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ORIGINAL ARTICLE

Inaccuracy of "Personal Best" Peak Expiratory Flow Rate Reported by Inner-City Patients with Acute Asthma

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ABSTRACT

Percent predicted peak expiratory flow (PEF) is used to determine the severity of asthma exacerbation and the appropriateness of discharge from the emergency department (ED). The 1995 Global Initiative for Asthma and 1997 National Asthma Education and Prevention Program guidelines recommend using a patient's "personal best" PEF, if available, as a better measurement than the predicted PEF obtained from population-based nomograms. We evaluated the accuracy of personal best PEF as provided by inner-city ED patients with acute asthma. One hundred four patients with acute asthma agreed to return to the ED for repeat PEF measurements on days 3, 7, 12, 21, and 24 after their initial ED visits for acute asthma. At the ED visit, only 29% (30/104) of patients were able to report a personal best PEF. Over the 24 days of follow-up, 45% (10/22) of these patients had a measured PEF greater than their reported personal best. If a predicted PEF of at least 70% was used as the criterion for ED discharge, as several asthma guidelines recommend, then using patients' reported personal best PEF would have led to inappropriate ED discharge for some patients.

KEY WORDS: Peak flow; Nomogram; Asthma, Emergency department; Guidelines.

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INTRODUCTION

Asthma is a common chronic disease with a prevalence of 4–8% and steadily increasing morbidity and mortality (1). Acute asthma accounts for almost 2 million emergency department (ED) visits per year in the United States (2). Accurate and objective measures of asthma exacerbation severity are necessary to determine the need for admission or discharge from the ED, since clinical parameters have been shown to be inadequate (3).

Peak expiratory flow (PEF) is one way of measuring the severity of airway obstruction. In the emergency department (ED), PEF has the advantage of being a simple, quantitative, and reproducible measurement (4,5). The PEF value correlates well with 1-second forced expiratory volume (FEV_1) (6). PEF is commonly used in EDs because of its relative ease of use by both the ED staff and the patient. The low cost, minimal training, and lack of specialized equipment are all advantages of the peak flow meter as compared to the spirometer (7). Accordingly, PEF measurements are used as the standard criteria for discharge or admission of the asthmatic patient from the ED (8).

According to the 1995 Global Initiative for Asthma (GINA) guidelines and the 1997 National Asthma Education and Prevention Program (NAEPP) guidelines, criteria for ED discharge should be a posttreatment PEF of at least 70% of the patient's predicted or "personal best" PEF (4). The NAEPP guidelines further recommend preferentially using the patient's personal best PEF, if available, since the NAEPP authors thought that it was better than a predicted PEF from a nomogram based on age, height, race, and sex (4,6).

The purpose of our study was to evaluate the accuracy of personal best PEF as provided by inner-city patients with acute asthma and to compare the clinical implications of using this value versus that obtained by a standard nomogram for predicting ideal PEF.

METHODS

The study was performed at a 642-bed inner-city teaching hospital with approximately 3000 acute asthma visits and 62,000 ED visits per year. Almost all patients presenting with an asthma exacerbation are managed in a separate area of the ED and are treated while sitting in a chair. Only patients with impending respiratory failure are treated on a gurney in an acute area. All patients presenting with asthma symptoms are brought into the ED without triage delays, and treatments are started immediately. Approximately 25% of the patients present by ambulance, and the rest are ambulatory (unpublished data). For 24 hours per day, 7 days per week, there is a trained physician research associate and a nurse assigned only to these asthma patients.

