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Effects of exposure to dust in swine confinement buildings — a working group report

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RYLANDER R, DONHAM KJ, HJORT C, BROUWER R, HEEDERIK D. Effects of exposure to dust in swine confinement buildings — a working group report. *Scand J Work Environ Health* 1989;15:309—312. Pulmonary and other symptoms among workers in swine confinement buildings were evaluated by an international working group. In several studies in five different countries a total of about 2000 workers has been studied in clinical and epidemiologic investigations. Symptoms indicative of acute and chronic airway inflammation were widespread, as were systemic reactions of organic dust toxic syndrome. The base-line, and across workshift, pulmonary function changes were moderate. There was no evidence that antigen-antibody reactions are important in the pathogenesis. Longitudinal studies are recommended to establish the relationship between acute and chronic symptoms and end stage disease.

Key terms: bronchitis, inflammation, organic dust, pulmonary function.

Recent research has shown that pulmonary disease and certain systemic symptoms caused by organic dusts are far more common among exposed workers than previously suspected (1). To the well-studied exposure sources of cotton dust and moldy hay have been added other environments (animal confinement buildings, sewage treatment stations, wood processing, and industrial fermentation) in which symptoms are prevalent.

In occupational medicine, it is a common practice to relate a disease to the occupation in which the clinical symptoms were first observed, eg, farmer's lung, welder's fever, and stone cutter's disease. As the number of studies on occupational disease grows, this concept becomes more complex and, indeed, cumbersome. When a farmer reports symptoms not typical of farmer's lung as originally described, new terms such as 'atypical" or "acute" farmer's lung are invented. The presence of similar symptoms in relation to other work environments may be disregarded and not considered appropriate for compensation, as they do not adhere to the traditional textbook description and disease title.

A systematic evaluation of all the symptoms and clinical findings related to a specific environment is thus necessary to establish a rationale for diagnosis, treatment, and compensation. This approach has previously been used to summarize information on the exposure effects of cotton dust (2).

Organic dust exposure is also present in swine confinement buildings. The first studies on the health of persons working in swine confinement buildings were published in the United States (3) and Finland (4), followed by several reports from the United States, The Netherlands, Canada, and Sweden (5—17). A working group was assembled to summarize the symptomatology, clinical findings, and pathogenesis of the exposure. A distinction was made between changes appearing after acute exposure and those present after prolonged exposure. Dose-response relationships for different specific agents in the environment were discussed. Effects of toxic gases which also might be present in this environment (eg, hydrogen sulfide and ammonia) were not discussed. This paper presents a summation of the working group's findings.

Symptomatology

Respiratory symptoms

Airway symptoms are frequently reported by workers in swine confinement buildings (5—17). Work-related cough and phlegm are the two most prevalent symptoms, the prevalence ranging from 15 to 55 % and from 12 to 55 % of the exposed populations. Wheezing and chest tightness are also common, in 12 to 35 % of the exposed populations. In several of the studies, symptoms were more than twice as common as in the reference group (8, 13, 16, 18). In addition shortness of breath was present in up to 20 % of the workers (13, 16—18). Longer exposure periods were related to the feeling of chest tightness.

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Data from some studies suggest that younger workers with a short history in pig farming report only symptoms of irritation in the airways, whereas workers with a longer history report cough with phlegm (chronic bronchitis) and occupational asthma-like symptoms (11). This finding has been supported by the results of other studies (5, 6, 10, 16).

The respiratory symptoms may occur with varying exposure patterns. Some recent data suggest that in many persons cough, phlegm, and chest tightness appear during the first day after time off work. This finding is similar to the symptoms of cotton workers, and the finding may be relevant to an understanding of the pathogenesis of the illness. However, among swine workers, the periods off work are very irregular, and a systematic evaluation of these "Monday" symptoms is difficult.

