Surveillance of Occupational Asthma Under the SENSOR Model*

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NIOSH = National Institute for Occupational Safety and Health; OSHA = Occupational Safety and Health Administration; RAST = radioallergosorben test; SENSOR = Sentinel Event Notification System for Occupational Risks; SHE(O) = Sentinel health event (occupational)

Much of this workshop is devoted to reviewing current scientific knowledge concerning the causation, diagnosis, and natural history of occupational asthma. Provided with this information, primary care physicians should be able to enhance their role in the prevention and optimal management of this condition. In addition to knowledgeable practitioners, however, certain nonclinical services and expertise are often needed to assess and control occupational asthma in a particular workplace after an index case is recognized. To effectively bring our prevention "know-how" to bear on occupational asthma, surveillance programs are needed that link practitioners who recognize occupational asthma cases to resources in industrial hygiene, epidemiology, and occupational medicine.

The National Institute for Occupational Safety and Health and others have recognized that occupational disease surveillance is presently inadequate in the country.[1] Recently, NIOSH initiated a pilot project with 10 state health departments known as the Sentinel Event Notification System for Occupational Risks, or SENSOR,[2] to improve the surveillance of occupational asthma as well as other work-related conditions. In this report we discuss public health surveillance in general, describe the SENSOR model, discuss occupational asthma as a target condition for SENSOR, and describe the implementation of SENSOR and the early experience in selected states conducting occupational asthma surveillance using this model.

Surveillance and Disease Prevention

Public health surveillance has been described as "the collection, collation, and analysis of [health] data and the dissemination to those who need to know so that action [to prevent and/or control disease] can result."[3] According to this definition, surveillance should be distinguished from research into causes. Indeed, most public health surveillance protocols focus on conditions for which important causes (and preventive measures) have already been identified. As with most occupational diseases, prevention of occupational asthma requires multiple intervention strategies and multiple approaches to surveillance. To see how SENSOR fits into an overall approach to occupational asthma surveillance, we will first consider different types of surveillance systems and how they relate to disease prevention.

Some surveillance systems focus on detection of individual cases of a health event or of individuals with risk factors for the health event so that preventive actions can be directed at the patient and, where appropriate, at contacts of the patient. An example would be a program for identifying individuals with tuberculosis to ensure that patients were appropriately treated and contacts received appropriate chemoprophylaxis. In other surveillance systems, the principal objective is to monitor trends or patterns of a health event or of risk factors. Trend monitoring may be used to target high-risk populations for intervention efforts or to monitor the efficacy of interventions. An example would be monitoring the number of deaths from pneumonia and influenza in selected US cities to identify and assess the impact of national and regional influenza outbreaks.[4] Of course, a single surveillance program may serve both case identification and trend monitoring functions. SENSOR is intended primarily to serve a case detection function.

For a given health condition, prevention and surveillance can be directed toward multiple points along the path from exposure to the development of clinical disease. In the case of occupational asthma (Fig 1), prevention would ideally focus on preventing exposure to known sensitizing agents. Since these primary prevention measures will not always be feasible or universally implemented, medical screening can be conducted to detect early sensitization (or risk factors for sensitization) and limit further exposure in the sensitized individual. When primary and secondary prevention measures are not completely effective or implemented, clinical occupational asthma will occur. In order to target and monitor preventive measures, surveillance systems can monitor chemical use and exposure, early disease markers, and clinical occupational asthma, the occurrence of which may indicate a need to improve prevention and surveillance earlier in the chain of causation. SENSOR focuses on the end point of clinically diagnosed occupational asthma and should be viewed as one facet of a comprehensive approach to surveillance.

