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A Prospective Multicenter Study of Written Action Plans among Emergency Department Patients with Acute Asthma

Carlos A. Camargo Jr.¹, Caitlin R. Reed¹, Adit A. Ginde², Sunday Clark¹, Stephen D. Emond³, and Mike S. Radeos⁴

¹Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts

²University of Colorado Denver School of Medicine, Aurora, Colorado

³Kaiser Santa Clara Medical Center, Santa Clara, CA and Stanford-Kaiser Emergency Medicine Residency Program, Palo Alto, California

⁴New York Hospital Queens, Flushing, New York

Abstract

Background—The prevalence of written “action plans” (APs) among emergency department (ED) patients with acute asthma is unknown.

Objective—To determine the prevalence of APs among ED patients, to describe the demographic and clinical profile of patients with and without APs, and to examine the appropriateness of response to an asthma exacerbation scenario.

Methods—Using a standard protocol, 49 North American EDs performed a prospective cohort study involving interviews of 1,756 patients, ages 2–54, with acute asthma. Among children only, a random sample was contacted two years after the index ED visit to assess current AP status and parents’ self-management knowledge.

Results—The overall prevalence of APs was 32% (95% confidence interval [CI], 30%–34%), and was higher among children than adults (34% vs. 26%, respectively; $p = 0.001$). Patients with APs had worse measures of chronic asthma severity ($p < 0.05$) and were more likely to be hospitalized (multivariate odds ratio, 1.5; 95% CI, 1.1–2.1). After 2 years, most children with an AP at the index ED visit still had one but only 20% of those without an AP had obtained one; moreover, many of the APs appeared inadequate. Parents of children with a current AP performed slightly better on the asthma scenario, but both groups overestimated their asthma knowledge.

Conclusion—The prevalence of APs among ED patients with acute asthma is unacceptably low, and many of these APs appear inadequate. “Confounding by severity” will complicate any non-randomized analysis of the potential impact of APs on asthma outcomes in ED patients.

Keywords

asthma; action plans; emergency medicine; education; self-management

Introduction

A written asthma self-management plan, or action plan (AP), directs patients to adjust medications at home in response to changes in peak expiratory flow (PEF) or asthma symptoms. APs usually are divided into colored zones that correspond to asthma status, and patients are directed to modify their behavior, begin oral steroids, or raise the dose of medication in a stepwise fashion based on their current zone. The National Heart, Lung, and Blood Institute (NHLBI) and National Asthma Education and Prevention Program (NAEPP) recommend that all asthma patients should have a written AP (1). A recent systematic review of 26 randomized controlled trials demonstrated that the use of self-management education emphasizing written individualized APs reduces morbidity, decreases use of acute medical services, and increases quality of life (2).

Acute asthma accounts for approximately 2 million emergency department (ED) visits and 500,000 hospitalizations annually, at a cost of at least \$18 billion per year (3). Many ED patients with asthma, particularly indigent and minority urban residents, do not have adequate primary care or exposure to asthma education (4–6). These high-risk patients often do not seek care until acute symptoms occur, so the ED may be the only place to begin preventive treatment and AP education (7–10).

The prevalence of written APs among North American ED patients with acute asthma is not known. Characterization of this population would be useful for designing future clinical trials to test the efficacy of ED-based AP interventions. Thus, the 3 objectives of this study were (1) to determine the prevalence of action plans among North American ED patients with acute asthma, (2) to describe the demographic and clinical profiles of patients with and without APs, including their risk of hospital admission, and (3) to assess AP status 2 years after the index ED visit and whether AP status correlates to appropriateness of response to an asthma exacerbation scenario.

Methods

Patient Population

The present analysis combines data from three prospective cohort studies by the Multicenter Airway Research Collaboration (MARC). MARC is part of the Emergency Medicine Network (EMNet), a collaboration of 181 participating EDs (www.emnet-usa.org). Using a standard protocol, investigators at 49 urban academic EDs in 17 US states and two Canadian provinces provided 24-hour per day coverage for a median of two weeks. All patients were managed at the discretion of the treating physician. Inclusion criteria were physician diagnosis of acute asthma; ages 2–17 (children) and ages 18–54 (adults); and the ability for the child's legal guardian or the adult patient to provide informed consent.