Table 1

Inclusion Criteria

- Age 18–50 years
- Physician-diagnosed asthma
- No use of inhaled corticosteroids or theophylline in the past week
- No oral corticosteroid in the past month
- Peak expiratory flow rate (PEF) < 70% after first $beta_2$-agonist treatment.
- No comorbid cardiopulmonary disease (e.g., emphysema, sarcoid, pneumocystis carinii, congestive heart failure)
- Not pregnant
- Did not sign out from ED "against medical advice"

In the context of a randomized clinical trial, conducted over a 16-month period, 1939 consecutive adult ED asthma visits were documented, of which 551 patients were eligible for the trial and 104 agreed to participate. Patients who were more likely to comply with the study and those who were able to demonstrate acceptable use of a spacer and PEF meter were preferentially chosen for enrollment. Table 1 lists the inclusion criteria for the study (9). Each of the patients agreed to return to the ED on days 3, 7, 12, 21, and 24 for follow-up PEF measurements. All PEFs obtained were the best of three efforts except for the initial PEF, which was the best of two or three efforts, depending on how well the patient tolerated the procedure. All PEFs were obtained by trained physician research associates who had been instructed in methods of obtaining PEF in asthmatics. Two methods were used to calculate the percent-predicted PEF. If the patient knew his or her personal best PEF when doing well at home and the patient used a home PEF meter, this value was used in preference to the value obtained by using the nomograms, and the value was recorded as the patient's personal best PEF. If the patient did not know his or her personal best PEF, then the nomogram in the 1991 NAEPP guidelines was used to obtain the predicted PEF (10). To increase clarity, the percent predicted PEF based on the nomogram-derived PEF value is termed "percent predicted PEF-N." All patients were treated according to the 1991 NAEPP guidelines for ED management of acute asthma and needed to have a predicted PEF of at least 70% at the time of ED discharge, a practice that is consistent

with both the 1991 NAEPP guidelines (10) and the 1995 GINA guidelines (4). The hospital's institutional review board approved this study.

On discharge, all patients received 40 mg of prednisone per day for 5 days and inhaled albuterol as needed. For the purpose of the trial, patients were randomly assigned to receive 2 mg (8 puffs) of inhaled flunisolide (Aerobid®; Forest Pharmaceutical, St Louis. MO) or placebo. At the time of discharge, patients were given all study medications (flunisolide, prednisone, and albuterol inhaler) and spacer and were told to start using the medications the morning after their ED visit (9). Subjects were also instructed on the use of their flunisolide/placebo inhaler and spacer, which lasted approximately 30 minutes and were administered from script. All patients successfully demonstrated the use of the inhaler and spacer before discharge from the ED.

Patients were telephoned every day to ascertain relapse or impending relapse and received PEF measurements, and symptom assessments were done on days 3, 7, 12, 21, and 24 ± 2 days. All PEF measurements were performed by using the Astech® peak flow meter (Center Laboratory, Port Washington, NY) in the ED, the patient's home, or the patient's workplace. All measurements were obtained by trained physician research associates and represent the best of three efforts. The Astech peak flow meter was chosen because it provides highly accurate and reproducible results (5). At each visit, medication compliance was reviewed, emphasizing the use of the study drug and spacer, according to the protocol (9).

In this study, our sample group was a combination of patients from both the flunisolide and placebo arms of the study. There was no difference in PEF between the two treatment groups on any of the 5 follow-up days (9); therefore, data from treatment and nontreatment groups were combined. Patients who knew their personal best PEF were compared to the group who did not know their personal best PEF. The data were analyzed by SPSS 6.1 (SPSS, Inc, Chicago, IL). Continuous variables were evaluated by using t-test, and categorical variables were evaluated by using the chi-square test. All p values are two-sided, and $p < 0.05$ is considered statistically significant.

RESULTS

Of the 104 study patients, only 30 (29%; 95% confidence interval: 20–39%) reported knowing their personal best PEF. Only one patient (1/30, or <5%) reported a best PEF value that was higher than the PEF value that would have been predicted for that patient on the basis of the nomogram. Of note, 7% (2/30) of the patients who supposedly knew their best PEF actually surpassed that number in the ED before discharge.

Table 2 shows patients' baseline characteristics, according to whether or not the patient claimed to know his or her personal best PEF. The average age of patients was 32 years, 65% were female, and 97% were black or Hispanic. Patients reported having asthma for an average of 14 years, and all reported prior ED visits in the past year for their asthma. The initial percent predicted PEF-N (i.e., that based on the nomogram) was 39% on arrival in the ED and approximately 75% at time of discharge. The percent predicted PEF-N was almost 10% higher at discharge in the group that did *not* know their personal best PEF than in the group that claimed to know their personal best PEF ($p = 0.005$). The increased PEF of those who did not know their personal best PEF, relative to those who did, persisted at 24 days ($p = 0.01$).