A surveillance system may also be classified according to the type of data it uses. Surveillance data may be collected specifically for surveillance, or existing secondary data (data originally collected for purposes other than surveillance) may be used. Examples of existing data sources that have been used for surveillance include death certificates, hospital discharge summaries, and workers' compensation claims. Although use of such documents has the advantage of not requiring additional resources for data collection,

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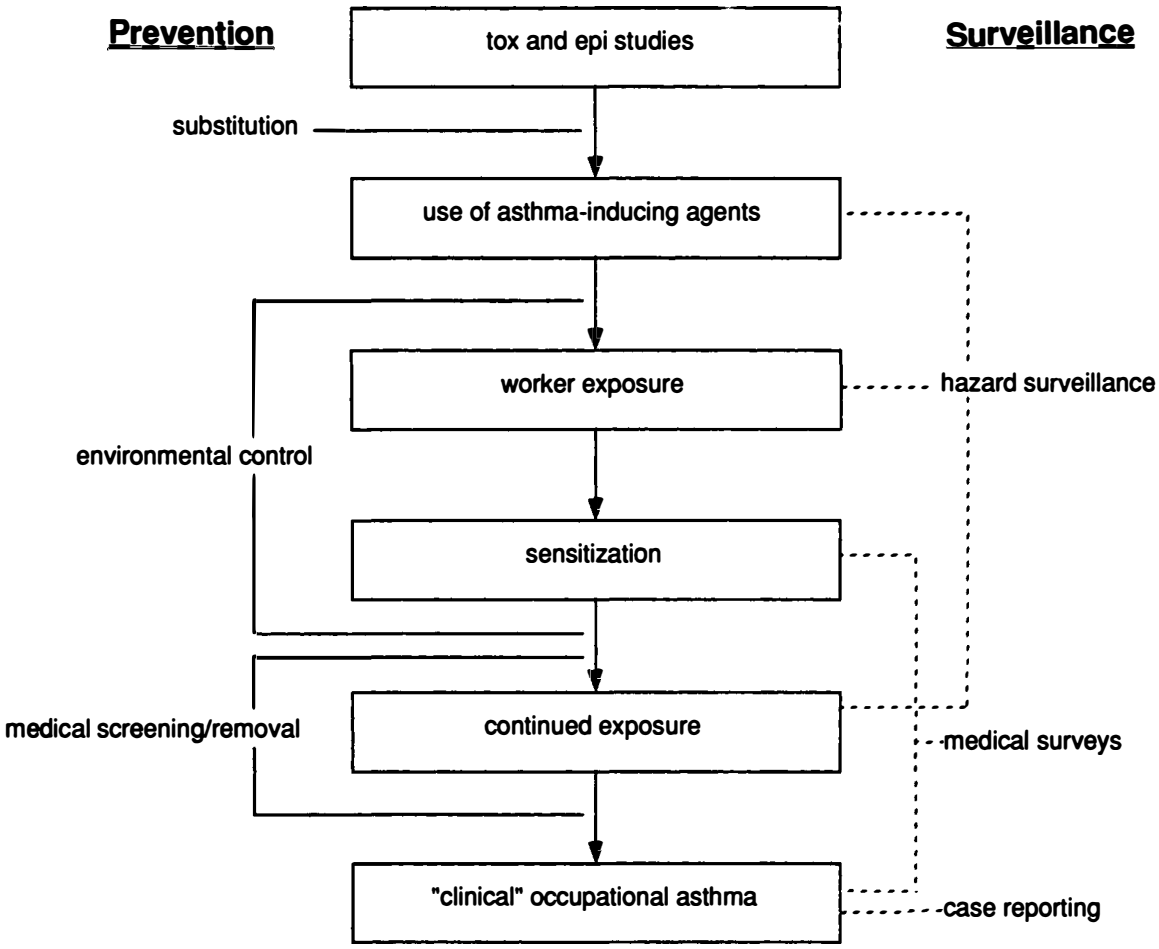

FIGURE 1. Prevention and surveillance of occupational asthma.

these data sources only identify cases resulting in death, hospitalization, or compensation and may be inadequate for surveillance of certain conditions. The SENSOR model, which proposes the use of health care provider reports, is aimed at conditions for which other sources of surveillance data are inadequate for timely case detection.