In addition, we contacted a random sample of enrolled patients approximately two years after the index ED visit to assess current AP status and asthma self-management knowledge. Because children were found to have a higher prevalence of AP use (see Results section) and are more likely to be reached for follow-up after long periods of time (11), only parents of enrolled children were contacted. The institutional review board at each site approved the study protocol, and informed consent was obtained from all study participants.

Data Collection

The ED interview assessed patients' demographic characteristics, asthma history, and details of their current asthma exacerbation. Trained personnel obtained data on ED management and disposition using standardized chart abstraction forms. Site investigators reviewed all

forms before submission to the Coordinating Center, where they underwent further review and double data entry by trained personnel.

We obtained AP status based on the following self-report question: “Has a doctor or nurse ever given you a written treatment plan for you to self-treat your (treat your child’s) asthma?” and primary care provider (PCP) status based on the following question: “Do you have a primary care provider (such as a family doctor, internist, or nurse practitioner)?” We estimated median family income using patients’ home ZIP codes (12, 13).

Assessment of acute asthma severity was complicated by the broad age range of enrolled patients (ages 2 to 54). We derived an overall severity score using pulmonary index scores for patients age 2–17 and PEF for patients age 18–54. We calculated pulmonary index scores for patients using respiratory rate, accessory muscle use, wheezing, and I:E ratio, based on a scale of 0 to 3 for each item (14), and expressed PEF as percentage of patient’s predicted value, based on race, age, sex, and height (15). Each variable was divided into quartiles using (1) pulmonary index score > 6 or PEF $< 33\%$; (2) pulmonary index score 5–6 or PEF 33%–45%; (3) pulmonary index score 3–4 or PEF 46%–60%; and (4) pulmonary index score < 3 or PEF $> 60\%$.

We assessed asthma knowledge among children and parents using previously validated instruments (16, 17). Additionally, we asked patients to explain what they would do during a hypothetical acute asthma attack; a score of 15 out of 25 was considered minimally acceptable.

Statistical Analysis

All analyses were performed using STATA 9.0 (StataCorp, College Station, TX). Data are presented as proportions (with 95% confidence intervals [CIs]), means (with standard deviation [SD]), or medians (with interquartile range [IQR]). We examined the association between AP status and other factors using Chi-squared test, Student’s *t*-test, and Wilcoxon rank sum test, as appropriate. We evaluated variables associated with AP status at $p < 0.10$ in univariate analysis for inclusion in multivariate logistic regression models. Additionally, we included age, sex, PCP status, and median household income in the multivariate models because of their potential clinical significance. We used Hosmer-Lemeshow test to evaluate the final models. All *p*-values are two-sided, with $p < 0.05$ considered statistically significant.

Results

A total of 1,756 ED patients with acute asthma enrolled in the study: 1,184 children and 572 adults. Overall, study investigators enrolled 74% of consecutive patients, and obtained two-week follow-up in 87% of enrolled children and 71% of enrolled adults. Non-enrolled patients did not significantly differ from the study population by age, sex, or race/ethnicity (all $p > 0.05$).

Prevalence of Action Plans

Of 1,741 patients enrolled with AP data available ($> 99\%$), a total of 552 (32%; 95% CI, 30–34%) stated they had an AP. Of the 1,173 children, 403 (34%) had an AP, while 149 (26%) of the 568 adults had APs ($p < 0.01$). The prevalence of APs was consistent across the pediatric age groups (Figure 1, $p = 0.38$).

Demographic Factors

Univariate analyses (not shown) and multivariate modeling (Table 1) revealed similar results for most demographic factors. For example, there were no significant differences between patients with and without APs in terms of sex, race/ethnicity, insurance status, or median household income. Likewise, there was no significant association between age and AP status among children or adults. However, when all patients were included in the final multivariate model, increasing age (per 10-year increment) was associated with a lower probability of having an AP (Table 1).

Patients with APs were more likely to have a PCP than those without an AP (children: 94% vs. 89%, $p < 0.01$; adults: 77% vs. 68%, $p < 0.05$); however, this association was not significant in the multivariate analysis (Table 1). In both univariate and multivariate analyses, patients with APs were significantly more likely to be children of high school graduates or, among adults, to be high school graduates.

