

Improving the quality of peak flow measurements for the diagnosis of occupational asthma

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Introduction Serial measurements of peak expiratory flow (PEF) are recommended in the evidence-based review list as the first stage in objective confirmation of occupational asthma. Different centres have reported widely different success in obtaining records of sufficient data quantity for diagnosis. We investigated different methods of instruction and determined the return rate and quality of the resulting record for the diagnosis of occupational asthma.

Methods Consecutive new referrals were recruited from a specialized occupational lung disease clinic and requested to carry out serial PEFs for the assessment of suspected occupational asthma. Requests to carry out the records were either from written postal instructions or personal instruction from a PEF specialist. Record quality received from other clinicians was also analysed separating those using dedicated occupational forms, and those submitting on graph type forms.

Results The postal return rate was 56% and the personal rate 85%. The number of records fulfilling all the data quality criteria were similar in the postal and personal groups (55 and 59%, respectively). Pre-existing records from other clinics plotted from graph charts (fulfilling all criteria) were only adequate in 23%, compared with 61% adequate for pre-existing records plotted from occupational forms. Failure of the record to contain consecutive work periods of ≥ 3 workdays was the most common failure.

Conclusion The return rate of PEFs for diagnosing occupational asthma is better when patients have been given specific instructions from a PEF specialist and the data quantity better when recorded on a dedicated form.

Key words Diagnosis; occupational asthma; peak expiratory flow measurements.

Introduction

Serial measurements of peak expiratory flow (PEF) are recommended as the first objective confirmatory test in workers with suspected occupational asthma [1]. Previous work has shown computer-assisted analysis of serial PEF records to have a sensitivity of 73–86% and a specificity of 74–100% [2–4]. The ability to obtain records of diagnostic value varies considerably with success rates of 52% in laboratory animal workers, 54% in previously diagnosed workers, 62% in grain workers, 63% in autobody shop workers, 78% of workers given an electronic peak flow meter and 78% of electroplaters [5–10]. Most of these studies achieved these results by visiting workers and/or seeing them in clinic. As records are quite labour intensive, it requires a certain degree of motivation and dedication from the patient, which is why return rates and data quantity can be low. However, there

is also the problem of workers fabricating data and several studies have found that when logging meters are used, only approximately 55% of the data is completely accurate [7,11]. We have also studied this previously and found that workers often regress to the mean peak flow value rather than giving themselves occupational asthma when fabricating records and the meters themselves can sometimes be the cause of inaccuracies [12]. As it is not currently known how many people can return adequate quality records when instructed on paper only, or whether the type of charts given to record the results on affects the quality of the data sent back, we undertook this study comparing three different ways of obtaining PEF records for the assessment of occupational asthma. We evaluated how many records were returned and how many fulfilled all data quality criteria (using pre-defined criteria) for the diagnosis of occupational asthma.

Methods

Three ways of obtaining PEF charts were investigated:

1. Postal. Upon receipt of a referral letter consecutive patients with suspected occupational asthma were sent

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- written instructions from a PEF specialist and specialized forms prior to being seen in clinic.
2. Personal. Patients seen consecutively in the Occupational Lung Disease Clinic where further evidence of suspected occupational asthma was required were given charts and verbal instructions by a PEF specialist at their clinic appointment.
 3. Other records. Consecutive peak flow records forwarded to us from patients seen and instructed in either a primary care or hospital clinic or by their employer's occupational health department were also analysed.

It is not known what instructions were given to this group. Each subject in both the personally instructed and the postal groups was given dedicated occupational record forms (see Figure 1, available as Supplementary data at *Occupational Medicine* Online) and asked to record the best of three readings every 2 h from waking until going to bed, at and away from work for a total of 4 weeks (see Figure 2, available as Supplementary data). The other records group generally used either graph charts such as those enclosed with the mini-Wright peak flow meter or forms that imitated our occupational record forms.

All records were plotted using Oasys-2 (Occupational Asthma System), which is a program specifically designed to analyse serial peak flow measurements using discriminant analysis [13]. The program scores the results from 1 to 4 on the probability of the record showing occupational asthma. To create the scores, Oasys analyses complexes that can be made up of either a rest-work-rest period (1 complex) or a work-rest-work period (1 complex). The records received in this study were assessed for data quantity using pre-defined criteria which gave optimal sensitivity and specificity for Oasys analysis. These have been defined as: (1) ≥ 4 readings per day, (2) ≥ 3 complexes in duration (equivalent to 2.5–3 standard working weeks) and (3) at least 3 consecutive workdays in the majority of work periods in the record [14].

The χ^2 -test was used to compare postal instruction versus personal instruction versus instructed by other (occupational forms) to see whether there was a significant difference in the data quantity received back. It was also used to compare all data received on occupational forms to that received on graph forms. The Yates' continuity correction was used for the latter group.

Results

Results are presented for 158 consecutive workers sent postal instructions and 86 instructed personally. The mean age of the postal group was 46 (22–74) and of the personal group 46 (21–63) and there were 69% males and 31% females in the postal group, 59% males and

41% females in the personal group (the instruction by other group is not known). A range of occupations were included such as foundry workers, welders, health care workers and school teachers. The return rates following postal and personal instruction were 56 and 85%, respectively ($P < 0.001$, χ^2 -test). We were unable to calculate the return rate for the other records group as we had no denominator data for this group. Table 1 shows the quality of returned records for the diagnosis of occupational asthma. Of the records returned, 16 postal records, five personal records and nine instructed by other records had no periods at work. No further data from these are presented. The quality was similar for all using specialized occupational forms ($P > 0.104$ for all criteria tested using the χ^2 -test), and significantly better than those not using them ($P < 0.05$ for all criteria except duration of the record where $P = 0.16$, χ^2 -test). Completing at least four readings per day was the most easily achieved element. Working for at least 3 consecutive days was the factor most likely to lead to an inadequate record quality.

