

Audit of quality of diagnostic procedures for occupational asthma

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Background	Previous studies have reported deficiencies in the quality of the diagnosis of occupational asthma. A low quality of diagnostic procedures means that the occupational cause of asthma is less likely to be revealed.
Aims	To assess the current quality of the diagnosis of occupational asthma before referral to a specialist occupational medicine centre.
Methods	The quality of diagnostic procedures was assessed by reviewing the files of 150 patients who were referred to the Finnish Institute of Occupational Health in 2003 with a suspicion of an occupational cause of their asthma. The quality indicators used were assessment of workplace exposures, spirometric studies, bronchodilator response, serial workplace measurements of peak expiratory flow (PEF) and the time since first symptoms to the final diagnosis. For each indicator, criteria to differentiate between sufficient and insufficient care were developed.
Results	Exposure assessments, spirometric studies and bronchodilator responses were performed in 92, 87 and 79% of cases in the total study group, respectively. Workplace measurements of PEF had been performed in 51% of the cases, and the quality of measurements was sufficient in 52%. Workplace exposures had been assessed significantly more often in occupational health care than in other health care units. The median time from the beginning of symptoms to the final diagnosis was 3.2 years.
Conclusions	Although the diagnostic procedures were mostly of sufficient quality, the performance of serial measurements of PEF at the workplace and the time to diagnosis should be substantially improved.
Key words	Occupational asthma; occupational health services; peak expiratory flow measurements; quality of diagnosis.

Introduction

Evidence-based guidelines for the prevention, identification and management of occupational asthma in Great Britain were published in 2005 [1]. The main statements of the guidelines have been adopted and amended to form the evidence-based guidelines for occupational asthma care in Finland [2]. The recommendations emphasize the importance of early measurements of peak expiratory flow (PEF) in the workplace. If PEF is measured reliably, repeatedly and under correct workplace circumstances, and there is neither significant variation nor typical symp-

toms for occupational asthma, the possibility of occupational asthma is sufficiently ruled out [3,4]. The sensitivity of serial PEF measurements at the workplace has been shown to be as high as 81.8%, and their specificity in the diagnosis of occupational asthma has been reported to be 93.8% [5].

In general, initial examinations for occupational asthma are carried out in basic health services. In Finland, such examinations are carried out either in occupational health care, in general primary care or in respiratory clinics of general hospitals. Subsequently, patients are usually referred for specialized examinations, e.g. specific inhalation provocation tests, to the Finnish Institute of Occupational Health (FIOH), where a definite diagnosis is made. Insurance companies only accept a diagnosis made in such a tertiary referral centre for compensation purposes.

The quality of these basic examinations is of utmost importance for the diagnosis of the work relatedness of asthma. If workplace exposure is not explored, the work relatedness of asthma will not be revealed. Workplace PEF measurements performed at an early stage will

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provide objective information that may be impossible to obtain later if the patient cannot go back to work or if the workplace no longer exists.

It is also important to detect the work relatedness of asthma symptoms at an early stage. Early diagnosis makes the early avoidance of further exposure possible, either through relocation of the worker or substitution of the hazard, and offers the best chance for complete recovery [1]. Workers who remain in the same job and continue to be exposed to the same causative agent after diagnosis are unlikely to improve, and symptoms may worsen.

In a Canadian study, the mean time to diagnosis of occupational asthma was 4.9 years [6]. The primary self-reported reasons for delay were lack of enquiry about work relatedness by the primary care physician and fear of lost work time. In previous studies, the delay has been shown to be related to exposure to a specific agent. The lapse was 2 years for diisocyanates and 3 years for other causes [7]. Other studies have reported 4.5 years [8] and 3.8 years [9] delays for occupational asthma diagnosis.

The aim of our present study was to evaluate the quality of the diagnostic process of occupational asthma before the patients were referred to FIOH, a specialist occupational medicine referral centre. Additional aims included ascertaining whether there were differences in quality of the diagnostics in patient referrals from occupational health services, respiratory clinics or from other health care units.

