
Detection and home management of worsening asthma symptoms

Jane Garbutt MBChB*; Gabrielle Highstein, RN, PhD†; Kyle A. Nelson, MD, MPH‡; Katherine Rivera-Spoljaric, MD§; and Robert Strunk, MD§

Background: Asthma guidelines recommend early home treatment of exacerbations. However, home treatment is often suboptimal and delayed.

Objectives: To describe antecedent symptoms and signs of asthma exacerbations noticed by parents and to learn when and how parents intensify asthma treatment.

Methods: Parents of children 2 to 12 years old with asthma exacerbations that required urgent care in the past 12 months completed telephone questionnaires. Where multiple responses were possible, percentages may sum to more than 100%.

Results: One hundred one parents were enrolled and interviewed; 94% were the children's mothers. Seventy percent of the children were black, and 64% had Medicaid insurance. Parents reported multiple antecedent symptoms and signs (median number per child, 3; range, 1–6), including respiratory symptoms (79%), allergy or cold symptoms (43%), behavioral changes (24%), and other nonspecific symptoms (29%). Twenty-three parents reported late respiratory symptoms, such as gasping for breath and using accessory muscles to breathe, as the earliest antecedent signs. Treatment was most often intensified when the parent noticed cough (55%), shortness of breath (54%), and wheeze (25%) and included adding albuterol (92%), an oral corticosteroid (17%), an inhaled corticosteroid (8%), or other nonasthma medications (16%).

Conclusions: Although parents described antecedent symptoms and signs of impending asthma exacerbations that they consistently noticed in their children, many waited for lower respiratory signs to be present before intensifying treatment. Oral corticosteroids were used infrequently. Interventions to improve the ability of parents and children to accurately recognize worsening symptoms and initiate timely, effective treatment are needed.

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INTRODUCTION

Two of every 3 children with asthma in the United States has at least 1 disease exacerbation each year.¹ Exacerbations often result in missed school days, emergency department (ED) visits (750,000 visits per year), and hospitalizations (198,000 per year). Many of these health care encounters may be preventable with early and aggressive intensification of treatment.

The National Asthma Education and Prevention Program asthma guidelines strongly recommend that patients and families of children with asthma learn how to recognize early signs of worsening asthma and how to promptly initiate early and appropriately aggressive therapy with albuterol.^{2,3} A short course of oral corticosteroids is recommended for children at increased risk for asthma mortality, and for those with a more severe attack, it has been shown to reduce ED visits.⁴

Affiliations: * Departments of Pediatrics and Medicine, Washington University School of Medicine, St Louis, Missouri; † Winds of Change at Crosswinds, East Falmouth, Massachusetts; ‡ Division of Emergency Medicine, Department of Pediatrics, The University of Pennsylvania and The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; § Division of Allergy and Pulmonary Medicine, Department of Pediatrics, Washington University School of Medicine, St Louis, Missouri.

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Initially, home management with albuterol should be guided by an asthma action plan (AAP), a written plan developed in partnership with the child's physician or nurse, with intensification of care determined in consultation with the physician. Despite widespread dissemination of the National Asthma Education and Prevention Program guidelines during the past decade, home use of albuterol and oral corticosteroids is often delayed.^{5–8} The reasons for this gap between guideline recommendations and home care are not well understood.

We conducted structured interviews with parents of young children with asthma who had had at least 1 exacerbation that required urgent care in the past year to learn (1) whether and how they monitor their children's asthma symptoms, (2) what antecedent signs and symptoms of an asthma exacerbation they notice, and (3) when and how they intervene when symptoms are worsening. Better understanding of home management of worsening symptoms is an important first step in the development of more effective interventions to improve outcomes of acute exacerbations, such as reduction in morbidity and mortality.

METHODS

Selection and Enrollment of Participants

Parents were eligible to participate if they reported that their child was diagnosed as having asthma by a physician at least 1 year ago, was 2 to 12 years old, and had at least 1 asthma exacerbation that required urgent care in the past 12 months.