In addition to detecting conditions not identified by existing data sources, physician reports may have other advantages. First, physician reports are generally available in a more timely way than, for example, hospital discharge data or workers' compensation claims data. Timeliness is especially important when case reports are used to direct intervention efforts in individual cases or during outbreaks. Second, for conditions such as toxic shock syndrome, where the diagnosis may not be straightforward, physician reporting may allow interaction between the surveillance program and physician, collection of clinical data needed for case confirmation, and suggestions for additional clinical evaluation when appropriate. Finally, by establishing a contact point for physicians to report specified diseases, physician reporting systems can also provide physicians with a resource for reporting unusual cases or clusters that may be of public health concern but are not legally notifiable.

The idea of using health care provider reports to identify cases of occupational disease is not new. According to a survey conducted in 1985,[5] 32 states had programs for reporting occupational illnesses by one or more sources, including physicians (25 states), hospitals, laboratories, and others. In 16 states, legal penalties existed for nonreporting. Such programs are hampered by severe underreporting by physicians,[6] for several reasons. Many programs require reporting of any and all occupational diseases without further guidance as to what conditions are reportable or what criteria should be used for reporting occupational diseases.[7] Many practitioners lack the training needed to recognize work-related conditions.[6,8] Others may perceive occupational disease reporting as having little utility, perhaps because of a lack of intervention programs linked to reporting, as well as a focus on individual patient care and a lack of orientation to public health among clinicians. Finally, some practitioners may be unwilling to report because they provide services to employers or because they are reluctant to become involved in workers' compensation systems.

THE SENSOR PROGRAM

The SENSOR model for occupational disease surveillance is intended to address some of the deficiencies enumerated above in previous occupational disease reporting programs. Conceptually, SENSOR has 4 principal components: a set of selected target conditions, a network of sentinel health care providers, a surveillance center that receives and analyzes reports, and worksite intervention activity that is guided by surveillance data.

SENSOR targets for reporting a selected sentinel health

event (occupational) [SHE(O)]. A SHE(O) is a preventable work-related disease, death, or disability[9] that serves as a signal that other workers in the same workplace, industry, or occupation may be at risk of a similar outcome and may benefit from interventions to abate a hazard or to detect and treat early disease. Although a single SHE(O) will not always provide enough information to implement a specific intervention, it may indicate that targeted industrial hygiene or epidemiologic studies are needed. SENSOR is a model for using health care provider reports to identify and respond to individual occupational disease cases.

The second component of the SENSOR model is a network of sentinel providers, such as physicians, clinics, nurse practitioners, or laboratories, likely to encounter the condition of interest by reason of their specialty, their practice setting, or some other consideration. The purpose of identifying sentinel providers is to target efficiently efforts to educate providers about the purpose of reporting and how to report a case. Dissemination of surveillance data can also be focused on the sentinel providers, alerting them to industries, occupations, and workplaces where occupational disease is being recognized in their State.

The third element of SENSOR is a surveillance center, usually located in the state health department. Its function is to analyze case reports, direct investigations and prevention activities at selected workplaces, and disseminate surveillance data to practitioners and others. Intervention, the fourth key component of SENSOR, may be carried out by staff in the surveillance center or referred to other agencies. Depending on the circumstances, workplace interventions may involve walk-through inspections, distribution of educational materials to employees, industrial hygiene surveys, questionnaire surveys, and screening of co-workers.

Occupational Asthma as a SENSOR Target Condition

SENSOR targets for reporting only those SHE(O)s most suited to provider reporting and intervention. These include conditions that have some or all of the following attributes: the condition is reasonably frequent, practitioners can attribute individual cases to work exposure with a reasonable degree of confidence, the induction period (between first exposure and disease recognition) is relatively short, individual patients can benefit from abatement of exposure, existing technology can be used to prevent new cases, and data sources are not available or are inadequate for surveillance purposes. Features of occupational asthma that make it suitable for SENSOR-type case surveillance are discussed below.