Methods

The records of 150 patients referred to the occupational medicine clinic in FIOH Helsinki for a suspected occupational cause of asthma in 2003 were retrospectively reviewed. A random sample of 97 cases of suspected occupational asthma without a diagnosis of occupational asthma, as well as a group of 53 cases with confirmed occupational asthma, were selected to determine whether there was a difference in the basic examinations of patients where occupational asthma was diagnosed and of those where occupational asthma was suspected but not confirmed. Only information from patients examined in 2003 was used, ensuring that there had been sufficient time for the examinations to be completed and for a final diagnosis to be made. All these patients had been diagnosed as having asthma either in primary health care, in occupational health care, in a respiratory clinic or on the basis of examinations in FIOH. Patients throughout Finland are referred to FIOH in Helsinki for the specialized examinations (e.g. specific inhalation challenge tests) needed for an official diagnosis of occupational asthma.

Finnish clinical practice guidelines on asthma recommend that, when occupational asthma is suspected, basic examinations for the diagnosis of asthma should be performed before the patient is referred to FIOH. In ad-

dition, the physician should explore the possible causative agents at the workplace and perform all the following lung function tests: spirometry, bronchodilation and serial PEF measurements at the workplace. The guidelines also underline the importance of avoiding delays in the diagnostic process.

Quality indicators were derived from the essential elements of the clinical guidelines for the diagnosis of occupational asthma [1–3]. For each indicator, we also determined criteria to differentiate between sufficient and insufficient care. The indicators were evaluated according to the data in referrals and their attachments found in the patient files of FIOH.

The first quality indicator related to information on workplace exposures for which the criterion to be met was whether the referral contained information on possible workplace exposures. If information on workplace exposures was available in the patient files, it was assessed as a diagnostic procedure of sufficient quality in accordance with the guidelines. The second indicator was spirometry, for which the criterion was whether numerical results of spirometric measurements could be found in the referral or its attachments. For bronchodilation tests of sufficient quality, the following two criteria had to be made to be met: the performance of the test was noted in the files and the percentage of improvement in the lung function tests had to be documented. For the serial workplace PEF measurements, the criterion was whether the numerical results were found in the files. If so, all the following additional criteria had to be met if a high-quality rating was to be given: to get the qualification high quality, the duration of the follow-up had to be ≥ 14 days, there had been at least two periods away from work and at least eight work days during the follow-up, there had to be at least four measurements documented each day and the parallel flow values had to be acceptable (no more than a variation of 20 l/min between the best two of three measurements). If fewer than all these criteria were met, the PEF measurements were qualified as being inadequate. The criteria reflect the generally accepted good practices in Finland and they are close to the criteria which gave optimal sensitivity and specificity for the British Oasys (Occupational Asthma System) analysis [10].

In addition, the time used in the diagnostic process was measured in the following three different ways: from the onset of asthmatic symptoms to the diagnosis of asthma, to the beginning of the examinations at FIOH in Helsinki and to the final diagnosis made at FIOH in Helsinki. An optimal time from the onset of symptoms to the occupational asthma diagnosis was estimated to be no more than 1 year. For a more realistic estimation, the time was doubled to a 2-year lag from the onset of occupational asthma symptoms to the final diagnosis.

Chi-square test and one-way analysis of variance (ANOVA) were used to compare the characteristics of the patient groups referred from occupational health care,

respiratory clinics or elsewhere. The percentage of cases that met the criteria for sufficient care was calculated. Cross tabulation and chi-square tests were used to examine the differences in the proportions between the groups. The differences in the continuous variables between the groups with different diagnostic pathways were analysed with ANOVA. The Mann–Whitney test was used to analyse the differences in the median time delay of occupational asthma diagnosis. Cox's proportional hazards analysis was used to examine factors affecting the time delay of diagnosis. In order to adjust the results, we entered the variables into the model using a single-step method. The analyses were performed using the SPSS 14.0 software package (SPSS Inc., Chicago, IL, USA). A *P*-value of <0.05 was considered significant.

Results

The patient characteristics are given in Table 1. The patients formed a representative sample of those who had attended the FIOH occupational medicine clinic because of suspected occupational asthma in 2003. The various groups did not differ with respect to age or sex. The proportion of blue- and white-collar workers did not differ between the study groups either. The most common occupations among blue-collar workers were welders, painters, cleaners, farmers, hairdressers and food processing workers. White-collar workers were teachers, medical workers, nurses, dental workers and office workers.

The commonest workplace exposure was an agent with a low molecular weight or an irritating agent in the groups referred from respiratory clinics or elsewhere and moulds in the group referred from occupational health care.