Urgent care included a course of oral corticosteroids, an unscheduled office visit, an ED visit, or hospitalization for treatment of an acute asthma exacerbation. Parents were ineligible if they could not speak English or if the child was currently participating in another asthma study.

Potentially eligible parents were identified from 2 sources: receipt of asthma care at the ED of St Louis Children's Hospital in the preceding month or from the After Hours Call Center associated with the hospital and subsequent participation in the control group of a randomized control trial to evaluate asthma coaching that had concluded in the previous 9 months. For the latter source, only parents who had agreed to be contacted for possible participation in future asthma studies were approached. All the potentially eligible parents were contacted by telephone by a member of the study team and were invited to participate. The study was approved by the Human Research Protection Office of Washington University School of Medicine. Consent to participate in the study was implied by completion of the survey. Parents received a \$15 gift voucher for participation.

The Survey

Parents completed a telephone interview conducted by 1 of 2 trained interviewers guided by a tool developed for this study. The interviewers were experienced, female, lay asthma coaches with personal experience in asthma management. Demographic information was gathered, and then parents reported the child's recent impairment (daytime and nighttime asthma symptoms, activity limitations, and albuterol use in the past month) and 12-month morbidity (oral corticosteroid bursts, ED visits, and hospitalizations). Questions inquired about medications used for asthma in the past week and the availability of oral corticosteroids at home. To evaluate symptom-monitoring behaviors, we inquired about the frequency (daily or as needed) of specific monitoring activities: listening for coughing or wheezing in the daytime or nighttime or asking the child about albuterol use at school (subjective measures) and using a peak flow meter (PFM), a symptom diary, or a stethoscope (objective measures). Parents reported from whom they received advice about how to manage an asthma attack and whether they had ever had an AAP and who provided it. Open-ended questions were used to elicit the signs and symptoms of worsening asthma first noticed by the parent (antecedent signs) (What do you hear? What do you see? What do you notice in your child before an asthma attack starts? What always happens?). Open-ended questions were used to help the parent describe the child's most recent asthma attack (How did it start? What did you notice that made you decide to give an asthma medicine?). We also asked when the attack occurred and about the use of albuterol, inhaled corticosteroids, oral systemic corticosteroids, and other prescribed and over-the-counter (OTC) medicines during this recent attack. Finally, we asked for suggestions for help with future management of an asthma attack.

Cough, wheeze, shortness of breath, and chest tightness or pain were considered to be respiratory symptoms.^{2,3} Gasping

for breath and using accessory muscles to breathe were further categorized as late respiratory signs. Reports of a runny nose, a stuffy nose, watery eyes, red eyes, "cold symptoms," and "allergy symptoms" were categorized as allergy or cold symptoms. Becoming tired, becoming quiet, sitting around, and having less energy or becoming irritable, moody, or whiney were categorized as behavioral signs.

Statistical Analysis

Descriptive statistics are reported as means and standard deviations or as medians and interquartile ranges (IQRs) for continuous variables and as percentages for categorical variables. Where multiple responses were possible, percentages may sum to more than 100%. Differences in behaviors by race (black vs other), health insurance status (Medicaid vs other), the child's age group (≤ 6 years vs > 6 years), the parent's education (high school or less vs higher education), and experience with asthma care (self or other family member with asthma vs no experience) were compared using the χ^2 test or the Fisher exact test as appropriate. Specific behaviors examined included using an objective monitoring strategy (at least some of the time), having an AAP, having oral corticosteroids at home and using them in the recent exacerbation, and identifying late respiratory signs as antecedent signs of an exacerbation. Unless otherwise stated, no statistically significant differences were found. A $P < .05$ (2-tailed) was used to establish statistical significance. All the statistical analyses were performed using Stata 9.0 (StataCorp, College Station, Texas).

