Evaluation of a Proposed NIOSH Surveillance*
Case Definition for Occupational Asthma

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FEV_1 = forced expiratory volume in 1 s; NIOSH = National Institute for Occupational Safety and Health; PEFR = peak expiratory flow rate

Occupational asthma has been defined as variable air flow obstruction caused or aggravated by workplace exposure to airborne dusts, gases, vapors, or fumes.[1-3] Asthma attributed to occupational causes has been estimated to account for 2% to 15% of all newly diagnosed cases in the United States.[3-5] However, the frequent insidious onset and worker underreporting of symptoms probably have contributed to underdiagnosis of occupational asthma.[4]

The Sentinel Health Notification System for Occupational Risks (SENSOR) is a program currently under development by NIOSH and is intended to be a comprehensive system that identifies and responds to case reports of potential occupational illness and injury.[6] Health care providers designated as "sentinel providers" will be used to report selected occupational disorders that are amenable to provider reporting; occupational asthma has been included on this list.[7] The purpose of this investigation was to validate the proposed NIOSH definition for occupational asthma as useful for the identification of cases to be reported under the SENSOR program. The specific objectives were (1) to assess the availability of information required for use of the case definition in occupational health clinic charts, and (2) to assess the frequencies with which the clinic primary physicians, an independent occupational medicine physician reviewer, and the surveillance case definition agreed with each other on the diagnosis of occupational asthma.

Materials and Methods

The proposed NIOSH surveillance case definition for occupational asthma that was evaluated in this study is presented in Table 1. This case definition was intended to be used by state health departments to consistently classify and count case reports in order to target workplace investigations. One hundred one medical records were selected from four occupational health clinics. Each clinic was asked to select charts for review that covered a range of diagnostic certainty, from those with an assessment of "rule out" occupational asthma to those with a final diagnosis of definite occupational asthma, but no uniform sampling strategy was employed. Information from the reviewed charts was recorded on an abstract form designed to collect the data required for use of the proposed NIOSH surveillance case definition. The primary clinician diagnosis at each of the clinics was categorized as possible, probable, or definite occupational asthma. The abstracts were reviewed independently by one of the authors (D.R.), an occupational medicine physician who was not cognizant of the NIOSH case definition. The reviewer recorded his opinion of the probability that occupational asthma was present (possible, probable, definite).

Frequencies of the presence in the clinic charts of various types of case definition-required data were calculated. A computer algorithm was devised to replicate the NIOSH case definition. Agreement with regard to the diagnosis of occupational asthma between the primary occupational health clinic physician and the

Table 1—*Proposed NIOSH Surveillance Case Definition for Occupational Asthma*

A. Symptoms suggestive of asthma, such as wheezing, dyspnea, cough, or chest tightness, which are variable or intermittent.
B. Documentation of significant reversible or variable airways obstruction.[a]
C. Evidence of an association between the pattern of airways obstruction and some workplace exposure. Any one of the following types of evidence are sufficient:
   1. Documented workplace exposure to an agent known to cause occupational asthma and an association between symptom patterns and work.[b]
   2. Significant work-related changes in spirogram or peak flow.[c]
   3. Positive response to bronchial provocation testing with agent to which patient is exposed at work.[d]

[a]The following are recommended criteria for evidence of "significant" variability in airways obstruction (only 1 of the criteria need be met): (1) improvement of 10% in FEV_1 with bronchodilator; (2) decrease of FEV_1 by more than 10% from baseline either spontaneously or in response to workplace exposure; (3) at least 20% variability in serial peak expiratory flow rate (PEFR) measurements in a 24-h period.

[b]Any of the following patterns should suggest an occupational etiology: (1) symptoms occur at work only; (2) worsening of symptoms Monday mornings; (3) improvement of symptoms on weekends or vacations; (4) symptoms occur in evening of workdays only; (5) symptoms worsen during the course of each work week; (6) symptoms resolve after change in work environment.

[c]The following are recommended criteria for significant work-related changes in airways obstruction: (1) greater than 10% decrease in FEV_1 across a work shift; (2) greater than 10% improvement in FEV_1 after removal from exposure (over weekend, during vacation, or after removal of suspect agent from workplace); (3) greater than 20% variation of PEFR in relation to work (either decreasing across work shift or each evening of workdays or improvement during days away from work).

[d]A decline of greater than 15% in FEV_1 after inhalation challenge with substance present in workplace at same or lower concentration than encountered at work is considered a positive response.

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Table 2—*Frequency of Information on Workplace Exposure and Work-Related Symptom Patterns in 101 Patients*

Parameter Evaluated	Information in Chart (%)	Positive Response (%)
1. Exposure to known asthma-inducing agent	84	40
2. Symptoms at work only	88	14
3. Symptoms worse Monday AM	37	9
4. Symptoms improve on weekends and vacations	69	49
5. Symptoms increase during work week	71	49
6. Symptoms improve with job change	70	52
7. Positive association between symptoms and work*	97	76

*Defined as a positive response to at least one of questions 2 to 6 above.