Low-molecular weight agents included substances like acrylates, aldehydes, isocyanates, colophony and formaldehyde. Flour and grain dust, wood dust, mites and dust of animal epithelium were classified as high-molecular weight substances. Irritant agents were mostly welding fumes. Indoor moulds from water-damaged buildings have caused an increasing number of cases and have become the most important causative agents of occupational asthma in Finland [11].

The quality indicators and criteria for diagnostic procedures for occupational asthma and the percentages of the performance indicators with sufficient quality are given in Table 2. The percentage of the patients with serial workplace PEF measurements was 51% for the total study group. Of these, 52% met all criteria for a well-performed workplace PEF measurement (Table 3).

The final diagnosis, occupational asthma or other asthma, was made within 2 years for 27% of the total study group. The median delays in the occupational asthma diagnostic process are shown in Table 4. There were no significant differences in the median of delay from the beginning of the symptoms to the final diagnosis between patients with confirmed occupational asthma and patients with suspected occupational asthma. The median time to the final diagnosis was 3.0–3.2 years, although asthma was diagnosed within 1.2–1.3 years from the beginning of symptoms.

Workplace exposures had been assessed significantly more often in cases referred by occupational health physicians than in those referred by others (*P* < 0.05) (Table 2). Serial workplace PEF measurements had been performed significantly less often outside occupational health services or respiratory clinics (*P* < 0.01). There were no significant differences in the quality of workplace

Table 1. Characteristics of patients with suspicion of occupational asthma in the study (*n* = 150)

	Referred from OHS (<i>n</i> = 83) <i>n</i> (%)	Referred from respiratory clinic (<i>n</i> = 41) <i>n</i> (%)	Referred from elsewhere ^a (<i>n</i> = 26) <i>n</i> (%)	Total group (<i>n</i> = 150) <i>n</i> (%)	<i>P</i> -value
Mean age at diagnosis (years)	45.2 ± 9.3	46.3 ± 9.4	47.6 ± 11.5	45.9 ± 9.7	NS ^b
Sex					
Male	31 (37)	22 (54)	8 (31)	61 (41)	NS ^c
Female	52 (63)	19 (46)	18 (69)	89 (59)	
Occupation					
White-collar worker	35 (42)	11 (27)	7 (27)	53 (35)	NS ^c
Blue-collar worker	48 (58)	30 (73)	19 (73)	97 (65)	
Exposure substance					
High-molecular weight agent	20 (24)	7 (17)	5 (19)	32 (21)	<0.001 ^b
Low-molecular weight or irritating agent	23 (28)	28 (68)	11 (42)	62 (41)	
Mould	40 (48)	6 (15)	10 (39)	56 (37)	

OHS, occupational services; NS, not significant.

^aReferred by physicians in primary health care or those in regional occupational medicine clinics or private practitioners.

^bOne-way ANOVA test.

^cChi-square test.

Table 2. Quality indicators, criteria for good diagnostic management and the percentages of the quality indicators of sufficient quality ($n = 150$)

Performance indicator	Criterion	Number of cases in which criteria were met, n (%)				P -value
		Referred from OHS ($n = 83$) n (%)	Referred from respiratory clinic ($n = 41$) n (%)	Referred from elsewhere ^a ($n = 26$) n (%)	Total group ($n = 150$) n (%)	
Assessment of a possible causative agent of OA in the workplace	Workplace exposures noted in the patient files	81 (98)	35 (85)	22 (85)	138 (92)	<0.05
Spirometry	Results of spirometry found in the files	71 (86)	39 (95)	20 (77)	130 (87)	NS
Bronchodilation	The performance of the test noted in the files and the percentage of improvement in lung function tests documented	64 (79)	33 (85)	18 (69)	115 (79)	NS
Serial workplace PEF measurements performed	The numerical results found in the files	46 (56)	24 (59)	6 (23)	76 (51)	<0.01
Time to final diagnosis	<2 years from onset of symptoms	22 (27)	11 (27)	8 (32)	41 (28)	NS

OA, occupational asthma; OHS, occupational health services; NS, not significant.

^aReferred by physicians in primary health care or those in regional occupational medicine clinics or private practitioners.