Occupational asthma is often a sentinel event because the prevalence of asthma can be high in industries where occupational asthma has been identified.[10] Individual cases may therefore identify large numbers of other at-risk individuals. Identification of new causes of occupational asthma—himic anhydride, for example[11]—can also follow the recognition of 1 or 2 cases. Other instances have been reported in which a known asthma-causing agent, such as toluene diisocyanate,[12] was not known to be present in a workplace until individual cases were recognized and investigated further. Investigations reported in the literature represent those situations when, by chance, a case is recognized at a center with the interest and capability to conduct work site investigations. By targeting asthma, a SENSOR program can provide a systematic mechanism for linking large numbers of practitioners to the resources for conducting work site investigations.

Although the incidence of occupational asthma in the United States is unknown, it is probably fairly common. Estimates of the proportion of asthma attributable to work range from 2% of adult asthma cases to 15% of asthma in Japanese males.[13] As an estimated 5 million adults in the United States have asthma,[14] the more conservative estimate of work attributability yields an estimated 100,000 prevalent cases of occupational asthma in the United States.

Provider reporting of all asthma cases would not be efficient or practical. For provider-based surveillance of occupational asthma to work, physicians must be able to recognize individual asthma cases that may be work-related. A survey of physicians in New Jersey suggests that diagnosis of occupational asthma by physicians is not unusual. Questionnaires were administered to 847 physicians who had discharged a patient with an occupational lung disease between 1985 and 1987. Of the 762 physicians (90%) who responded to the survey, 134 had seen at least one newly diagnosed case of occupational asthma in 1987; a total of 446 patients were seen during that year. Only 101 of these had been hospitalized, indicating that hospital discharge data would probably be an insensitive source of data for this condition (Rosenman K, Stanbury M, unpublished data).

It is likely that criteria for the diagnosis of occupational asthma vary among physicians and even among patients seen by the same practitioner. For surveillance purposes, it would be desirable to use consistent criteria for classifying cases as possibly work-related. To this end, NIOSH has developed a surveillance case definition for use by state health departments to classify cases reported by physicians in a consistent way (see Appendix). A definitive diagnosis of occupational asthma is not always straightforward, and the NIOSH definition is intended to identify individual patients with sufficient evidence of work-related asthma to warrant additional investigation. The definition is also intended to promote consistent counting of reported occupational asthma cases over time and by different states. The current definition was reached in an iterative fashion, based on comments from clinicians familiar with occupational asthma and feedback from state health departments after field testing of earlier versions. Like any definition used in surveillance, the definition of occupational asthma represents a compromise among specificity, sensitivity, and practicality, and it may not be appropriate for other uses.

The interval between first exposure to a sensitizing agent at work and the development of occupational asthma is variable, generally ranging from months to years.[15] Even for cases with a relatively long induction period, however, the sensitizing agent usually is still present in the workplace when symptoms arise (although the patient may have left the workplace). Thus, recognition of a case of occupational asthma may provide the opportunity for primary prevention in co-workers of the index patient.

Although some individuals remain symptomatic after abatement of exposure to certain asthma-causing agents,[10] a substantial proportion of those removed from exposure do recover, and others improve. Persons who remain in exposure

Table 1—*States Participating in SENSOR Program, 1989*

Colorado*	New York*
California	Ohio
Massachusetts*	Oregon
Michigan*	Texas
New Jersey*	Wisconsin*

*Occupational asthma is a target condition.

are more likely to have deteriorating health. Clearly, intervention to reduce or eliminate exposure to an asthmagen can benefit individuals already affected. Reporting and follow-up may therefore benefit index patients as well as coworkers with secondary occupational asthma identified in the course of a workplace investigation.