Seventy-three percent (22/30) of those who supposedly knew their personal best PEF returned for at least one follow-up visit. Of these 22 patients, 77% (17/22) improved their PEF over their PEF at time of ED discharge, and the remainder had similar or worse values. The overall median change was 19% (range: –25 to 89%). During the 24 days of follow-up, almost half (10/22, or 45%) had a measured PEF that was *greater* than their reported personal best; in seven of the cases this difference between personal best PEF and measured PEF was greater than 15 percentage points. Only 13% (3/22) of patients who knew their personal best PEF attained that PEF during follow-up.

Of the patients who knew their personal best PEF and exceeded this value during the 24-day follow-up period, 30% (3/10) exceeded this value sufficiently that if a predicted PEF of at least 70% was used as the criteria for ED discharge, then using that value would have led to inappropriate ED discharge for three patients. Figure 1 shows that in only 10–15% of all these asthmatic patients could the personal best PEF provide useful information. Unfortunately, we found no between-group differences that would allow clinicians to a priori distinguish in which patients the personal best PEF might have clinical utility (Table 2).

DISCUSSION

Our results suggest that most inner-city urban asthmatic patients do not know their personal best PEF and, among those who do know, approximately half of the reported values are inaccurate. If the 1997 NAEPP guidelines that

Table 2

Comparison of Patients with Acute Asthma Discharged from the ED Who Knew Their "Personal Best" PEF vs. Those Who Did Not (n = 104)

	Peak Flow Known ($n = 30$)	Peak Flow Not Known ($n = 74$)	p-Value
Mean age, year (S.D.)	30 (9)	32 (9)	0.94
Female (%)	63	66	0.76
Race (%)			
Afro-American	80	64	0.40
Hispanic	17	26	
Other	3	10	
Mean asthma duration, year (S.D.)	19 (13)	14 (13)	0.78
Number of ED visits past year (%)			
0	0	0	0.55
1	16	36	
2	20	16	
3	12	9	
4	8	7	
>4	44	33	
Smoking (pack-year)			0.97
Never and <10	63	58	
10 to <20	25	29	
20 or more	13	13	
Hospital admission past year (%)			0.24
0	6	8	
1	31	63	
2	6	8	
3	19	8	
>3	38	13	
Owns peak flow meter (%)	95	77	0.28
Mean % predicted PEFR-N			
At ED presentation	39 (12)	42 (13)	0.26
At ED discharge	71 (16)	79 (11)	0.005
24 days after ED visit[a]	75 (14)	88 (18)	0.01

The percent predicted PEF-N denotes % predicted value based on nomogram-derived PEF.

[a]Based on 17 patients in the group that reportedly knew their personal best PEF and 46 patients in the group that did not know their personal best PEF.

recommend using personal best PEF were implemented in assessing criteria for discharge from the ED (6), then some patients would be discharged prematurely. Use of a population-based nomogram for estimating ideal PEF would provide better information among most inner-city asthmatic patients.

Guidelines from many different countries, such as the United States, Canada, the United Kingdom, South Africa, and Australia (11), urge the use of personal best or nomogram-derived PEF values for objective assessment of the patient with acute asthma. Although the actual percent predicted values for ED discharge vary from 60% to 75% across guidelines, the overall consistency across guidelines is striking. The results of our study conflict with the advice of experts who specifically advocate using personal best PEF in the ED setting. Patients with marked bronchospasm and a low measured PEF may want early discharge from the ED and may not want to wait to achieve 70% of predicted PEF. The patient would state that this low measured PEF approximates his or her personal best PEF, thereby reassuring the clinician that this asthmatic has achieved at least 70% of his or her personal best PEF and allowing for more rapid discharge from the ED. The results of this study imply that for the