Table 3. Quality of the serial workplace PEF measurements ($n = 76$)

Criteria for serial workplace PEF measurements with high quality	Percentage of criteria met n (%) in cases with serial workplace PEF measurements that could be evaluated for quality				
	Referred from OHS ($n = 46$) n (%)	Referred from respiratory clinic ($n = 24$) n (%)	Referred elsewhere ^a ($n = 6$) n (%)	Total group ($n = 76$) n (%)	P -value ^b
Duration at minimum of 14 days	34 (83)	15 (88)	3 (60)	52 (83)	NS
At least two time periods away from work	35 (85)	12 (71)	4 (80)	51 (81)	NS
At least eight work days	31 (76)	15 (88)	4 (80)	50 (79)	NS
Measurements: minimum four per day	30 (73)	12 (71)	4 (80)	46 (73)	NS
Parallel flow values acceptable ^c	38 (93)	14 (82)	3 (60)	55 (87)	NS
Total score of serial workplace PEF measurements (all five above-mentioned criteria met)	21 (53)	8 (53)	2 (40)	31 (52)	NS

OHS, occupational health services; NS, not significant.

^aReferred by physicians in primary health care or those in regional occupational medicine clinics or private practitioners.

^bChi-square test was performed only between the groups referred from OHS and referred from respiratory clinic because there were only six patients in the third group.

^cA variation of no more than 20 l/min between the best two of three measurements.

PEF measurements between patients referred from occupational health care, respiratory clinics or elsewhere (Table 3).

Age had a significant effect on length of delay in the diagnostic process [hazard ratio (HR) 0.98, 95% confidence interval (CI) 0.96–1.0], the delay being shorter for the

younger patients (Table 5). The diagnostic delay was significantly shorter for the group in which the occupational exposure had been either an irritating agent or a low-molecular weight compound than in the group exposed to a high-molecular weight compound [HR 1.60, 95% CI 1.01–2.54]. Sex, occupation or diagnostic pathway did

Table 4. Median time delays (years) in the diagnostic process for 150 patients suspected of occupational asthma

	Occupational asthma diagnosed (<i>n</i> = 53) Md (IQR), years	Suspected occupational asthma (<i>n</i> = 97) Md (IQR), years	Total group (<i>n</i> = 150) Md (IQR), years	<i>P</i> -value
How long did the patient have symptoms before asthma was diagnosed?	1.3 (0.5–2.7)	1.2 (0.6–2.6)	1.2 (0.5–2.7)	NS
How long did the patient have occupational asthma symptoms before examinations in FIOH?	2.8 (1.5–6.6)	2.6 (1.7–4.9)	2.7 (1.6–5.3)	NS
How long did the patient have occupational asthma symptoms before the final diagnosis?	3.3 (2.0–7.2)	3.0 (1.9–5.5)	3.2 (1.9–5.8)	NS

Md, median; IQR, interquartile ranges Q_{25} and Q_{75} ; NS, not significant.

Table 5. Cox proportional hazards analysis of factors affecting the length of delay from the beginning of symptoms to the final diagnosis for 150 patients suspected of occupational asthma

Variable	Reference	HR (95% CI)
Age		
Continuous variable		0.98 (0.96–1.0)
Gender		
Female	Male	1.12 (0.76–1.63)
Occupation		
White-collar worker	Blue-collar worker	0.87 (0.57–1.34)
Workplace exposure		
Low-molecular weight agent or irritating agent	High-molecular weight agent	1.60 (1.01–2.54)
Mould	High-molecular weight agent	1.14 (0.67–1.95)
Diagnostic pathway		
Examinations in primary health care and a respiratory clinic	Examinations only in primary health care	0.76 (0.50–1.15)
Examinations in primary health care and a respiratory clinic and a regional clinic of occupational medicine	Examinations only in primary health care	1.1 (0.63–1.89)

not have an effect on the time to diagnosis. There were no statistically significant differences in the diagnostic delay according to whether the patient was referred from primary health care, occupational health care, a respiratory clinic or a regional occupational medicine clinic.

Discussion

The quality criteria for occupational asthma diagnosis had been met in 79–98% of the total study group for exposure assessment, spirometry and bronchodilation, but only in half of the cases with respect to workplace PEF measurements, and in 28% of the cases as regards time to diagnosis.

The strength of our study was our use of the evidence-based Finnish guidelines for diagnosing occupational asthma to derive quality indicators and criteria. Our quality criteria for workplace PEF measurements were partly the same as in Oasys [10]. Also other criteria have been published previously [12,13]. Serial PEF measurements performed in the workplace can be consid-

ered a good quality indicator for occupational asthma diagnostics, because the procedure is an essential element of the diagnosis, it can easily be evaluated since it is expressed in numerals and it should be obtainable in the patient files.