Systemic and other symptoms

Episodes of a febrile illness with influenza-like symptoms, including malaise, muscle aches, joint pain, and fatigue, are experienced by 5 to 20 % of swine confinement workers (5, 8, 13, 16—18). These symptoms are consistent with what has been described as the organic dust toxic syndrome (1). This syndrome is often reported 2 to 6 h after an unusually heavy exposure to a variety of organic dusts.

In addition, more persistent symptoms, including fatigue, muscle aches, and joint pain, are seen (8, 16). Clinical evidence of classical hypersensitivity pneumonitis has not yet been reported (3—17). This lack should not, however, be interpreted as an absence of risk. As the incidence of strictly defined allergic alveolitis is less than 1 % in populations at risk (19), the chances of finding such cases in cohorts of the sizes studied are very small.

Irritation of the eyes, nose, and throat and a dry cough are commonly reported (5, 8). These symptoms suggest that this work environment causes a general inflammation of the mucous membrane. Another group of symptoms often reported includes stuffy nose, "popping" ears, continuous cold, headaches, and dizziness (8). These symptoms are also consistent with an inflammation in and swelling of the epithelium in the nasopharyngeal area.

One epidemiologic study suggests that the swine confinement environment might lower the resistance of the respiratory tract to infections (16). This study reported that 16 % of the Swedish swine farmers studied had a previous history of pneumonia confirmed by a physician as compared to 6 % of the reference group. In addition, frequent chest cold was reported by 53 % of the workers as compared with 20 % of the referents. This finding is consistent with 30 % of the workers reporting that they have had to take time off from work as a result of respiratory illness, compared to 18 % of the referents.

In support of this finding, one animal study has demonstrated that the swine environment can severely damage the respiratory epithelium (7).

Clinical and epidemiologic studies

Lung function — base-line changes

Pulmonary function studies have so far been performed on a total population of approximately 1000 farmers and pig farm workers in eleven independent studies in five countries (6, 8, 10, 11, 13—18, 20). Several of these population studies reported small mean decreases in the base-line lung function when compared with reference values; these differences remained after standardization for smoking (13, 15, 16, 18). Clinically significant lung function decrements have been found in 15—20 % of the working population (11, 18). Most of these studies refer to measurements of forced vital capacity and the forced expiratory volume in 1 s. Flow-volume parameters were decreased in some studies (8, 16).

Dose-response relationships between lung function changes and exposure have been suggested in three studies (6, 10, 16). There is information suggesting a relation between base-line lung function and several exposure variables, like duration of exposure during the day or the years of employment (10). Such relations have also been found for certain exposure agents, eg, dust, ammonia and endotoxin (3).

Lung function — across shift changes

Changes in lung function across a workshift or workday have been reported in several studies (6, 15, 16). In all these studies the average decrease was small and seldom exceeded 5 % of the base-line value (6, 8). As compared with base-line values, 15—20 % of the population have clinically significant work-period decrements (16). There were indications of relationships between the workday change in lung function and exposure to endotoxin and ammonia. In one study (7), the work-period decrements were significantly related to endotoxin exposure.

No clear relations to total dust or respirable dust fractions have been reported.

Serology

Only a few studies have evaluated the relation of atopy to the development of symptoms and lung function changes (4, 16, 20, 21). The number of workers studied has usually been small, and appropriate reference groups have sometimes been lacking.

In a Dutch study (21), 13 % of 130 pig farmers had elevated levels of immunoglobulin (Ig) E antibodies against storage mites, detected by the radioallergosorbent test. However, 70 % of these farmers also had

an elevated IgE level against house dust mite (Dermatophygoides) allergens. No IgE antibodies were found against swine antigens; this finding is consistent with the results of a Finnish study (4). Another study showed no difference in precipitating antibodies to agents related to hypersensitivity and swine antigens and molds isolated from the swine environment (16).