RESULTS

Study Population

One hundred one parents were enrolled and interviewed between August 25, 2006, and April 30, 2007 (mean [SD] duration of interview, 26 [5.4] minutes). Ninety-four percent of respondents were mothers (fathers, 4%, and other, 2%), and 58% had at least some college education (Table 1). Forty-seven percent of respondents reported that their children used at least 1 controller medication daily (17 used an inhaled corticosteroid, 7 a leukotriene receptor antagonist, and 23 both). In the year before the interview, parents reported that their children had 1 or more courses of prednisone (84%), an ED visit (92%), or hospitalization (35%) for asthma care. The median time since the child's most recent exacerbation was 4.5 weeks (IQR, 3–12 weeks) before the study interview.

Previous Acute Asthma Care Instruction

Parents reported receiving instructions for home management of an asthma attack from multiple sources, including the pediatrician (76%), the ED (30%), an asthma specialist (20%), the After Hours Call Center (10%), and during a hospital admission (8%) (multiple responses were possible). Sixty-five percent of parents reported that they had been given a written AAP (Medicaid, 57%; other insurance, 81%; $P = .02$). The AAP was provided by the pediatrician (36%),

Table 1. Patient and Family Characteristics of the 101 Study Participants

Characteristic	Value
Patient characteristics	
Male sex, No. (%)	61 (60)
Age, median (range), y	6 (2.25–12.5)
Race, No. (%)	
White	27 (27)
Black	70 (70)
Other	3 (3)
Missing	4 (1)
Ethnicity: Hispanic, No. (%)	1 (1)
Asthma duration, mean (SD), y	4.2 (2.8)
Family characteristics	
Medicaid insurance, No. (%)	65 (64)
Household, No. (%)	
Two parent	41 (41)
Single parent	57 (56)
Other	3 (3)
One parent not working outside the home, No. (%)	44 (44)
Respondent's education, No. (%) ^a	
Did not complete high school	19 (19)
Completed high school	24 (24)
Some college	42 (42)
Bachelors or post graduate degree	16 (16)
Another family member with asthma, No. (%)	76 (75)
Respondent with asthma, No. (%)	30 (30)

^a Ninety-four percent of respondents were the children's mothers.

an asthma specialist (17%), or the ED (15%). Fifty-four percent of parents reported that they had oral corticosteroids for home use for a subsequent exacerbation (black participants, 47%; others, 68%; $P = .08$) prescribed by the pediatrician (35 of 54) or the ED (20 of 54).

Asthma Monitoring Activities

Seventy-two percent of parents said that they monitored the child's asthma symptoms daily using at least 1 subjective or objective strategy (Table 2). Parents with older children were more likely to use an objective monitoring strategy at least

sometimes (≤ 6 years old, 42%; > 6 years old, 73%; $P = .002$), as were parents with experience in caring for other family members with asthma (no experience, 26%; experience, 65%; $P = .004$). Thirty-five percent of parents reported using PFMs, but only 8% used a PFM at least 2 to 3 times a week.

Antecedent Warning Signs

All the parents reported at least 1 antecedent symptom or sign that they always noticed in their children before an asthma attack (median, 3 signs; IQR, 2–4 signs; range, 1–6 signs), but these varied (Table 3). Eighty parents (79%) identified a respiratory sign or symptom, most commonly cough (62%). Twenty-four percent of parents reported noticing at least 1 behavioral change, 43% reported allergy or cold signs or symptoms, and 29% reported at least 1 other nonspecific sign or symptom, such as vomiting, stomach pain, a change in the child's voice, and dark circles under their eyes. Eleven parents (11%) reported that their child's antecedent signs comprised only behavioral changes or nonspecific signs and symptoms.

Of the 80 parents who identified antecedent respiratory signs, 67 (84%) noticed additional antecedent signs or symptoms (32 allergy or cold, 14 behavioral, and 21 nonspecific). Twenty-three parents identified gasping for breath or using ancillary muscles as antecedent respiratory signs.