Chronic Asthma

In both univariate analyses (not shown) and multivariate modeling (Table 1), patients with APs differed from patients without APs in several measures of chronic asthma severity, including use of inhaled B-agonists, inhaled corticosteroids, and steroid medications in the past 4 weeks, and hospitalization for asthma in the past year. Several other measures of chronic asthma severity were significantly associated with AP status on univariate analysis (data not shown), but dropped out of the multivariate model due to colinearity with other included severity measures. These factors included ever being hospitalized or intubated for asthma and the number of urgent clinic or ED visits for asthma in the past year.

Owning a peak flow meter was strongly associated with having an AP on multivariate analysis (Table 1). However, we found that there was incomplete overlap between AP status and peak-flow meter ownership. For example, only 15% of adults had both an AP and a peak-flow meter (Figure 2). Approximately 11% of adults had an AP but not a peak-flow meter, while 24% owned a peak-flow meter but did not have an AP.

Risk of Hospital Admission

Although patients with APs did not differ from those without APs with respect to PEF or pulmonary index score, AP patients were more likely to report severe asthma symptoms prior to the ED visit. In the unadjusted analysis, patients with APs were more likely to be admitted than patients without APs (children: 28% vs. 21%, $p < 0.01$; adults: 36% vs. 23%, $p < 0.01$). After adjustment for age, sex, initial asthma severity, and 12 other factors, patients with APs remained 50% more likely than patients without APs to be admitted to the hospital for acute asthma (Table 2).

Asthma Self-management

We contacted a random sample of parents approximately two years after their children's ED visit. We were able to contact 39% of 187 patients previously reporting an AP, and 33% of 179 patients who previously denied having an AP ($p = 0.23$). Although contacted patients were more often white than those who we were unable to reach (27% vs. 15%; $p < 0.01$), the two groups did not differ by other demographic or asthma factors (all $p > 0.05$).

We found that most parents who reported an AP at the index ED visit also reported having an AP at the 2-year follow-up call (71%), but only 20% of those who reported not having an AP at their index visit now reported an AP at 2-year follow-up. Among all 50 patients who reported an AP at two-year follow-up—and specifically excluding the 32 who reported having an AP at the index ED visit but not two years later—at least 22% of the APs

appeared inadequate (e.g., the “plan” did not provide any indication of when to take rescue medicines). Indeed, parents of children with and without APs performed similarly on the rapid-onset scenario (15 ± 3 vs 14 ± 4 , $p = 0.11$), though there was a suggestion that those with current APs were more likely to score 15 or higher (84% vs. 70%, $p = 0.06$).

When asked to rate their knowledge on what to do during a severe asthma attack, the overwhelming majority of parents with and without APs stated that their knowledge was “good” or better (96% with current AP vs. 90% without current AP; $p = 0.43$). The groups were equally likely to report shortness of breath (90% vs. 82%; $p = 0.25$), tightness in the chest (96% vs. 94%; $p = 0.60$), cough at night (88% vs. 73%; $p = 0.06$), and wheezing after exercise (98% vs. 90%; $p = 0.08$) as signs of asthma. A comparably high percentage of parents incorrectly reported severe headaches (85% vs. 84%; $p = 0.87$) as another sign of asthma.

Discussion

Action plans (APs) are considered an important component of asthma patient education, with demonstrated efficacy in reducing morbidity and use of health care resources (1, 2). We found that the prevalence of APs among ED asthmatics is very low, with only one-third having an AP; the prevalence among adults (26%) was lower than that among children (34%). Patients with APs were more likely to be (or to be children of) high school graduates than those without APs, and several measures of chronic asthma severity predicted AP status. Patients with APs who presented to the ED with an asthma exacerbation were more likely to be hospitalized.

To better understand the observed AP prevalence, we compared our results to those reported in other studies. Prevalence of APs in primary care settings range from 20% in adults with asthma in one large medical group practice (18) to 75% in children with asthma seen in a pediatric primary care practice (19). Practice characteristics may account for some of the variability: a survey of the general population of HMO members with asthma in California found that 42% had APs, attributed to the HMO’s emphasis on asthma monitoring and prevention to reduce the costs of treating acute exacerbations (20). Baseline asthma severity may account for further variability: in the survey with the highest AP prevalence in children with asthma reported that 80% had persistent asthma (19). However, one study of children *hospitalized* with acute asthma reported that only 51% were given a written action plan on discharge (21).