Implementation and Early Experience of Three State SENSOR Projects Conducting Occupational Asthma Surveillance

Of the 10 states participating in the SENSOR program, 6 identified occupational asthma as a target condition (Table 1). Three states, Massachusetts, Wisconsin, and New York, initiated their reporting activity with a small, selected group of practitioners with whom they interact on a regular basis. This approach was used to take advantage of particular circumstances in these states, such as the existence of state-supported occupational medicine clinics, and to gain experience with case reporting, follow-up, and workplace investigations. Three other states, Colorado, Michigan, and New Jersey, established more traditional reporting systems, soliciting reports from providers throughout each state. The experience of this latter group may be more generalizable and is the focus of the rest of this report.

All 3 programs have utilized the concept of sentinel providers by aiming publicity and outreach to physicians most likely to see patients with occupational asthma. Mailings and presentations have been addressed to pulmonary physicians, allergists, and occupational medicine specialists. In addition, all 3 state programs have used 1 or more additional data sources to identify groups of physicians who have diagnosed occupational disease or shown an interest in occupational exposures. These other groups include attending physicians identified from hospital discharge records with occupational lung disease diagnoses, physicians supplying health services to hazardous waste contractors, physicians identified by workers' compensation claims for respiratory disease, members of departments of family medicine and internal medicine at medical schools, and physicians previously reporting an occupational disease to the state under other reporting programs.

All 3 states have designed their reporting systems to minimize the effort needed to report a case. All allow physicians to report a suspected case by phone. Phone numbers for reporting are disseminated in letters to sentinel physicians, in state health department newsletters, at presentations to professional organizations, and in program brochures. After receiving a phone report, SENSOR staff personnel contact the physician reporting the case to request additional information and, if appropriate, to obtain medical records. Patients may also be contacted by phone to obtain additional history and information about the workplace. From this information, it is determined whether the patient's symptoms are consistent with occupational asthma, how many other workers may have had similar exposure, and if any other workers are symptomatic. All of this information is used to set priorities for workplace follow-up.

Each program has also encouraged reporting by marketing SENSOR, in part, as a service to physicians and patients. In addition to the workplace investigation service, other inducements, such as providing peak flow meters and RAST testing, have been offered to reporting providers.

Disease reporting may be either voluntary or mandatory (governed by state statutes or regulations). Important features of some reporting regulations are provisions for protecting the confidentiality of case report data and authorizing providers to release otherwise confidential medical data to state health officials. Penalties for nonreporting are probably the least important feature of such regulations, and they have rarely been enforced. In Michigan, an occupational disease-reporting law was already in effect when the SENSOR program started. With the implementation of SENSOR, physician education efforts and case follow-up were enhanced and focused on a few target conditions, including occupational asthma. In Colorado, voluntary occupational asthma case reporting started in October 1987, and in August 1988, state health regulations were modified to make occupational asthma a reportable condition. New Jersey implemented voluntary reporting of occupational asthma in 1988, but a mandatory reporting regulation is presently under consideration.

All 3 state programs have augmented existing expertise in areas relevant to occupational asthma surveillance. Each established a relationship with an academic occupational medicine program to obtain assistance in interpretation of individual case reports as well as in the design and conduct of workplace investigations. Colorado SENSOR works with the Occupational Health Program at the National Jewish Center for Immunology and Respiratory Medicine, Michigan SENSOR with the Department of Medicine at the College of Human Medicine, Michigan State University, and New Jersey SENSOR with the Occupational Medicine Division at the University of Medicine and Dentistry of New Jersey. In addition, each program has established or supplemented industrial hygiene capability. In Colorado and New Jersey, a full-time industrial hygienist is employed by the SENSOR program to participate in workplace investigations. The Michigan SENSOR program is within the states OSHA program, which is located in the state health department, and OSHA industrial hygienists, either in the compliance or consultation programs, participate in work site investigations triggered by case reports.