Table 2 shows the inclusion of other information required to analyse the record for work effect, such as times at work and treatment changes, which is important for analysis with Oasys-2. Details of times of waking and work exposure and changes in treatment were recorded significantly more often when specialized occupational forms were used ($P < 0.001$), but were not different between those instructed personally, by post or by others ($P > 0.14$).

Discussion

Our study found that personal instruction in completing serial PEF measurements increased the proportion of patients returning records to 85% compared with 56% for those receiving written instructions. Fifty-nine per cent of those personally instructed were able to return a record fulfilling all data quality criteria. The commonest reason for poor quality records from the point of view of the diagnosis of occupational asthma was the requirement for at least 3 consecutive days at work for $>75\%$ of work weeks, which reduces record sensitivity but does not affect specificity [13]. This limitation was due to most workers having little say in their work pattern and this factor was beyond their control. Records with less than 3 complexes (approximately 3 work weeks) compromise specificity, but short duration of recording was an infrequent problem when specifically instructed to keep a 4-week record. The number of readings a day influences the assessment of diurnal variation, and particularly helps in records with different shifts, but, in this study at least, four readings/day was the most easily achieved factor. Overall, the amount of data quantity depended mainly on

Table 1. Summary of results of number of patients who returned adequate quality PEFs for each group

	Postal (<i>n</i> = 158)	Personal (<i>n</i> = 86)	Other (occupational forms)	Other (graph forms)	χ^2 (method of instruction)	<i>P</i>	χ^2 (occupational versus graph forms)	<i>P</i>
No. of PEFs analysed (those not at work not included) (no.)	72 (16)	68 (5)	18 (2)	13 (7)	N/A	N/A	N/A	N/A
Adequate duration (≥ 3 complexes) (%)	80	79	100	62	4.54	0.10	1.96	0.16
≥ 3 consecutive workdays in most work periods (%)	73	72	66	31	0.26	0.88	7.54	<0.01
≥ 4 readings per day (%)	93	91	94	39	0.31	0.86	29.04	<0.0001
Adequate for all criteria (%)	55	59	61	23	0.36	0.84	4.36	<0.05
Factors within workers control: ≥ 3 complexes and ≥ 4 readings per day only (%)	75	77	94	39	3.18	0.20	8.02	<0.01
% of PEFs adequate for all quality criteria and work/rest times	51	54	56	8	0.26	0.88	8.07	<0.01
% of PEFs adequate for factors within workers control: ≥ 3 complexes, ≥ 4 readings per day and work/rest times	71	72	83	15	1.12	0.57	15.92	<0.0001

Table 2. Percentage of PEFs containing additional information

% recorded	Postal	Personal	Other (occupational forms)	Other (graph forms)	χ^2 (method of instruction)	<i>P</i>	χ^2 (occupational versus graph forms)	<i>P</i>
No. of PEFs analysed for non-work related criteria	89	73	20	20	N/A	N/A	N/A	N/A
Work/rest times	88	92	89	15	0.74	0.69	63.40	<0.0001
Wake/sleep times	91	95	94	5	0.90	0.64	97.84	<0.0001
Jobs done	75	78	67	10	1.44	0.49	32.80	<0.0001
Treatment	72	63	50	25	3.95	0.14	11.12	<0.001
All additional information	57	51	44	5	1.33	0.52	14.95	<0.0001

the record form used, rather than the method of instruction. The main reason for not returning the personally instructed records was failing to keep the next clinic appointment because postal records were being lost in the post and a small number of workers were found to be illiterate.

Our written instructions ask for 2-hourly readings from waking to going to bed. We have previously shown that satisfactory sensitivity and specificity can be obtained with at least four daily readings, which were the quality standard used in this study [13]. These criteria were more stringent than many other studies that have requested peak expiratory flows to aid diagnosis of occupational asthma. For example, Henneberger *et al.* [9] managed to obtain 54% of records when requesting 15 days of readings. However, it was commented that if readings had been obtained when conditions were first diagnosed, they may have been more successful.

This may also be true for our study as some had already changed exposure when peak flows were requested. A similar scenario was found in a group of laboratory animal workers by Hollander *et al.* [5], where 208 out of 398 (52%) managed to supply at least 9 days of readings containing information at and away from work. Others who have achieved better return rates and data quality in defined populations include Gannon *et al.* [10], who attempted to obtain records in an entire cohort of electroplaters and received satisfactory records from 78% of workers after two visits. Blainey *et al.* [6] studied 133 grain dockers and farmers by seeing them in clinic and giving them a mini-Wright peak flow meter with a set of written instructions and obtained recordings from 62% of this epidemiologically defined cohort. Cullen *et al.* [8] found that, out of 38 autobody shop workers given full training on how to take peak flow readings, only 24 (63%) provided adequate data.

Although fabrication of readings could be a factor in this study, previous studies have found that 71–79% of recorded values were stored on the meter even though the time and reading may have differed slightly [7,11] and, as we are examining across groups, one group is no more likely to fabricate than another, so this is unlikely to be an important factor in this study.

We have shown that return rates can be significantly increased by personally instructing patients in clinic. Being adaptable with timing may also have improved this. For example, those unable to leave their workplace or those wearing respiratory protective equipment make readings on waking, arriving at work, at each break, on leaving work, mid-evening and bedtime, overcoming rigid timing problems. We have also shown the importance of using a dedicated form when completing serial peak flows by comparing those plotted on a graph chart to those on an occupational form (instructions on peak flow completion and record forms can be downloaded from www.occupationalasthma.com). Further research regarding the reproducibility of peak flow charts could be undertaken to see whether adequate quality and return rates can be maintained.

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