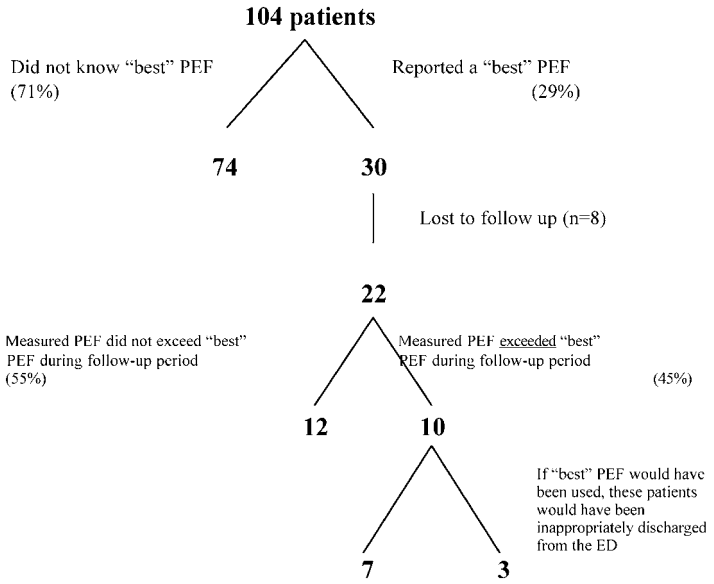

Figure 1. Flowchart of study patients.

patient with knowledge of his personal best PEF, those PEF values are *not* the best standard and should be interpreted cautiously. Ultimately, of course, all spirometric parameters (PEF or FEV_1) are dependent on patient technique and effort. Accordingly, these parameters must always be interpreted in conjunction with the patient's history, physical examination, and other clinical data.

When patients who claimed to know their personal best PEF were compared with patients who did not, the ED characteristics did not differ significantly on any measurement except for the percent predicted PEF-N at ED discharge. One potential explanation could be that the patients who present to the ED with acute asthma and utilize home peak flow meters also have more severe asthma and do not improve in the ED as readily as do those without home PEF meters. This contention is supported by the observation that the percent predicted PEF-N at 24 days continued to be lower in the group that stated that they knew their personal best PEF.

Our study has several potential limitations. The inner-city focus may have produced results that do not generalize to suburban or rural EDs. However, inner cities are most affected by asthma, so our findings still apply to those with the highest disease burden (2). Likewise, the use of patients enrolled in a clinical trial suggests a bias that would, if anything, make patients appear more knowledgeable. If true, this would make the observed inaccuracies even more worrisome. Selecting patients from a general ED population of patients with asthma who were not on inhaled corticosteroids (ICS) may have created a selection bias. This group may represent asthmatics with poor access to good health care. The majority of all ED patients with acute asthma, however, are not on inhaled corticosteroids at the time of ED presentation (12). In addition, in a large, recent study in which both those using ICS and those not using ICS were included, the findings were virtually identical (13). Another potential limitation relates to the relatively small sample size. Important between-group differences for outcome variables (e.g., relapse) could not be determined, and the small numbers yield wide 95% confidence intervals. Nonetheless, we believe that we can safely conclude that most inner-city asthmatic patients do not know their best PEF and that, among those who do, these values are often inaccurate. Further study with larger populations will be needed to determine the impact of using erroneous personal best PEF values on the admission decision and on post-ED relapse. Such an effort would be greatly facilitated by collaboration between EDs and primary care providers, a group that should closely monitor patients' PEF after discharge from the ED.

In summary, inner-city asthmatic patients often are not accurate in reporting their personal best PEF, and these values should not be used preferentially as part of the discharge decision unless it is quite clear that the patient reliably monitors his or her home PEF. The recommendations set out by the 1997 NAEPP guidelines favoring personal best PEF instead of the nomogram-derived predicted PEF

may not apply to an inner-city population. Future work, using larger ED databases, might try to confirm some of the more disturbing findings in our study, such as whether a substantial number of patients with acute asthma who claimed to know their personal best PEF actually achieve the same value or better while still in the ED. As we have shown, such gross inaccuracies may result in a premature discharge from the ED. To avoid such events, clinicians should remember to interpret PEF results cautiously and to correlate these "objective" findings with the patient's symptoms and clinical appearance.

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