Compliance With Peak Expiratory Flow Monitoring in Home Management of Asthma*

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Background: **The recent consensus reports on asthma management emphasize the importance of using peak flowmeters to accurately assess the degree of airflow obstruction. However, the optimal way to use those devices has not yet been determined.**
Objectives: **To assess compliance with peak expiratory flow (PEF) measurements in the long-term management of asthma, and identify the characteristics of patients with poor compliance.**
Setting: **Asthma clinics from three tertiary-care hospitals.**
Design: **A descriptive and prospective study of 1-year duration.**
Patients: **Twenty-six patients with moderate to severe asthma taking part in an asthma education program.**
Main outcome measures: **Patients were asked to measure morning and evening PEF using an electronic peak flowmeter with a 3-month memory; they were unaware that PEF values were being recorded by this device.**
Results: **Compliance with PEF measurements was relatively good during the first month (63% of the measurements done) but even with regular reinforcement, fell to 50% at 6 months and to 33% at 12 months. Right from the beginning, 8 of 26 subjects (30%) never or almost never (<5% of the readings done) measured PEF, with seven of these subjects writing fabricated results in their diaries most of the time. At 12 months, 60% of the subjects were measuring PEF <25% of the time, and most of them continued writing fabricated PEF values in their diaries. None of the subjects' characteristics helped us to identify those who had poor compliance with these measurements.**
Conclusions: **While short-term compliance with PEF measurements is fairly good, most patients with moderate to severe asthma are not interested in measuring PEF twice daily over a prolonged period. In the current management of asthma, PEF measurement devices can be suggested to those showing a strong personal interest in using them, but should be limited to short periods of time. Furthermore, this study outlines the usefulness of electronic peak flowmeters when doing clinical research where PEF improvement is an important outcome.**
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Key words: asthma management; asthma treatment; prevention and control; respiratory function tests

Abbreviations: EP=educated patients; NA=nonattenders; PEF=peak expiratory flow

Asthmatic patients can assess asthma severity by monitoring respiratory symptoms such as shortness of breath, wheezing, cough, nighttime awakening, and bronchodilator need, or by monitoring peak expiratory flow (PEF) using a portable device. Previous studies have clearly demonstrated that estimates of the degree of airflow obstruction, whether by asthma patients themselves or by physicians, are incorrect at least 50% of the time.[1,2] As an accurate evaluation of airflow obstruction is essential for the optimal treatment of asthma, the use of home self-monitoring of PEF has been widely recommended.[3-6] Results from one randomized controlled study done with a small group of patients suggest that in comparison with usual care treatment, daily PEF monitoring might be a valuable tool to assess airflow

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obstruction and help detect early acute exacerbations of asthma, especially when it is combined with an educational intervention.[7]

However, the usefulness of long-term home monitoring of PEF remains controversial.[8] Some studies have shown that the outcome in asthmatic subjects measuring PEF regularly was similar to that of those only assessing the severity of asthma symptoms.[9,10] Furthermore, two studies have outlined the facts that the correlation between FEV_1 and PEF is not always good, and that in some patients, PEF values can remain unchanged while FEV_1 decreases by as much as 30%.[11,12] In three studies, asthma symptoms predicted the onset of asthma flare-ups more reliably than PEF monitoring.[13-15]

Although many physicians believe that PEF monitoring can improve the outcome of some subgroups of asthmatics, the long-term compliance of moderate to severe asthmatics with such monitoring has not been studied extensively.

This trial was designed to evaluate the short- and long-term compliance of patients with moderate to severe asthma with daily PEF monitoring after participation in an individualized asthma educational program, and to identify the factors that could predict better compliance with this specific monitoring.

Methods

Twenty-six patients with moderate to severe asthma from three different asthma clinics were enrolled. They were a subgroup of subjects who participated in a randomized, controlled trial of 1 year's duration assessing the value of an educational program based either on PEF or asthma symptom monitoring. Twenty-three subjects had dropped out of the study for various reasons (nonattenders, or group NA). The remaining 26 subjects were randomly assigned to take part in an asthma education program including an action plan based on PEF monitoring and were asked to measure their PEF morning and evening; they were given a peak flowmeter with a 3-month electronic memory (VMX monitor; Clement Clarke; Ohio) and a diary card. Subjects in this study took part in an individualized asthma education program that included at least a 1-hour session; they were asked to adjust asthma treatment according to PEF values and were seen by the educator at least every 3 months. At each follow-up visit, reinforcement regarding the usefulness of PEF monitoring was given. The specialized educator also reviewed the diary card to check whether the patient had increased his asthma medication when PEF dropped. To be included in this study, subjects had to require daily use of inhaled corticosteroids to maintain optimal control of asthma.

