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HOME USE OF ALBUTEROL FOR ASTHMA EXACERBATIONS

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Abstract

Background—To reduce symptoms and emergency department (ED) visits, the National Asthma Education and Prevention Program (NAEPP) guidelines recommend early treatment of acute asthma symptoms with albuterol and oral corticosteroids. Yet, ED visits for asthma are frequent and often occur several days after onset of increased symptoms, particularly for children from low-income urban neighborhoods.

Objective—To describe home use of albuterol and identify factors associated with appropriate albuterol use.

Methods—114 caregivers in the intervention group of a randomized trial to reduce emergent care for low-income, urban children completed a structured telephone interview with an asthma nurse to assess home management of their child's acute asthma symptoms. Albuterol use as reported by caregivers was categorized as appropriate or inappropriate based on NAEPP recommendations.

Results—Albuterol use for worsening asthma symptoms was categorized as appropriate for only 68% of caregivers and was more likely if the children had an ED visit or hospitalization for asthma in the prior year. The remaining 32% of caregivers used albuterol inappropriately (over or under treatment). Appropriate albuterol use was not associated with caregiver report of having an Asthma Action Plan (AAP) or a recent primary care provider visit to discuss asthma maintenance care.

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Conclusions—Caregivers reported they would use albuterol to treat their child’s worsening asthma symptoms, but many described inappropriate use. Detailed assessment of proper albuterol use at home may provide insight into how healthcare providers can better educate and support parents in their management of acute exacerbations and more effective use of AAPs.

Keywords

Childhood asthma; asthma action plan

INTRODUCTION

For over 15 years, guidelines by the National Asthma Education and Prevention Program (NAEPP) have recommended that caregivers of asthmatic children begin treatment for asthma exacerbations at home to avoid treatment delays and reduce the severity of the attack.^{1–4} Yet asthma remains the leading cause of ED visits for children,⁵ and these visits often follow extended periods of symptoms at home.^{6–9}

The recommended action for worsening asthma symptoms is to increase use of albuterol, with the dosing frequency guided by symptom severity and response to treatment. Up to three back-to-back treatments (every 20 minutes) are recommended during the first hour, with reassessment after each treatment.² If symptoms improve, albuterol can then be given every 3–4 hours for 24–48 hours as needed and the primary care provider (PCP) contacted for follow up instructions and further management. If symptoms persist, it is recommended to start oral corticosteroids and continue albuterol treatment every 2–4 hours as needed, with same day assessment by the PCP. If symptoms worsen or improvement lasts less than two hours, it is recommended to seek emergency care immediately.² The guidelines recommend that caregivers be provided an asthma action plan (AAP) for guidance in recognizing worsening symptoms and effective, safe use of rescue medications.

Little is known about how families typically use albuterol at home, and whether having an AAP increases the likelihood that albuterol will be used in accordance with guideline recommendations. As part of an intervention to reduce asthma morbidity and ED visits for low-income children, telephone interviews of caregivers (parents) were conducted by an asthma nurse to better understand parent’s home management of worsening asthma symptoms. Significant variation was noted in caregivers’ reported action in response to a scenario of worsening asthma symptoms articulated by the nurse (yellow zone symptoms on the AAP). These data were further analyzed to determine whether having an AAP was associated with using albuterol in accordance with guideline recommendations.

METHODS

This is a cross-sectional analysis of data from caregivers enrolled in a randomized controlled trial to evaluate an 18-month peer-coach delivered intervention to reduce asthma-related ED visits for children from low income, urban families. The study was approved by the Human Research Protection Office at Washington University School of Medicine. All participants provided written consent to participate and were paid a nominal amount for completion of enrollment surveys, but were not paid for completion of the nurse telephone interviews.