NIOSH case definition, and agreement between the independent reviewer and the case definition were assessed by use of the kappa statistic. For purposes of this analysis, only patients with adequate information in their charts to permit application of the proposed NIOSH surveillance case definition were considered. Also, the probable and definite occupational asthma categories for both the clinic physician and the independent reviewer diagnoses were combined into one category (probable/definite).

Results

Of the 101 patients whose charts were reviewed, 39 were diagnosed as having probable or definite occupational asthma by the independent reviewer. Of the 63 patients with adequate information recorded in their charts to apply the proposed NIOSH surveillance case definition, 21 met the requirements of the case definition.

In the 101 occupational health clinic charts reviewed, documentation that the presence or absence of specific symptoms had been assessed was frequently lacking. However, at least 1 of 4 respiratory symptoms (cough, dyspnea, wheezing, chest tightness) and a variable pattern of this symptom or symptoms were recorded in 86% of the charts reviewed. The presence or absence of chest tightness was recorded least often (52% of the charts), and dyspnea was the symptom most frequently recorded (94% of charts).

The frequency of information available on workplace exposure and work-related symptom patterns is summarized in Table 2. In 84% of the 101 charts, the presence or absence of workplace exposure to an agent known to cause occupational asthma was documented; in 40%, such exposure was present. Of charts recording work-related complaints, the presence or absence of symptoms only at work was the most commonly recorded information (88% of charts). Whether symptoms worsened on Monday mornings was the information recorded least often (37% of charts). Information about an association between symptom patterns and work was recorded in 97% of all charts reviewed; in 76% a work-related pattern was present. Information about symptoms that occurred only in the evenings of workdays was unavailable, due to chart abstract form deficiency.

Table 4—*Documentation of Work-Relatedness of Asthma Symptoms in 101 Patients*

Parameter Evaluated	Test Performed (%)	Positive Result When Test Performed (%)
Measurement of FEV_1 across a work shift	3	33
Measurement of FEV_1 after job change	11	73
Measurement of PEFR in relation to work	12	50
Any of above	17	65
Specific challenge	4	75

The possibility of significant reversible or variable airways obstruction was investigated in 75 of the 101 patients evaluated for occupational asthma at the clinics (Table 3). Measurement of a change in FEV_1 after administration of inhaled bronchodilator and measurement of a change in FEV_1 from baseline on repeat testing were performed more frequently (in 54% and 36% of the patients, respectively) than measurement of serial PEFR (in 13% of the patients) and testing for nonspecific airway hyperresponsiveness (22% of the patients). Of the 39 patients with a probable or definite diagnosis of occupational asthma as determined by the independent reviewer, 92% had reversible or variable airways obstruction documented by at least one objective test (Table 4).

Evidence that work-relatedness of changes in FEV_1 or PEFR had been evaluated was present in 17 of the 101 charts reviewed, and significant work-related changes were documented in 11 (65%) of the 17. Four of the 101 patients

Table 3—*Documentation of Variable Airways Obstruction*

	All Patients ($n = 101$)		Probable/Definite Cases of Occupational Asthma ($n = 39$)	
Parameter Evaluated	Test Performed (%)	Positive Result (%)	Test Performed (%)	Positive Result (%)
>10% increase in FEV_1 post bronchodilator	54	23	67	44
>10% decrease in serial FEV_1	36	13	49	23
≥20% variability in PEFR over 24 h	13	6	18	13
≥20% decrease in FEV_1 or 100% increase in SRaw after methacholine	22	12	31	26
Any of above	75	54	92	92

Table 5—*Agreement Between NIOSH Case Definition and Occupational Health Clinic and Reviewer Diagnosis of Occupational Asthma*

Charts with adequate information to apply NIOSH case definition, $n = 63$

A. OHC vs NIOSH case definition*

		NIOSH	
		met	not met
OHC	OA	21	18
	no OA	0	24/63

B. Reviewer vs NIOSH case definition*

		NIOSH	
		met	not met
Reviewer	OA	21	10
	no OA	0	32/63

*Significant association ($p<0.001$).
OHC = occupational health clinic, OA = occupational asthma.

underwent specific inhalational challenge testing with a suspected agent; the test was positive in 3 (see Table 4).