During a 1-year randomized prospective study, participants were asked to measure morning and evening PEF throughout the year. The best of the three consecutive measurements of PEF values had to be recorded in their diaries. Throughout the study, patients were unaware that the VMX monitor incorporated a chip that allowed for storage of PEF values with date and time indicated for the best values. They all participated in an individualized asthma education program that covered the following issues: physiopathology of asthma, role of medication and side effects, inhaler technique, allergenic and nonallergenic asthma triggers, criteria of good asthma control, usefulness of PEF monitoring, and management of asthma exacerbations according to PEF values. The action plan consisted of increasing the dose of inhaled corticosteroids for a minimum of 10 days or until asthma symptoms became stable, or even starting to take oral prednisone if PEF dropped by more than 50% of the patient's best value. In such cases, patients were also asked to visit their physician promptly.

Compliance with PEF measurements was assessed over a 1-month period at different time intervals (1, 6, and 12 months). It was calculated by dividing the number of PEF readings recorded by the electronic peak flowmeter over 1 month (minimal value=0, maximal value=60) by 60 (maximal number of readings over 1 month) and multiplying by 100; compliance was expressed in percentage. Subjects were considered to have a good compliance with PEF monitoring if they measured at least 30 readings over 1 month (50%). Those who did not fulfill this criterion were considered to have poor compliance.

Statistical Analysis

Results are expressed as mean±SEM. Means between groups were compared using Student's *t* test (two ways). Linear correlations were assessed using the Pearson correlation coefficient. Statistical significance was established at $p<0.05$.

Results

As Table 1 shows, the 26 subjects who were given the electronic peak flowmeter (educated patients, or group EP) were similar to the control patients who received the usual care treatment (group C) and to those subjects who did not complete the study (group NA) with regard to age, sex, asthma duration, atopy, and the daily dose of inhaled corticosteroids needed to maintain good asthma control.

Throughout the study period, the average compliance decreased from 63% of measurements at 1 month, to 51% at 6 months, and finally to 33% at 12 months. The range of compliance was quite large, varying between 0% and 100%.

As shown in Figure 1, even at 1 month, 30% of the subjects measured PEF <25% of the time, and this

Table 1—*Characteristics of Study Subjects

	Group C (n=54)	Group EP (n=26)	Group NA (n=23)
Age, yr	36±2	38±3	36±3
Male/female	16/38	14/12	9/14
Atopy	78%	76%	†
Duration of asthma, yr	12±2	14±2	17±3
Daily dose of inhaled corticosteroids, μg/day	1370±89	1308±100	1411±167

*C=control.

†Data not available.

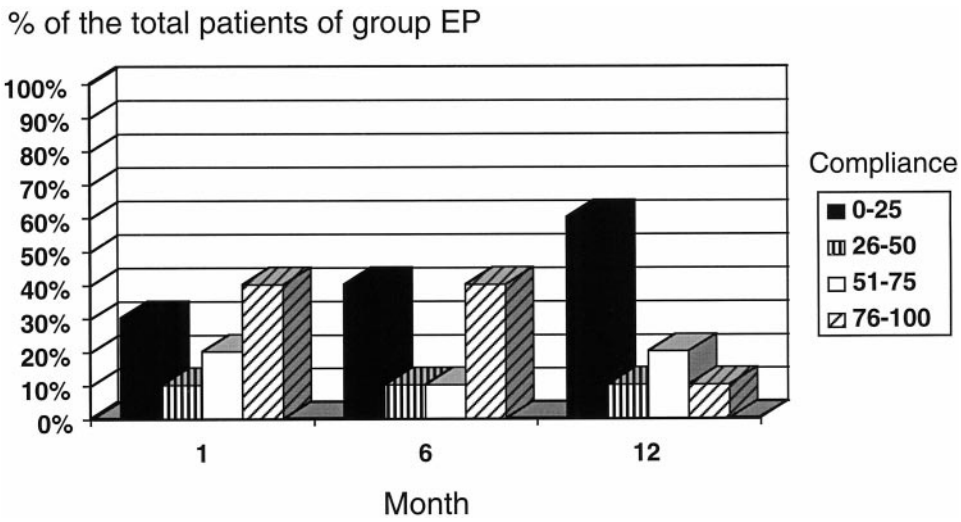

FIGURE 1. This graph shows the compliance with PEF measurement stratified by category (percentage compliance over the 12-month period).

number increased to 60% at 12 months. The number of subjects measuring PEF >50% of the time remained stable around 50% over the first 6-month period but decreased thereafter to reach 30% at 12 months.