Selection and Enrollment of Participants

Participants were enrolled during ED visits for treatment of acute asthma exacerbations at St. Louis Children’s Hospital (SLCH). Subjects were eligible if they attested that they were the primary caregivers for the children, and if their children had a pre-existing diagnosis of persistent asthma, and reported acute asthma visits to the child’s PCP, ED, or hospital during

the previous 15 months. In addition, eligibility required the children to be between 2 and 12 years old and have either Medicaid or no health insurance. After enrollment, subjects were randomly assigned to the intervention or usual care. This report includes only those subjects assigned to the intervention group.

Intervention—The 18 month coaching intervention targeted asthma self-management strategies recommended in the NAEPP guidelines.²⁻⁴ Using a non-directive approach, lay asthma coaches provided tailored education and social support to help caregivers adopt and implement the targeted management strategies. Most interactions with the coach were by phone.

In addition to interactions with the coach, the intervention included telephone interviews by an asthma nurse (a registered nurse with extensive experience with telephone management of asthma exacerbations at SLCH after hours call center). The first call was made after contact with the coach had occurred, between 2 and 4 months after enrollment. During this call, the nurse reviewed with the caregiver the child's current symptoms, environmental controls, use of routine daily medications as recommended in their AAP, and a specific review of actions to be taken when symptoms worsen. Data from the nurse's first call are presented in this report.

Data Collection

Demographic data were collected prior to randomization during an interview with a research assistant. Data about PCP visits, ED visits and hospitalization for asthma care in the previous 12 months were abstracted during review of medical records.

Using a structured interview guide, the nurse recorded information about AAP use and the subject's reported action in response to a scenario involving management of their child with worsening symptoms (yellow zone symptoms). First the nurse asked, "Do you have an AAP?" and "Do you understand the AAP?" If the subject hesitated, the nurse would prompt, "A piece of paper with red, yellow and green zones." The nurse also asked which medications were routinely used as rescue medications. Later during the interview the nurse asked: "What do you do when your child has yellow zone symptoms?" A standard definition of yellow zone symptoms was not provided, but the nurse always presented the scenario: "If you walk in the room and find your child coughing or wheezing, starting to have worsening asthma symptoms, what do you do?" If there was any hesitation in the caregivers response, the nurse prompted, "Or what have you been instructed to do?" The subject was not prompted to discuss continued treatment and follow up care, but many caregivers spontaneously provided this information. Interviews lasted approximately 20 minutes and were conducted from November 2003 through September 2005.

Definitions for Appropriate and Inappropriate Albuterol Use

Albuterol use reported by the caregivers was categorized as *appropriate* or *inappropriate* using the NAEPP recommendations for care as the gold standard²⁻⁴. As information about the severity of yellow zone symptoms was not provided, a conservative approach to defining appropriate and inappropriate albuterol use was taken.

Appropriate albuterol use included any of the following:

- a. 1 to 3 albuterol treatments in the first hour,
- b. Albuterol treatments every 4 to 6 hours providing the treatments are effective for 4 hours,
- c. Referring to the child's AAP.

Inappropriate albuterol use was defined as any of the following:

- a. Over-treatment: either dosing albuterol too frequently (>3 treatments in an hour) or continuing frequent dosing for too long (< 4 hours between treatments for >24 hours),
- b. Under-treatment: dosing intervals for albuterol were too long (>6 hours between treatments),
- c. Over-reacting: calling 911 before giving albuterol or giving only one treatment and not waiting to assess response before calling 911 or going to ED.

Statistical Analysis

Frequency distributions were examined for all sociodemographic and asthma care variables collected. Descriptive statistics are reported as means and standard deviations or medians or modes and ranges for continuous variables, and percentages for categorical variables. We used the Student's t-test, Wilcoxon rank sum test, or the chi-square test as appropriate to compare the distribution of these factors among the groups categorized as using albuterol appropriately and inappropriately. A probability of $p < 0.05$ (two-tailed) was used to establish statistical significance. All statistical analyses were done using STATA 9.0 (Stata Corporation, College Station, TX) or SAS 9.2 (SAS Institute Inc., Cary N.C.)