Management of the Most Recent Asthma Attack

Parents described home management of their child's most recent asthma attack. For 82% of children, parents noticed that the attack started with the child's usual antecedent signs. During this attack, parents reported initiating treatment with albuterol (92%), an oral corticosteroid (17% overall, 86% with a child ≤ 6 years old, and 27% with a child > 6 years old, $P = .01$), an inhaled corticosteroid (8%; 5 started treatment and 3 doubled their child's usual dose), and other nonasthma medications, such as an antihistamine or an OTC cough or cold medication (16%). Three percent of parents reported that they waited a day or more before giving a medication, and 5% never gave any medication.

Table 2. Asthma Monitoring Activities Reported by 101 Parents

	Total, No. (%)	Frequency of use, No.					
		Daily	2–3 Times per week	Weekly	Weekly-monthly	As needed	NR
Subjective strategies							
Listen at night	86 (85)	58	7	1	1	17	2
Listen in day	72 (71)	41	6	1	0	21	3
Ask about albuterol use at school	60 (59)	31	7	4	2	16	0
Objective strategies							
Peak flow meter	35 (35)	7	1	3	3	20	1
Stethoscope	32 (32)	3	3	3	2	21	0
Symptom diary	9 (9)	2	2	1	1	3	0

Abbreviation: NR, not reported.

Table 3. Signs Always Noticed by Parent Before an Asthma Attack and Used to Intensify Asthma Treatment During Their Child's Most Recent Asthma Attack

Sign	Reported as an antecedent sign, % (n = 101)	Triggered intensified treatment, % (n = 96)
Cough	62	55
Short of breath (includes gasping and using ancillary muscles)	42	54
Cold or allergy symptoms	42	17
Tired, quiet, less energy	30	3
Chest tightness or pain	26	10
Wheeze	22	25
Stomach pain or vomit	7	4
Irritable	6	NR
Other (eg, dark circles under eyes, turns red)	33	21

Abbreviation: NR, not reported

Among 96 parents who reported giving a medication in the first 4 hours after noticing worsening symptoms (62 [65%] within 20 minutes and 79 [82%] within an hour), treatment was most commonly initiated in response to respiratory symptoms (Table 3). Ninety percent of parents administered albuterol either by nebulizer (n = 52) or metered-dose inhaler (n = 38; 24 with a holding chamber and 14 without). The reported dosing frequency for albuterol varied: every 20 to 30 minutes (n = 11), every 1 to 3 hours (n = 27), and every 4 to 6 hours (n = 30). Eleven parents reported giving albuterol more often than every 20 minutes, and 11 administered only 1 dose (median, 2 doses; IQR, 1–3 doses). Eighty percent of parents felt very confident that they were doing the right thing, 17% were somewhat confident, and 3% were not at all confident. Sixty percent thought that the child improved with treatment.

For the 45 children treated at home with albuterol for more than 4 hours, the duration of albuterol use before doing something else, such as adding another medication or calling the physician, varied from 1 day or less (n = 27) to 2 to 3 days (n = 6), 4 to 5 days (n = 4), and 1 week (n = 1); information about timing was not obtained from 7 parents. When asked specifically, 44 parents reported use of the child's AAP during the most recent attack, and 41 found the AAP to be helpful. Although availability of an AAP did not vary by any demographic factor, fewer black families reported using it during this attack (47%) compared with other families (80%) ($P = .006$). Fourteen percent of parents reported use of a PFM to monitor their child's status during the attack.

Seventy-nine percent of parents contacted the health care system for care during the exacerbation: 72 called the child's pediatrician, 7 had an unscheduled office visit (5 had also called the office), and 63 went to the ED (27 had called the pediatrician some time before going to the ED, but none had an office visit). One child was hospitalized. Children with

Medicaid insurance were more likely to go to the ED compared with other children (71% vs 50%, $P = .04$). Forty-six parents provided suggestions that might help them manage future attacks, including more education about asthma (37%) and how to use asthma medications (26%) and equipment (24%).

