assessment survey was designed so that many of the items were similar to that of the risk-assessment survey administered at the ED visit. This enabled descriptive assessment of longitudinal trends in symptoms and medication use, which may be altered by health care encounters. The results of this study show that the majority of children continued to be burdened by asthma symptoms despite having at least 1 health care encounter: the ED visit. At the follow-up telephone call 1 month after the ED visit, 66.6% of the children were found to have persistent-level asthma symptoms, a proportion statistically unchanged from that ED visit. At follow-up, use of ICS medications in children with persistent-level asthma symptoms was found in 64.2% of the children, which was statistically unchanged compared with the ED visit. It is promising that, at follow-up, 54.4% of the children with persistent-level asthma symptoms were both using ICS medications and using the medications with an appropriate frequency, compared with 28.7% of such children at the ED visit.

Follow-up data on health care encounters and activity limitations also portrayed a significant impact on quality of life for these children 1 month after discharge from the ED. As with previously reported studies, the relapse rate for return to the ED or hospitalization after ED discharge was found to be high, occurring in 24.5% of the children in this study.^{7,8,10,29,30} Limitation in daily activities and school was reported in at least half of the children at follow-up. These data suggest that most children with asthma requiring ED care have an exacerbation in the midst of persistent symptoms with a consequential high rate of short-term morbidity. A minority of children seem to be those who require a brief episode of

intensive therapy and quickly return to a life minimally or not affected by asthma.

Besides ICS-medication use in children with persistent-level asthma symptoms, other trends in medication use were observed. It is encouraging that the proportion of ICS-medication use in all children at follow-up increased, as had the use of any controller medication. Use of oral β -agonist medications occurred in 28.1% of the children at the ED visit and declined to 2.0% at follow-up. This suggests that the children's health care encounters resulted in medication use more consistent with the latest national guidelines.¹⁷ An interesting finding was that 25.0% of the children reportedly used oral corticosteroids in the month preceding the ED visit. A possible reason is that these children could have been treated for poorly controlled asthma or a recent exacerbation.

As noted, surveillance in this study included monitoring of clinical management by medical chart review. Use of peak-flow monitoring in children ≥ 5 years of age occurred in 50.6% of such children. This may be acceptable, because a recent study suggested that children presenting to EDs with asthma are often unable to perform this maneuver.³¹ Documentation of any asthma education occurred for 62.8% of the discharged children, and younger children had less education documented than older children. Such age discrepancy was also found for documentation of instructions to the parent/caregiver of what to do if the child's asthma symptoms worsen.

The following limitations apply to this study. First, the administration mode of the risk- and outcome-assessment surveys differed, potentially causing subtle differences in responses. Parent/caregiver self-administration for the risk-assessment survey was chosen to optimize ease of use and expansion to other study sites. Telephone interview for the outcome-assessment survey was selected for its improved survey completion and item-response rates. Second, items referring to symptom and medication frequency as well as general medication use had different time windows in the risk- and outcome-assessment surveys. This was necessary to achieve ease of use and avoid measuring symptoms and medications related to the exacerbation alone. The intent of these items was to assess how chronic symptoms and medication use related to the exacerbations. Third, most participating EDs were based at academic medical centers, and the results may not be generalizable to other EDs. These centers were chosen because of prior collaboration and are sites at which high rates of asthma morbidity have been found in the community. Fourth, this study extended over 6 months. Trends across a longer time period will be assessed in a subsequent study. Last, convenience sampling could have biased the results, although this seems unlikely because others also found that most patients with asthma presented to EDs during similar hours of the day.³²

This study demonstrates the feasibility of the IEDAC ED-based surveillance system in children with asthma and provides insight into patient and clinical management characteristics. The majority of children who presented to these EDs were persistently burdened by asthma that continued at follow-up 1 month later despite having been treated for an exacerbation. These children had a substantial relapse rate and activity limitation at follow-up. Identified areas of shortcomings in care were considered for inclusion in a quality-improvement initiative that was included in another part of the IEDAC study. Assessment of the relationship between patient clinical features, care, and outcome will be addressed as well.

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