All the patients that we included in our study were extensively examined after referral, and therefore, we are sure that the final diagnosis is valid. We were able to extract details about the examinations and information in the referrals to FIOH from the files. Furthermore, we extracted the data in a systematic and reliable way by using uniform criteria for assessing the quality of care.

The limitations of our study lie in its retrospective nature. Other studies concerning the quality of diagnosis and the management of asthma or occupational asthma have been performed prospectively [14,15]. However, questionnaires and information data sheets are implementation interventions in themselves and may have an effect on the results. Our information could be biased, if all available data were not recorded in the patient files.

It is known that physicians tend not to document all information obtained from their patients. Negative findings are more seldom reported than positive findings (e.g. absence of sensitizing agents in the workplace), and this difference may explain some of the missing data.

No significant differences were found for the quality of occupational asthma diagnostics between the patients referred from occupational health care or respiratory clinics, except in the assessment of workplace exposures. The finding that occupational physicians reported possible causative agents significantly more often could be expected because occupational physicians have a key role in recognizing association of symptoms with workplace exposures. Serial workplace PEF measurements were performed significantly less by other physicians than occupational physicians or respiratory specialists. More information should be given to physicians in primary health care about the importance of PEF measurements at workplace and enhance the opportunities to consult a specialist in occupational medicine when needed.

Our results indicate that there is still room for improvement and that interventions to increase compliance with the guidelines are needed, especially concerning workplace PEF measurements. It has been shown that physicians are not commonly performing objective physiological tests to substantiate a diagnosis of occupational asthma [16]. This was also the case in our study, in which occupational physicians performed workplace PEF measurements in 56% of the cases and respiratory specialists did so in 59% of the cases. The number of serial workplace PEF measurements was very low (23%) for other health care units. It has been suggested that acceptable peak flow series can be obtained in around two-thirds of those in whom a diagnosis of occupational asthma is being considered [1].

The quality of serial PEF measurements was not high since all five quality indicators were met in only about half of the cases. It can be argued that our criteria were too stringent, but similar numbers of workplace PEF measurements with adequate quality have also been reported in other studies, although the criteria have varied [12,13,17]. It has been proposed that specific instructions from a PEF specialist and a special form on which to record the data would improve the quality of PEF measurements [17].

The median time from the onset of symptoms to the final diagnosis was 3.2 years, and only 27% met our criterion of 2 years. In Toronto, the mean time to occupational asthma diagnosis was 4.9 years, and once four outliers had been excluded, it was 3.4 years [6]. The main reasons for the delay were the lack of enquiry about work relatedness and a fear of lost work time. In addition, difficulties in completing the investigations, a lower level of education and a lower household income were reported to be associated with increased time to diagnosis. In a study by Santos *et al.* [18], the risk factors for a delay in the di-

agnosis of occupational asthma included male sex, single marital status, low education and a lack of awareness of associations between symptoms and work. In our study, the long delay was related to age and exposure to low-molecular weight compounds in the workplace. It remains a challenge to decrease the time to occupational asthma diagnosis.

Time from the diagnosis of asthma to the diagnosis of occupational asthma accounted for about half of the total delay in all three of the studied patient groups. This finding suggests that the possibility of occupational asthma should be taken into account more often when examinations for asthma are carried out. It has been proposed that every adult asthmatic should be investigated for possible occupational asthma if they are exposed at work to an agent known to cause occupational asthma [19]. A recent study revealed that clinicians who manage adults with newly diagnosed asthma take incomplete occupational histories [20]. Thus, it is not surprising that many cases of occupational asthma may remain unrecognized [16,21] and are therefore improperly treated.

This study shows that occupational asthma guidelines need to be more accurately implemented. More timely serial workplace PEF measurements with good quality should be encouraged in all health care units. It is also advisable to shorten time to diagnosis which would result in a better prognostic outcome for cases of occupational asthma.

Key points

- For the diagnosis of occupational asthma in basic health services, serial workplace peak expiratory flow measurements should be performed more often and their quality should be improved.
- Every adult asthmatic should be investigated for possible occupational asthma if they are exposed at work to an agent known to cause occupational asthma and the symptoms are related to work.
- Time to the diagnosis of occupational asthma should be shortened.

Conflicts of interest

None declared.

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