More appropriate comparison groups arise from ED-based studies. Two studies of adults presenting to the ED with acute asthma found that 21% and 28% had APs, although both studies were small ($n = 88$ and 101) (22, 23). In a Canadian randomized trial of discharged ED patients with asthma, 23% of patients stated they had an AP (24). These data suggest that our results are consistent with patterns of AP usage among acute care patients.

Peak expiratory flow readings provide an objective measure of lung function and are used to guide peak-flow-based APs. However, controversy exists about the use of PEF to monitor asthma (1). Accordingly, we identified a mismatch between patients with APs and peak-flow meters (Figure 2). This finding may also suggest that some patients own peak-flow meters but lack the self-management plan needed to act appropriately when PEF readings indicate an asthma exacerbation. Peak-flow ownership without a means of interpreting peak flow values offers no motivation for use (25). A recent telephone survey of 197 children seen in the ED for acute asthma reported that only 3 in 5 children possessed either a spacer or a peak-flow meter, whereas approximately 2 in 5 reported having a written asthma action plan (26).

In the current study, a significant number of patients, both children and adults, reported having an AP but did not own a peak-flow meter. A possible result of this mismatch (presence of AP without peak-flow meter ownership) is that these patients did not implement their plans. An alternative explanation is that these patients use symptom-based, not peak-flow-based, APs. NAEPP recommendations for adults suggest daily peak-flow monitoring as part of an AP (1), though a systematic review of four trials comparing symptom-based versus PEF-based self-management plans reported no difference in morbidity and with intermediate outcomes favoring symptom-based APs (27).

We found that among patients presenting to the ED with acute asthma, those with APs had worse chronic asthma by several different measures and were more likely to be admitted to the hospital. The apparent increased risk of admission among patients with an AP does not imply a causal relationship. One must keep in mind confounding by severity (28); in a non-randomized study, it is likely that only the most severely ill patients with APs actually presented to the ED. Randomized trials have demonstrated that APs reduce morbidity and use of medical services (26). Furthermore, our aim was to identify characteristics of patients in this cohort who lack APs, not to demonstrate that APs are effective. In this observational study, patients with more severe chronic asthma were also more likely to have received an AP during one of their many contacts with the health care system. Both the risk of hospitalization and presence of AP are likely to be independently associated with asthma severity.

We also found that adults and parents of children with APs were more likely to have graduated from high school. Education may confer increased understanding and retention of APs, although further investigation is warranted. Nevertheless, our finding suggests that future AP educational interventions might benefit patients with lower education or literacy levels. Designing education programs for this audience is challenging but important since prior studies suggest that only 27% of ED patients with asthma read at a high school level (29), and low health literacy is associated with poor long-term asthma outcomes (30). Preliminary data suggest these barriers may be overcome (31).

To better understand the longitudinal changes in AP status after ED presentation for acute asthma, we contacted a random sample of patients 2 years after their index ED visit. Although the response rate in this hard-to-reach population was low (36%), we did not find evidence of a significant response bias. Nevertheless, the prevalence of APs remained unacceptably low, and many of the described APs appeared inadequate. Although self-rated knowledge of how to respond to an asthma exacerbation did not differ by AP status, with both groups giving themselves high scores, actual responses to the rapid-onset scenario was low in both groups.

Several studies have demonstrated a positive effect of ED-based interventions on asthma knowledge and outcomes. A recent meta-analysis of ED-based educational interventions demonstrated a reduction in subsequent asthma admissions for a wide range of interventions (32). For instance, both resource-intensive, tailored educational interventions (33) and less resource-intensive asthma “kiosks” (34) have been successful at improving outcomes. These results suggest receipt of an AP along with a brief behavioral intervention may be effective in helping ED patients to improve self-management.

This study has a few potential limitations. AP status was based on self report. Thus, appropriate use of, or compliance with, APs was not directly measured in this study, and we do not know if patients who have written APs are able to respond more appropriately to an actual asthma exacerbation than patients without APs. Another potential limitation is that AP status may be primarily a surrogate marker for educational level or access to health care.