RESULTS

Study Population

Interviews were completed for 114/122 (93%) of enrolled intervention subjects (7 could not be reached and 1 withdrew). Ninety-two percent of subjects interviewed were mothers; 4% were grandmothers and 4% were fathers. Fifty-eight percent of subjects had received a high-school education or less

The median age of study children was 5.2 years (range 2 to 10 years), 65% were male, and 94% were African American. Participants received their usual health care from 19 private practices and 11 community clinics in the St. Louis area. In the 12 months preceding enrollment, 50% of children had at least one ED visit (median 0.5, range 0–5), 26% had at least one hospitalization (mode 0, range 0–3) and 13% had at least one PCP visit for acute asthma care (mode 0, range 0–3). Nineteen percent had at least one asthma planning visit (when the child was well) with the PCP (mode 0, range 0–1).

Eighty-six (75%) subjects reported that they had an AAP, although two could not locate it. All except one who had an AAP reported that they understood it.

Response to Worsening Asthma Symptoms

When asked how they would react to their child with yellow zone symptoms, 113/114 (99%) caregivers reported they would start treatment with albuterol, but the dosing frequency varied considerably (Table 1). Twelve (10%) caregivers did not elaborate regarding dosing frequency after the first treatment. Instead they provided responses such as, 'start him on machine,' 'start treatments,' 'give till he's better.' As a result, their reported albuterol use could not be categorized as appropriate or inappropriate.

Of the remaining 102 respondents, 68% reported albuterol use that was categorized as appropriate. In this group, more caregivers chose to give albuterol as back-to back treatments rather than every 4 to 6 hours (38 vs. 31)(Table 1). Thirty-two percent reported albuterol use that was categorized as inappropriate, either over-treatment (16) or under-

treatment (8), or seeking emergency care without waiting to assess response to the first albuterol treatment (9).

Factors Associated With Providing Appropriate Albuterol Use

The analyses that examined demographic and asthma care-related factors associated with reporting appropriate albuterol use were limited to the 102 cases in which the appropriateness of use could be categorized (Table 2). Among these cases, only one statistically significant factor was identified. Appropriate albuterol use was more likely to be reported by caregivers whose children had either an ED visit or hospitalization for asthma during the 12 months preceding enrollment compared to those without ED or hospital visits during that year (51/69, 75% vs. 17/33, 52%, $p=0.025$). The appropriateness of albuterol use did not differ according to reportedly having an AAP (AAP 52/69, 75% vs. No AAP 24/33, 73%, $p=0.78$) or having an asthma planning visit with the PCP during the preceding 12 months (16/69, 23% vs 4/33, 12%, $p=0.19$). Demographic factors were also not associated with reported albuterol use (Table 2).

DISCUSSION

Albuterol is the most effective treatment for providing prompt relief from worsening asthma symptoms and is recommended for home use, guided by an AAP. When presented with a hypothetical scenario in which their child experienced worsening symptoms, most caregivers from this high-risk, urban population reported that they would begin albuterol treatment. However, variation in the reported dosing frequency and duration of use suggests that many caregivers did not understand how to use albuterol effectively. Also reportedly having an AAP did not increase the likelihood that albuterol use was appropriate. This finding is consistent with other studies that found no clinical benefit to having an AAP.^{7, 10} However, AAPs have been shown to reduce acute care visits when used in combination with education and regular management review.^{11–13} Regular monitoring of home care with education as needed appears to be the key to successful home use of albuterol, as emphasized in the most recent NAEPP guidelines.⁴