The frequency of agreement between occupational health clinic physicians' findings and the proposed NIOSH surveillance case definition is presented in a 2×2 format (Table 5) for the 63 patients for whom adequate information was available in their charts to apply the NIOSH case definition. The frequency of agreement between the independent reviewer and the NIOSH case definition for these 63 patients is presented in the second part of Table 5. Although only 33% of the 63 patients met the requirements of the case definition, the frequency of agreement with the NIOSH case definition was somewhat higher for the independent reviewer than for the occupational health clinic physicians (84% vs 71%). The frequency of agreement between the clinic physicians and the independent reviewer ranged from 60% to 80% across the four clinics, with an overall frequency of 70%.

Discussion

The results of this study indicate that there is variable and incomplete physician recording of symptoms and collection of objective data necessary for the diagnosis of occupational asthma using the proposed NIOSH surveillance case definition at occupational health clinics at academic medical centers. A significant percentage (46%) of the patients diagnosed as having occupational asthma by the clinic physicians did not meet the proposed NIOSH surveillance case definition, even if one considers only the 63 patients for whom adequate information to apply the case definition was available. This suggests that the case definition would be insensitive as a surveillance tool. An independent physician reviewer, who is an occupational medicine specialist at a state health department involved in occupational disease surveillance, agreed with the diagnosis of the clinic physicians with a frequency similar to that of the NIOSH case definition.

Even though the presence of respiratory symptoms was almost always recorded, it was often recorded without specific information as to whether the symptoms were variable or intermittent and thus was less useful for application of the NIOSH case definition. The presence or absence of significant reversible or variable airways obstruction was investigated frequently (in 75% of the 101 patients), but obviously such investigation is not universal practice among occupational health clinic physicians. The objective confirmation of a reported association between respiratory symptoms and workplace exposure by measurement of work-related changes in FEV_1 and PEFR was pursued uncommonly by the clinic physicians (in only 17% of the 101 patients). Since occupational health clinic physicians at academic medical centers were not routinely obtaining information required for use of the NIOSH surveillance case definition, it seems unlikely that primary care providers in community settings would provide such information. Although the relative infrequency of clinic physician documentation of work-related pulmonary function changes is probably due in part to inability to collect such data (many of the patients evaluated for occupational asthma at the occupational health clinics may no longer have been working at a job with asthma-inducing exposures), the extremely low rate with which this diagnostic modality was pursued suggests that it will not be a particularly useful component of the surveillance case definition.

The significant number of patients with occupational asthma diagnosed at an occupational health clinic who did not meet the requirements of the proposed NIOSH surveillance case definition was due in large part to the relatively stringent NIOSH requirements for the presence of intermittent symptoms related to workplace exposure and for objective confirmation of variable airways obstruction. There was also considerable variability of agreement across the clinics, probably reflecting differences in regional use of case definitions for occupational asthma and in the sampling strategies employed to select charts for review. This finding suggests the need for further research to validate a standard case definition for diagnostic as well as surveillance purposes.

In part because of the results reported here, NIOSH has revised its surveillance case definition for occupational asthma. The requirement of variable or intermittent symptoms and the requirement for documentaton of significant reversible or variable airways obstruction have been eliminated in favor of a physician diagnosis of asthma.[8] However, potential problems with the new surveillance case definition include the continued presumption of occupational asthma if there is exposure to a known asthma inducer and the continued need for objective confirmation of work-related air flow obstruction if there is no such exposure. As noted above, objective confirmation of asthmatic symptoms in relation to workplace exposure was uncommonly pursued by the occupational health clinic physicians. For the surveil-

lance case definition to work in less than obvious cases, work-related changes in air flow obstruction must be documented. However, even when such changes are documented, the requirements of the case definition do not permit a diagnosis of occupational asthma unless there also are variable or intermittent symptoms present. A problem with dependence on use of variable or intermittent symptoms as a key criterion in the algorithm is that persons with severe asthma may have persistent and less variable symptoms. In addition, persons whose asthma initially may have been only work-related may have symptoms away from work, owing to persistent nonspecific airway hyperresponsiveness and exposure to environmental irritants. Information about exposure to an agent known to induce asthma is not always obtainable. With the rapid introduction of new chemicals in US industry, an unrecognized asthma inducer may be present in a workplace. The dichotomization of the requirements for the diagnosis of occupational asthma by the surveillance case definition according to whether a person has been exposed to a known cause of occupational asthma may be unnecessary. Furthermore, the requirements of the revised NIOSH case definition may still be inappropriately stringent for an instrument that is to be used for surveillance purposes.

Conclusions

The proposed NIOSH surveillance case definition is likely to miss many cases of work-related asthma because of its relatively stringent requirements for information that is not routinely collected by primary case providers. As the case definition is implemented in the SENSOR program, further research should address the sensitivity, specificity, and validity of the various requirements of the case definition. Efforts will also need to be made to educate the clinician population who will be reporting cases, as the success of the program will depend on adequate data collection by the diagnosing physician.

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