Sustaining a successful surveillance program requires dissemination of surveillance data, especially to those who have provided case reports. In each state, reporting physicians receive letters summarizing the results of work site investigations. These letters show providers how their reports have been used and in some cases provide information useful for case management. In addition, summaries of reported cases and noteworthy case investigations are disseminated in state health department newsletters, in state medical journals, at professional meetings, and at hospital grand rounds.

In the first year of reporting (June 1, 1988, to June 1,

Table 2—*New Jersey SENSOR Findings on First Eight Workplace Investigations*

Industry or Occupation	Agent(s)	Employees Exposed (*n*)	Employees Symptomatic (*n*)	Air Monitoring	Engineering Controls
Coffee processing	Green coffee beans	9	5	Ineffective	Ineffective
Renal dialysis	Formaldehyde	9	6	Ineffective	Ineffective
Renal dialysis	Glutaraldehyde	8	3	Ineffective	Ineffective
Yacht manufacturing	Isocyanate paints	15	2	Not in place	Ineffective
Yacht manufacturing	Isocyanate paints	20	2	Not in place	Effective
Realtor	Microbials	14	12	Not in place	Ineffective
Plastic foam products	Glue/adhesive (methyl ethyl ketone?)	3	2	Not in place	Ineffective
Food processing	Perlite	20	3	Not in place	Ineffective

1989), the New Jersey SENSOR program received 46 reports of possible occupational asthma cases. Data from the first 8 work site investigations are summarized in Table 2. As can be seen, these investigations identified other symptomatic individuals as well as work sites with inadequate engineering controls and air monitoring.

The Michigan SENSOR program added more intensive provider education and case follow-up activities to a preexisting mandatory occupational disease-reporting program. This resulted in a dramatic increase in the number of occupational asthma reports received, from a total of 18 during the period 1984-1986 to 101 reported between Sept 30, 1988, and Aug 3, 1989. Reported cases have come from a wide variety of exposure settings (Table 3), including cases that led to the recognition of a new setting for occupational asthma, sugar beet pulp processing. In 8 work site investigations that are completed or pending, employee interviews have identified 97 co-workers of employees reported to have symptoms suggestive of occupational asthma.

Between October 1987 and October 1989, Colorado SENSOR received 97 disease reports that fell in its occupational asthma category. Table 4 shows the workplace settings for which more than one case has been reported. Colorado's experience illustrates 1 of the benefits of a provider reporting system for specified conditions: it provides a contact point where physicians can report other conditions or clusters that they suspect are related to occupational or environmental exposure. For example, among the case reports received in Colorado is a cluster of 6 cases of probable hypersensitivity pneumonitis in swimming pool employees; this is currently being investigated.

Table 3—*Exposures and Settings for the First 30 Occupational Asthma Cases, Michigan SENSOR*

No of Cases	Exposure	Type of Workplace or Occupation
14	Isocyanates (TDI, MDI, NDI)	Auto parts manufacturer, florist, car dealers
4	Grain/plant dusts	Grain mill, sugar beet pulp mill
2	Cobalt	Carbide tools
2	Formaldehyde	Auto parts manufacturer, cabinet maker
2	X-ray developer	Medical, dental offices
2	Ventilation system	Office workers
2	Coolant	Transmission manufacturer
1	Epoxy	Aircraft part manufacturer
1	Chromium	Tool manufacturer

Conclusions

SENSOR is a system for linking physicians who recognize occupational disease cases to public health officials who can direct intervention at specific workplaces and alert other physicians to settings where occupational disease may be occurring in their state. Certain features of occupational asthma may make it suitable for surveillance under the SENSOR model. Experience from a limited number of states indicates that many physicians are willing to report occupational asthma cases to state health officials and that case reports can be used to identify workplaces with remediable health hazards.