Most children with asthma receive their care from their PCP,⁵ but AAPs and education about asthma management are also provided in EDs and during hospitalizations.¹⁴ In this study, appropriate albuterol use for the yellow zone scenario was more likely to be reported if the child had been in the ED or hospital for asthma in the prior 12 months. Locally, discharge instructions from the ED include a plan with reference to medications for regular use, actions to take for levels of symptoms, and specific advice to return to the PCP within 3 days.¹⁵ Also during asthma-related hospitalizations, nurse practitioners consistently educate parents and provide a detailed AAP.¹⁶ The increased likelihood of appropriate albuterol use following one of these contacts suggests that caregivers may have learned to provide appropriate care through this experience. ED-based educational interventions have been shown to reduce subsequent ED visits and unscheduled office visits for asthma care and to increase asthma well-visits and the use of inhaled corticosteroids.^{17–19} Some researchers have suggested that ED visits may be the only opportunities to provide education about asthma self-management.^{17–21} Yet, none of these effective interventions are in widespread use.

One in ten caregivers in our study was unwilling to provide initial management of their child's yellow zone symptoms at home, preferring to seek emergency care immediately. Their responses may have been due to discomfort with treating yellow zone symptoms, inability to distinguish yellow zone from more severe red zone symptoms, or unfamiliarity with use of albuterol. It is also possible that these children had been assessed as high risk for asthma-related death and their caregivers were advised to seek medical help early in an

exacerbation.^{2, 4} While immediate referral to the ED may be the safest option for severe symptoms, repeated use of this coping strategy may have negative psychological impacts on both children and parents.^{22, 23} Seeing their parents repeatedly unable to cope with their asthma symptoms may lead children to believe that they are helpless to prevent and control exacerbations. These high-risk families need continued education and support to enable them to recognize acute asthma symptoms and the level of severity of an exacerbation, and understand how to use medication and equipment and when to seek help.

Several factors may explain the apparent lack of effect of reportedly having an AAP on appropriate albuterol use. Some caregivers may actually not have had an AAP. Three-quarters of caregivers in our sample reported having AAPs, many more than in other studies of similar populations,^{5, 7, 8, 24, 25} and it is possible that social desirability influenced the accuracy of these self-reported data. Parents with AAPs may not actually use them. Other studies have reported that few caregivers referred to their AAPs during home management of exacerbations.^{7, 25} They may not be able to find their child's AAPs at the time of exacerbations, not know how and when to use them, or not be able to read or understand them.^{26, 27} Caregivers may not feel empowered to implement the plans,²⁸ or not realize they should do so without consultation with the PCPs.^{29, 30} Alternatively, parents may modify the AAPs based on their own experience with asthma,³¹ or follow the given plans but fail to administer medications correctly,³² possibly due to not having the right equipment at home.³³ Caregivers may also have difficulty assessing the severity of their children's asthma symptoms and be unaware of the appropriate symptom intensity to trigger initiation of treatment.³⁴ A study using peak flow readings as the reference standard confirmed these inaccuracies occur for both caregivers and children and were worse when symptoms were severe.³⁵

Inappropriate albuterol use is associated with increased morbidity and mortality.³⁶ Deficits in home management of worsening asthma symptoms are unlikely to be identified unless specific questions are asked about how the parents recognize worsening symptoms and decide to initiate treatment, and about albuterol use including the dose, dosing frequency, mode of administration, and follow-up plans.^{37, 38} Office visits for asthma planning or reassessment after an acute exacerbation provide ideal opportunities to conduct a detailed assessment of home management, review and modify the AAP and provide education to improve care of future episodes.⁴ However, office visits for non-urgent asthma care are infrequent,^{39–41} especially for this high risk population,^{42, 43} and limited time and competing demands make effective asthma education difficult for PCPs and parents.^{20, 44} Patient education is a critical requirement for successful disease self-management, and alternative efficient and effective strategies to provide education are needed. Possibilities that show promise include using allied health professionals, peer educators or coaches and web-based programs.¹⁴

Limitations

There are several limitations to this study. We studied urban low-income families from one geographical area, subjects were recruited at the time of ED visits for asthma care, and the study population was receiving asthma education from asthma coaches as part of an intervention trial. These features may limit generalizability of our findings to other populations. Relying on self-reported data and assessing caregivers' response to a hypothetical yellow zone scenario may have resulted in an overestimate of perceived desired behaviors such as albuterol use. Yet this approach to assess home management of worsening asthma symptoms is likely to be used by PCPs and therefore our findings may be relevant to clinical care. We used conservative definitions for appropriate and inappropriate albuterol use that were based on the NAEPP guidelines but these categories were not validated. Also, we did not clarify mode of delivery for albuterol. Finally, we do not have data about when

and how families would use oral corticosteroids, an important component of the management of moderate and severe exacerbations.