DISCUSSION

These findings suggest that there are missed opportunities to intensify asthma therapy to relieve symptoms, reduce the duration of exacerbations, and prevent the failures of home care represented by ED use and hospitalization.³ The parents studied easily described antecedent symptoms and signs that consistently preceded an asthma attack in their children. However, 1 in 4 parents reported late respiratory signs, such as gasping for breath and retractions, as signs to alert them that an attack was imminent. Lack of knowledge of the level of symptom intensity that requires additional treatment may explain delays in home treatment.⁹ It is also possible that the parent and physician or nurse may interpret commonly used terms to describe worsening symptoms, such as "short of breath" and "wheeze," differently.¹⁰ Careful review and discussion of the specific meaning of these terms may avoid such ambiguity. Many parents identified allergy or cold symptoms and nonrespiratory symptoms as earlier harbingers of worsening asthma, a finding consistent with other studies.^{11,12} However, few of these parents intensified treatment until respiratory signs occurred. Parents must be alerted to the multidimensional nature of the early signs and symptoms of asthma and must be helped to identify their child's particular antecedent signs and symptoms. Tools such as a symptom list¹³ or a symptom diary may be helpful. Personalizing the child's AAP to include intensifying treatment with the onset of these nonrespiratory signs may reduce morbidity and should be evaluated.

Home use of asthma medications could be improved. Use of nonasthma medications (such as antihistamines or OTC medications) to treat the child's worsening symptoms was common in the study population and may delay the use of effective treatment. Delivery of albuterol without a holding chamber may reduce treatment effectiveness, and prolonged treatment without symptom improvement may delay contact with the health care system and initiation of oral corticosteroid therapy. Despite previous use, availability at home, and calls to the physician's office during the exacerbation, few parents started oral corticosteroid therapy at home, a finding consistent with other studies.^{8,14} Providing a home supply of oral corticosteroids for children at risk for needing them in the future could facilitate use of this effective treatment. A careful evaluation of exactly which medications are used and how they are administered and dosed could identify suboptimal home management strategies. Education and training about effective use of asthma medications must be ongoing for all families of children with asthma. These data suggest that many parents would welcome such help.

Self-monitoring of disease status is key to effective management of any chronic condition. Most parents in the study population routinely checked for worsening asthma symptoms by watching their child, listening for cough and wheeze, and inquiring about albuterol use at school. Although this finding is consistent with other studies,^{15,16} the accuracy of symptom severity evaluation by parents and children is poor, particularly when symptoms are severe.¹⁷ To avoid delays in care and inappropriate home management, parents and children must learn how to accurately evaluate symptom severity. This may require training with a reference standard, possibly a PFM, particularly when symptoms seem to be escalating. Regular monitoring of asthma control using the asthma control questionnaire^{18,19} or the asthma control test²⁰ may be an effective strategy for identifying when management needs to be reassessed and adjusted.

There are some limitations to this study. Most important, we relied on self-reported data from a volunteer sample. Although most respondents reported their behaviors during a recent asthma attack, these data are probably influenced by volunteer recall and social desirability biases. We do not have data to evaluate the magnitude of these biases because we were unable to complete medical record reviews and did not record the nonresponse and refusal rates. Despite the likely influence of these biases to increase reporting of favorable responses, we identified several opportunities for improvement. We did not evaluate the severity of the attack described, but two-thirds of the study population reportedly went to the ED or the pediatrician's office for treatment. This study sample is demographically diverse, but it is from one geographic area, and the results may not be generalizable to other populations.

These findings identify actions that clinicians, particularly primary care providers, can take to reduce asthma morbidity associated with acute exacerbations. Parents receive information about asthma management from many sources, and it is important that this information is correct, consistent, and unambiguous. The primary care provider could identify specific opportunities for improvement by routinely reviewing the details of symptom monitoring and home management of worsening symptoms, helping the parent to identify earlier opportunities for intensification of treatment and making sure that they understand how and when to use asthma medications, how to evaluate treatment response, and when to seek additional help. This education may be best accomplished by routinely discussing an appropriate action plan and providing written copies for home use.

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Requests for reprints should be addressed to:

Jane Garbutt, MBChB

General Medical Sciences

Washington University School of Medicine

Campus Box 8005

660 S Euclid Ave

St Louis, MO 63110

E-mail: jgarbutt@dom.wustl.edu