From early experience, SENSOR shows promise as an approach to providing occupational asthma surveillance and identifying opportunities for primary and secondary prevention. More widespread and sustained application of the SENSOR method requires that certain issues be addressed. Confirmation and investigation of occupational asthma cases are labor-intensive and demand certain types of expertise. As with notifiable communicable diseases, underreporting is a persistent problem. To encourage reporting, sufficient resources must be devoted to assure timely, quality follow-up of patients and to demonstrate the utility of reporting to providers. Further efforts are needed to increase physician recognition of occupational disease. These efforts should include dissemination of reporting criteria, surveillance data, and other educational material to providers through the SENSOR surveillance system.

Table 4—*Exposure Settings for Selected Cases Reported to Colorado SENSOR*

No of Cases	Type of Workplace or Occupation
25	Office workers (14 in one building, 9 in one building)
6	Swimming pool employees
3	Diesel mechanics
3	Foam manufacture
3	Auto painter
3	Sales clerks
3	Teachers
2	Beauty salon
2	Waferboard manufacture
2	Custodian

Appendix

Surveillance Guidelines for State Health Departments:

OCCUPATIONAL ASTHMA

October 4, 1989

Reporting Guidelines

State health departments should encourage providers to report all suspected or diagnosed cases of occupational asthma. These should include individuals with:

(A) A physician diagnosis of asthma

and

(B) An association between symptoms of asthma and work

Surveillance Case Definition

State health departments should collect appropriate clinical, epidemiologic, and workplace information on reported cases as needed to set priorities for workplace investigations. The surveillance case definition includes meeting criteria A and B below.

(A) A physician diagnosis of asthma[a]

and

(B) An association between symptoms of asthma and work[b] plus any 1 of the following:

(1) Workplace exposure to an agent or process previously associated with occupational asthma[c]

or

(2) Significant work-related changes in forced expiratory volume in one second (FEV_1) or peak expiratory flow rate (PEFR)

or

(3) Significant work-related changes in airways responsiveness as measured by nonspecific inhalation challenge[d]

or

(4) Positive response to inhalation provocation testing with agent to which patient is exposed at work. Inhalation provocation testing with workplace substances is potentially dangerous and should be performed by experienced personnel in a hospital setting where resuscitation facilities are available and where frequent observations can be made over a sufficient time period to monitor for delayed reactions.

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[a] "Asthma is a clinical syndrome characterized by increased responsiveness of the tracheobronchial tree to a variety of stimuli."[1] Symptoms of asthma include episodic wheezing, chest tightness, and dyspnea or recurrent attacks of "bronchitis" with cough, sputum production, and rhinitis.[2] The primary physiological manifestation of airways hyperresponsiveness is variable or reversible airflow obstruction. It is suggested that airflow variability be demonstrated by significant changes in the forced expiratory volume in one second (FEV_1) or the peak expiratory flow rate (PEFR). Airflow changes may occur spontaneously, with treatment, with a precipitating exposure, or with diagnostic maneuvers, such as nonspecific inhalation challenge.

[b] Patterns of association can be varied. The following examples are patterns that may suggest an occupational etiology: symptoms of asthma develop after a worker starts new job or after new materials are introduced on job (a substantial period of time may lapse between initial exposure and development of symptoms); symptoms develop within minutes of specific activities or exposures at work; delayed symptoms occur several hours after exposure, during the evenings of workdays; symptoms occur less frequently or not at all on days away from work and on vacations; symptoms occur more frequently on returning to work. Work-related changes in medication requirements may have similar patterns, also suggesting an occupational etiology.

[c] The number of agents and processes that have been associated with occupational asthma is large and constantly growing. Lists of agents are published in a number of references (*eg*, see references 2 and 3).

[d] Changes in nonspecific bronchial hyperreactivity can be measured by serial inhalation challenge testing with methacholine or histamine. Increased bronchial reactivity (manifested by reaction to lower concentrations of methacholine or histamine) following exposure and decreased bronchial reactivity after some time away from work is evidence or work-relatedness.

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