CONCLUSION

Based on our results, many caregivers seem unsure how to use albuterol for home treatment of worsening asthma symptoms, despite having an AAP. Detailed assessment of how worsening symptoms are recognized and how albuterol is used at home may provide insight into how to better educate and support parents in the effective home management of worsening symptoms. These discussions may identify opportunities to intensify treatment (for example, add oral corticosteroids) to reduce asthma morbidity. Since this is difficult within the time frame of an office visit, perhaps it is time to address barriers to implementing effective alternative strategies to provide this needed education and support and thereby reduce asthma morbidity.

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TABLE 1

Caregivers Reported Use Of Albuterol In Response To A Scenario Of Their Asthmatic Child With Onset of Yellow Zone Symptoms (N=102).

Albuterol Use	TOTAL N (%)	EXAMPLES
Appropriate Albuterol Use	69 (68%)	
Gave 1–3 albuterol treatments in the first hour	36/69 (52%)	'Gave 3 treatments in the first hour' 'Gave 2 back to back treatments'
Gave albuterol every 4–6 hours	31/69 (45%)	'Starts treatments every 4 hours' 'Gives one treatments and then every 4–6 hours'
Referred to Asthma Action Plan (AAP)	2/69 (3%)	'Goes to action plan and follows it'
Inappropriate Albuterol Use	33 (32%)	
Over treatment - giving too much rescue medication, either too close or for too long	16/33 (48%)	'Give nebulizer every 2–3 hrs' '3 treatments in an hour then every 2 hrs for a day or two' 'Every hour for 24 hours'.
Under treatment with albuterol	8/33 (24%)	'Starts albuterol twice a day or three times a day'
Over-reacting – goes to ED after one treatment without waiting for response, or without giving albuterol treatment	9/33 (27%)	'Gives one treatment and then calls 911 or goes to ED' 'Usually just goes to ED'
TOTAL	102	

ED= Emergency Department

TABLE 2

Appropriateness of Albuterol Use for “Yellow Zone Symptoms” Reported by Caregivers.

	Albuterol Use		
	Appropriate (N=69) Mean (SD) or N (%)	Inappropriate (N=33) Mean (SD) or N (%)	P-value
Demographic factors			
Number of children in household	2.9 (1.5)	2.8 (1.4)	0.9
Number of adults in household	1.5 (0.7)	1.8 (1.0)	0.086
Male gender of child	47 (68%)	20 (61%)	0.46
Caregiver has high school education or less	39 (57%)	18 (55%)	0.85
Asthma care factors			
At least 1 ED visit or hospitalization for asthma in prior 12 months [§]	51 (74%)	17 (52%)	0.025
Number of ED visits and hospitalizations for asthma in the 12 months prior to study enrollment. [§]	1.48 (1.5)	0.85 (1.1)	0.0312
ED visits	1.1 (1.3)	0.67 (1.1)	0.104
Hospitalizations	0.4 (0.7)	0.2 (0.4)	0.118
Number of coach calls prior to nurse call	3.2 (1.8)	3.0 (1.5)	0.7
Asthma planning visit with PCP in year before enrollment	16 (23%)	4 (12%)	0.19
AAP (n=100)	52 (75%)	24 (73%)	0.78

[§]Data are from chart documentation, not self-report.

ED= Emergency Department

Note. 12 parents were excluded from this analysis as they provided insufficient information about the episode of care for albuterol use to be categorized as appropriate or inappropriate.