The correlation between the number of missing values on the diary card and the number of missing values according to the electronic peak flowmeter was poor at 1 month (Fig 2, *top*) ($r=0.3$, $p<0.13$). Of the eight subjects who rarely measured PEF, seven continued to write fabricated results in their diaries.

At the 12-month follow-up visit (Fig 2, *bottom*), the correlation between the number of missing values on the diary card and those in the electronic memory was even poorer ($r=0.1$, $p>0.60$). Fifteen of 26 subjects (53%) measured PEF <15% of the time (*ie,* >50 missing values during 1 month). Most of these patients continued writing daily PEF values in their diaries although they were not measuring them.

We compared the subgroup of asthmatic subjects who measured PEF very regularly (≥50% of the readings done) with those who were poorly compliant (<50% of the recordings done) with regard to the following parameters: asthma severity, as determined by the degree of airway responsiveness and the dose of inhaled corticosteroids required to obtain good asthma control; morbidity parameters, including the number of emergency room visits with asthma and the number of hospitalizations in the year prior to participation in the asthma education program; social status; level of education; age; sex; and duration of asthma. None of these factors correlated with good or poor compliance with PEF measurements.

DISCUSSION

This study shows that short-term compliance with PEF monitoring is fairly good, although one third of the subjects did not comply right from the start despite having been given specific information on the usefulness of the portable device in the management of their asthma. However, long-term compliance with such monitoring is poor, even among a group of patients who have moderate to severe asthma requiring daily use of inhaled corticosteroids and who are motivated to take part in an asthma education program.

The results of our study should be taken into consideration in regard to asthma education programs, asthma consensus recommendations, and clinical research using PEF as one of the main outcome parameters. Monitoring PEF regularly could help to ensure good asthma control and the earliest possible detection of the onset of an asthma exacerbation. But according to our results, the motivation to assess PEF values regularly is of short duration. Consequently, it does not make sense to focus all educational interventions on asthma monitoring by means of daily PEF measurements alone. Our results suggest that recommendations about PEF monitoring and interpretation should be tailored to individuals' needs and degree of motivation. If an asthmatic patient shows a strong interest in using a peak flowmeter, then the educator should give the specific instructions that will enable the patient to measure PEF accurately and interpret PEF results appropriately. For those involved in asthma care, PEF monitoring seems a most interesting method to monitor asthma, although patients