However, educational programs aimed at teaching low-income asthmatics to use APs have been successful (35, 36), and this patient group is likely to benefit from ED-based interventional trials using APs.

Data from the 2-year telephone follow-up calls also have limitations. Although we reached only a relatively small proportion of pediatric patients two years after the index ED visit, those reached did not appear to differ significantly from those who were not. Additionally, we did not gather these data on adult patients and cannot comment on whether they would have similar findings. Finally, our population included only patients presenting to the ED with acute asthma, so the results of this study may not be applicable to the general population. While results may not generalize to all asthmatic individuals, this cohort consisted of predominately low-income and minority patients, a population that has been identified as a high-risk group for asthma morbidity and mortality (36–38).

Conclusion

In summary, this prospective multicenter study demonstrated a low prevalence of APs among ED patients with acute asthma. Patients relying on the ED as their primary source of care need self-management education, but these are the patients who are least likely to attend asthma clinics and programs (39). Without self-management skills, patients with moderate-to-severe asthma are more likely to relapse to the ED (40, 41). Future studies should focus on whether patients who claim to have APs are able to use them appropriately during an acute exacerbation. In addition, randomized controlled trials are needed to investigate the efficacy of ED-based AP education, which types of simple APs are most useful, and what teaching methods and materials are most appropriate, for brief interventions in the acute-care setting. The present study will guide the development of such research by providing insights into the need for such work and a better understanding of the target population. The ED environment presents unique challenges to delivering feasible and effective interventions, but it also offers a unique opportunity to reach patients with the most severe asthma.

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Appendix

EMNet Steering Committee

Edwin D. Boudreaux, PhD; Carlos A. Camargo, Jr., MD, DrPH (Chair); Adit A. Ginde, MD, MPH; Jonathan M. Mansbach, MD; Steven Polevoi, MD; Michael S. Radeos, MD, MPH; and Ashley F. Sullivan, MPH, MS.

EMNet Coordinating Center

Angela T. Anderson; Carlos A. Camargo, Jr., MD, DrPH (Director); Lisa A. Dubois; Janice Espinola, MPH; Jessica M. Pang; John F. Pearson; Chu-Lin Tsai, MD, MPH; Ashley F. Sullivan, MPH, MS—all at Massachusetts General Hospital, Boston.