In an unpublished Dutch study (Brouwer et al, personal communication) elevated levels of IgG4 antibodies were seen among subgroups of swine confinement workers involved in intensive forms of pig farming. Relationships were seen between respiratory complaints during, or shortly after work and the IgG4 levels in serum after adjustment for age, smoking, and endotoxin exposure. Another study reported elevated levels of IgG antibodies against swine antigens (4) in comparison with the levels of reference groups, but there were no correlations with respiratory symptoms. Matson et al (22) studied the occurrence of IgG and IgE antibodies. Some farmers had elevated levels of antibodies to swine antigens, but in none of the cases could the presence of elevated levels of antibodies be correlated with symptoms.

Pathogenesis

The question concerning a causative agent(s) for the symptoms and clinical findings presented in the preceding discussion has not been resolved. Several of the symptoms and pulmonary function deficits are closely related to bacterial endotoxins, but associations also exist between dust levels, ammonia, and other agents. Several potential toxic agents are present in the swine confinement environment (3), and it is at present impossible to exclude a possible role for these in addition to the ones presented in the preceding discussion.

In view of the imprecise documentation on causative agents, conclusions concerning the pathogenesis behind the observed symptoms and clinical changes remain uncertain. Several of the effects described can, however, be caused by acute or chronic inflammation of the airways. Many agents in the swine confinement environment, such as endotoxins, ammonia, and hydrogen sulfide, may induce inflammation causing swelling and edema of the epithelium or induce contraction of bronchial smooth muscle. Both events cause narrowing of the airway lumen. Experience also indicates that this inflammation may cause an increased bronchial reactivity to other inhaled agents, such as tobacco smoke. The combined effects of organic dust and tobacco smoke may occur in a synergistic manner and decrease defense mechanisms to inhaled microorganisms. This may be the reason for the increased frequency of upper respiratory infections observed in some studies. Inflammation may also develop in other contact surfaces, such as the epithelium in the nasal passages or in the eye, and cause subjective irritation.

The role of traditional immunologic mechanisms, particularly the type-III reaction (antigen-antibody reactions) remains obscure. In spite of efforts to characterize the immunologic responsiveness of the host (atopy) and the determination of antibodies against various antigens in the swine confinement building air, no clearcut relationships have been demonstrated. An increase in a specific subclass of antibodies may indicate the involvement of antibody-antigen reactions, but it may also simply reflect the exposure. General increases in antibody levels are also found after a general stimulation of the immune system through inflammatory and adjuvant agents, such as endotoxins.

Comments

Information on reported symptoms is important for attending physicians, occupational hygienists, engineers, managers, and the employees themselves. They must recognize that a series of local and general symptoms may be caused by exposure to the swine confinement environment. These symptoms are common in exposed groups, and the individual may suffer considerable discomfort and be forced to leave work. Although the symptomatology and clinical findings reported do not adhere to the criteria of traditional occupational lung diseases (asthma, hypersensitivity pneumonitis, pneumoconiosis), they should, nevertheless, be recognized as posing a health hazard, and action should be taken to decrease the risk of the workers.

The information on dose-response relationships and different agents for the development of symptoms and clinical findings is as yet limited. The most complete information available refers to endotoxin, for which dose-response relationships have been demonstrated for an acute decrease in the forced expiratory volume in 1 s over the workshift, and for cough, phlegm, wheezing, chest tightness, and fever as well. The importance of other agents, such as ammonia and other irritating gases, other microbial products (such as glucans and mycotoxins), and the particles themselves, needs to be investigated further.

For the purposes of long-term prevention, the relation between acute effects over the workshift and the risk for long-term effects needs to be evaluated. The only means with which to obtain such information is to perform longitudinal studies, in which persons starting work in swine confinement buildings are screened for airway reactivity, atopy, the presence of symptoms after an exposure period, and pulmonary function. These workers need to be followed on a regular basis. For those who leave their work in swine confinement buildings, the reasons, particularly if related to adverse pulmonary reaction, should be documented. Furthermore, dose-response relationships between irritating gases, other microbial products such as glucans, and the particles themselves need to be investigated further.

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