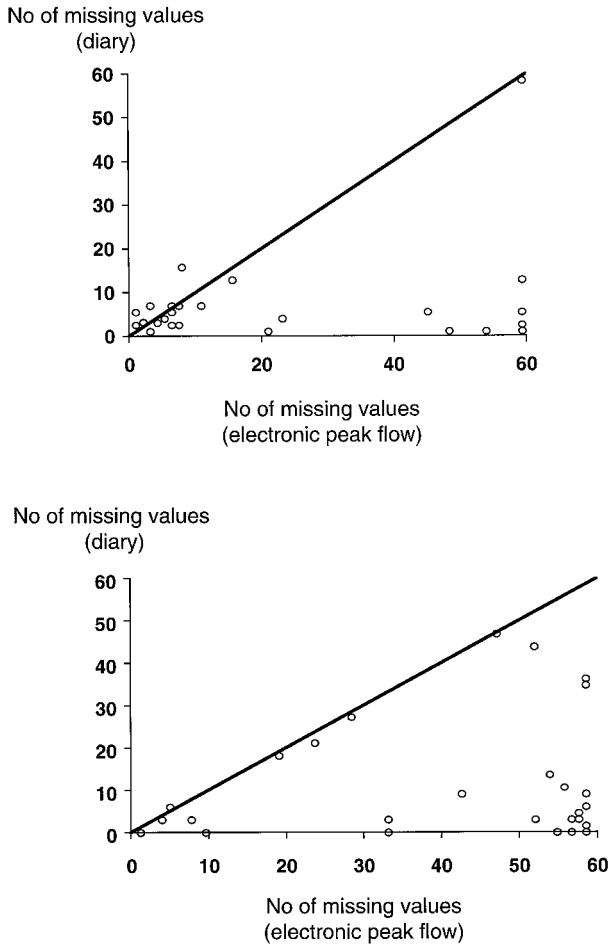

FIGURE 2. Correlation between the number of missing PEF readings (maximum=60, minimum=0) according to the data from the diary card (y axis) and the electronic memory of the peak flowmeter (x axis). The black line is the identity line (number of missing values according to the diary=number of missing values according to the electronic memory of the peak flowmeter). *Top:* at 1 month, one third of the subjects (8 of 26) did not record PEF most of the time (>50 missing values in 1 month). *Bottom:* 1 year after participating in the asthma education program, >50% of the subjects almost never measured PEF (>50 values missing out of 60). Only 10 of 26 subjects remained reliable at reporting nonfabricated results on their diary cards.

may not share this enthusiasm for PEF monitoring. In our study, even though patients were instructed in why to use peak flowmeters and how to use them properly, their compliance with monitoring was not optimal. This suggests that the usefulness of peak flowmeters given without any education would be very limited indeed. This was confirmed in a recent publication showing that short-term compliance in asthmatic subjects who did not take part in an educational program was poor.[16] We expected that an asthma education program would improve adherence to PEF monitoring. However, our results did not support this hypothesis, although the number of subjects who were given the electronic peak flowmeter was small. More studies need to be done with regard to this issue, but it suggests that behaviors such as objectively measuring airflow obstruction by regular PEF monitoring may be difficult to acquire, even with high-quality asthma education.

Having observed such rapid reduction in compliance with PEF measures, when should we use these measures? First, some asthmatic patients perceive the degree of airflow obstruction poorly.[17,18] For this particular subgroup of asthmatic patients, regular PEF monitoring might help them to assess the severity of asthma flare-ups more accurately and to determine whether they should seek medical help or increase their dosage of inhaled corticosteroids to re-establish asthma control. Patients who are poor sensors of airflow obstruction could surely benefit from PEF monitoring, but they need to be well motivated.

PEF measures could also be used to help diagnose asthma, assess the influence of environmental factors on asthma, and document changes in asthma therapy. However, these measures should ideally be done for short periods of time. Our study suggests that asthma education programs should focus not on PEF measures alone, but particularly on respiratory symptoms that indicate the onset of an asthma flare-up, such as increased use of a bronchodilator, worsening shortness of breath, unusual cough, and nocturnal asthma symptoms, because these can be easily assessed in most patients. Peak flowmeters can, however, be used intermittently to confirm the clinical status, although the usefulness of such an approach needs to be ascertained.

Our observations have significant implications for asthma research as well. The rapid fall in compliance with regular PEF measurements should be taken into account, particularly when PEF change is one of the primary measures of efficacy. Electronic peak flowmeters with memory storage can therefore provide useful information when doing clinical studies on the efficacy of new drugs or other specific interventions, helping to ensure the validity of the results.

Our results are in keeping with observations made in other situations. Two recent studies have shown that peak flowmeters are of limited usefulness for the investigation of workers with possible occupational asthma; more than 50% of the reported results were inaccurate with regard to the time of the measurement or the absolute value.[19,20] In these last studies, at least 25% of the reported PEF values were falsified. Our study seems to indicate that because asthma patients want to please their physicians, they continue writing PEF values in their diaries even though they are not really measuring them.

Our data did not allow us to identify patient

characteristics that would predict better adherence to PEF monitoring. Logically, we would presume that patients with moderate to severe asthma are more likely to measure PEF regularly, but our results do not support this hypothesis. Surprisingly, even the level of education was not related to better compliance with PEF home monitoring.

In conclusion, our results demonstrate that short-term compliance with PEF monitoring is fairly good. However, long-term compliance with PEF measurements is poor, and long-term management of asthma should not rely on PEF measures alone, but should include educational intervention, ideally aimed at improving patient recognition of asthma symptoms. Peak flowmeter use should probably be reserved for those patients who show a significant interest in using the device, poor perceivers of airflow obstruction, and severely asthmatic subjects. In clinical trials on asthma that include PEF measurements as an important outcome, the use of electronic peak flowmeters that store recorded data could help ensure the validity of the data.

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