Principal Investigators at the 49 Participating Sites

FC Baker III (Maine Medical Center, Portland, ME); JM Baren (Hospital of the University of Pennsylvania, Philadelphia, PA); D Bond (Grey Nun's Community Hospital, Edmonton, AB); GW Bota (Sudbury General Hospital, Sudbury, BC); ED Boudreaux (Earl K. Long Memorial Hospital, Baton Rouge, LA); BE Brenner (The Brooklyn Hospital Center, Brooklyn, NY); J Brown (Misericordia Community Hospital, Edmonton, AB); K Brown (University Hospital, SUNY HSC, Syracuse, NY); CA Camargo Jr. (Massachusetts General Hospital, Boston, MA); K Camasso-Richardson (Rainbow Babies & Children's Hospital, Cleveland, OH); EF Crain (Jacobi Hospital, Bronx, NY); F Cunningham (Newark Beth Israel Hospital, Newark, NJ); RK Cydulka (MetroHealth Medical Center, Cleveland, OH); CO Davis (University of Rochester Hospital, Rochester, NY); L de Ybarrondo (LBJ General Hospital, Houston, TX); MA Dolan (Medical College of Virginia, Richmond, VA); MD Dowd (Children's Mercy Hospital, Kansas City, MO); SD Emond (St. Luke's/Roosevelt Hospital Center, New York, NY); F Fairfield (Sturgeon Community Hospital, St. Albert, AB); TJ Gaeta (Methodist Hospital, Brooklyn, NY); TJ Gaeta (St. Barnabas Hospital, Bronx, NY); MA Gibbs (Carolinas Medical Center, Charlotte, NC); TE Glynn (Brooke Army Medical Center, Fort Sam Houston, TX); TE Glynn (Wilford Hall Medical Center, Ft. Sam Houston, TX); RO Gray (Hennepin County Medical Center, Minneapolis, MN); JP Hanrahan (Beth Israel Hospital, Boston, MA); F Harchelroad (Allegheny General Hospital, Pittsburgh, PA); SE Hughes (Albany Medical College, Albany, NY); LW Kreplik (Christ Hospital & Medical Center, Oak Lawn, IL); S Lelyveld (University of Chicago Hospital, Chicago, IL); A Mangione (Albert Einstein Medical Center, Philadelphia, PA); JS Mylinski (Richland Memorial Hospital, Columbia, SC); ES Nadel (Brigham and Women's Hospital, Boston, MA); RM Nowak and H Sedik (Henry Ford Hospital, Detroit, MI); JB Orenstein (Fairfax Hospital, Falls Church, VA); CV Pollack Jr. (Maricopa Medical Center, Phoenix, AZ); F Qureshi (Children's Hospital of the King's Daughters, Norfolk, VA); MS Radeos (Lincoln Medical Center, Bronx, NY); BH Rowe (University of Alberta Hospital, Edmonton, AB); G Rudnitsky (Allegheny University - MCP Division, Philadelphia, PA); RJ Scarfone (St. Christopher's Hospital for Children, Philadelphia, PA); D Schreiber (Stanford University Medical Center, Stanford, CA); RA Silverman (Long Island Jewish Medical Center, New Hyde Park, NY); S Smith (St. Louis Children's Hospital, St. Louis, MO); H Smithline (Baystate Medical Center, Springfield, MA); CA Terregino (Cooper Hospital/University Medical Center, Camden, NJ); D Travers (University of North Carolina Hospitals, Chapel Hill, NC); A Walker (Royal Alexandria Hospital, Edmonton, AB); and JL Zimmerman (Ben Taub General Hospital, Houston, TX).

Figure 1.
Percentage of emergency department patients with action plan, by age group.

Figure 2.
Percentage of adult patients with action plans, peak-flow meters, or both.

Table 1

Multivariate model of factors associated with having an action plan.

	Odds Ratio	95% CI	p-value
Age (per ↑ 10 years)	0.8	0.7–0.9	<0.01
Female	1.0	0.8–1.2	0.71
White	0.8	0.6–1.2	0.31
High school graduate *	1.4	1.1–1.8	0.02
Estimated household income (per ↑ \$10,000)	1.0	0.9–1.1	0.78
Primary care provider	1.2	0.9–1.8	0.25
Ever taken steroid medicine for asthma	1.4	1.1–1.9	0.02
Admitted for asthma during past year	1.5	1.2–1.9	<0.01
Has hayfever	1.4	1.1–1.7	<0.01
Inhaled β -agonist during past 4 weeks	1.7	1.2–2.4	<0.01
Inhaled corticosteroids during past 4 weeks	1.5	1.1–2.0	<0.01
Owens peak flow meter	2.2	1.7–2.8	<0.01

CI denotes confidence interval. Hosmer-Lemeshow statistic = 9.14 on 8 degrees of freedom ($p = 0.33$).

* Parent's education level for patients age 2–17. Patient's education level for patients age 18–54.

Table 2

Confounding by severity: Relation of having an action plan to hospital admission.

	Odds Ratio	95% CI	p-value
Model 1 (age-adjusted)	1.7	1.3–2.1	<0.01
Model 2 (adjusted for age + sex)	1.7	1.3–2.1	<0.01
Model 3 (adjusted for above + initial severity) [*]	1.8	1.4–2.4	<0.01
Model 4 (adjusted for above + 12 factors) [†]	1.5	1.1–2.1	0.02

CI denotes confidence interval. For Model 4, the Hosmer-Lemeshow statistic is 11.15 on 8 degrees of freedom ($p = 0.19$).

^{*} See Methods section for details.

[†] Final model includes age, sex, initial asthma severity, plus 12 factors (race, education, estimated household income, PCP status, insurance, history of intubation, recent use of asthma medications other than inhaled corticosteroids or β -agonists, use of steroids, hospital admission for asthma during past year, duration of asthma symptoms, asthma severity during past 24 hours, respiratory rate, and number of β -agonists during ED stay). See Methods section for definitions of variables.