Biological agents causing occupational airborne contact dermatitis

**ABSTRACT**

**Introduction:** Exposure to airborne biological agents (plant and animal) is frequently associated with occupational contact dermatitis. Airborne bacteria and fungi have also been associated with work-related skin disease in the absence of pulmonary disease.

**Methodology:** A literature review of scientific papers (1966-2009) related to biological agents implicated in occupational airborne contact dermatitis was conducted. The search was done using Google, as well as major dermatitis and occupational health journals and information from credible occupational health and safety institutes.

**Results:** An overview of airborne biological agents and their role in occupational dermatoses, as well as the diagnosis of such conditions is provided. The coexistence of occupational and non-occupational skin diseases is highlighted.

**Conclusion:** Occupationally induced skin reactions by airborne biological agents (microbial, plant, animal) are more common than in the non-occupational context. The role of airborne biological agents should be considered in the diagnostic workup of workers with skin reactions in air-exposed areas.

**Keywords:** hazardous biological agents, occupational, airborne, contact dermatitis, skin disease, dust, plant, animal, bacteria, fungi, mould, allergens, allergy

**INTRODUCTION**

Certain workers, particularly in agriculture, are exposed to large quantities of dust during their work. The dust consists of varying amounts of inorganic material, organic substances of plant and animal origin as well as viable and non-viable microorganisms and their by-products (biochemical components, toxins, antigens).¹⁻⁴ The pathogenic role of dust components in relation to respiratory disease has been well documented.⁵ Apart from inhalation, these airborne dust particles, which are regarded as hazardous biological agents, also settle on exposed skin and may trigger local inflammatory reactions, referred to as ‘airborne contact dermatitis’.⁶⁻⁹ The dermatitis was coined airborne contact dermatitis due to the inflammatory reaction (either allergic or irritant) of exposed skin areas (in which the causative role of sunlight can be excluded) initiated by airborne agents that settle on the skin.¹⁰⁻¹¹ Airborne causal agents may be protein in nature resulting in protein contact dermatitis. The pathogenesis of protein contact dermatitis is unclear but may involve a type I (IgE mediated) hypersensitivity reaction, type IV (cell-mediated delayed) hypersensitivity reaction, and/or a delayed reaction due to IgE-bearing Langerhans’ cells.¹²

Many occupational practitioners overlook the effects of these agents on exposed workers and it is important to promote awareness of airborne particle deposition as a trigger of local inflammation. The main purpose of this paper is to explain the role of airborne biological agents in occupational contact dermatitis, to emphasise the challenges regarding the coexistence of non-occupational and occupational skin diseases and to describe the diagnosis of the condition.

**METHODOLOGY**

Studies on occupational airborne contact dermatitis associated with hazardous biological agents and their constituents were identified through a Google search. The keywords used included hazardous biological agents, microorganisms, occupational, airborne, contact dermatitis, skin disorder, exposure, bacteria, fungi, mould, allergens, type IV allergy and T cell mediated. Major peer-reviewed dermatitis journals and occupational health journals were also searched. Only selected publications (1966-2009) were used after evaluation, as this review focused on the influence of airborne biological agents and their constituents on occupational contact dermatitis. There are numerous case reports of chemical exposure which were excluded, with the exception of endotoxin which is briefly mentioned in this manuscript.

**RESULTS**

**Epidemiological studies**

Only two epidemiological studies have been reported to date among Austrian and Italian population groups.¹³,¹⁴ In the former study, 0.29% (15/5092) patients were diagnosed with airborne contact dermatitis of which 0.09% (5/5092) were confirmed as occupational and 0.14% (7/5092) could be regarded as occupational if ‘housewife’ was included as an occupation.¹³ In the study by Crippa et al.,
occupational airborne contact dermatitis was suspected in 0.85% (10/1169) patients. These studies highlighted that occupational airborne contact dermatitis due to biological and chemical exposure exists, although it is more rare in unselected patch-test populations than implied by the increasing number of biologically-related case reports over the last few decades.

Sources of exposure in various occupational settings
The sources of the reactions may be multiple with new agents causing airborne dermatoses continually being added to the list. Table 1 gives an unexhaustive list of biological agents and their by-products causing dermatoses. Cases of occupational airborne contact dermatitis have mainly been reported in agriculture and food-processing industries but are not uncommon in other industries such as health care and waste industries.

The role of plant and animal derivatives in work-related skin disease
Historically, grain was regarded almost exclusively as the source of respiratory disease in farmers. However, recent studies have shown that working with grain was a cause of skin problems in 15.8% of grain workers and 18.4% in cow and pig breeders. Contrary to the belief that storage mites only cause asthma and rhinitis, skin symptoms related to storage mites were also demonstrated in a Polish farmer.

The role of microbial derivatives in work-related skin disease
Most studies of workers exposed to high concentrations of airborne bacteria focus on respiratory symptoms. However, bacterial extracts contain superantigens which are potent inducers of the immune reactions and are suspected of playing a role in a variety of skin diseases. In a study of compost workers a significantly increased frequency of skin diseases was related to increased IgG levels to Saccharopolyspora rectivirgula and Streptomyces thermovulgaris. Positive patch tests to S. rectivirgula were also found in two farming students. Interestingly, all farming students in this study also reacted to the Gram negative bacterium Pantoea agglomerans, which is the main source of endotoxin found in agricultural dust. P. agglomerans has been shown to induce a type III response in agricultural workers exposed to organic dust, resulting in cutaneous late phase reactions. Several cases of work-related dermatitis due to Bacillus thuringiensis, widely used as a bacterial insecticide, have also been reported.

Fungal substances are capable of inducing delayed allergic reactions in workers. Aspergillus fumigatus had been implicated in respiratory allergy due to the Asp f 1/2 allergen however, it appears that skin reactions are caused by a different A. fumigatus antigen. High concentrations of A. fumigatus antibodies were found among compost workers which co-existed with work-related skin disease in some cases.

Although only a handful of studies have been reported on the relationship between skin symptoms and bacteria and fungi and their products, the possible link needs to be considered for the management of the affected worker. The rarity of the condition may be due to misdiagnosis owing to practitioners failing to look for an association between airborne exposure and skin symptoms.

Skin reactions and location of lesions
A variety of reactions may occur (e.g. irritant, allergic or urticarial), depending on the nature of the airborne agent. Furthermore, a particular agent can cause several different reactions as in the case with garlic exposure which may cause irritant as well as allergic type reactions. Generally, rashes in airborne contact dermatitis have a characteristic appearance, and mainly affect the face and hands. This eruption frequently has a sharp demarcation at the mid-biceps level and the upper sternal V line. Unlike photo-induced dermatitis, airborne contact dermatitis also affects the submental area or skin and may trigger local inflammatory reactions . . .

Table 1. Biological agents implicated in occupational airborne contact dermatitis.

<table>
<thead>
<tr>
<th>AGENT NAME</th>
<th>MICROBIAL DERIVED AGENTS</th>
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<tbody>
<tr>
<td>Animal derived allergens</td>
<td>Fungi, Bacteria, Fungal alpha-amylase</td>
</tr>
<tr>
<td>Fish</td>
<td></td>
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<tr>
<td>Cow dander</td>
<td></td>
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<tr>
<td>Mites (house dust mite, storage mites)</td>
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</tr>
<tr>
<td>Microbial derived agents</td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td>Saccharopolyspora rectivirgula, Streptomyces thermovulgaris</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Pantoea agglomerans</td>
</tr>
<tr>
<td>Plant derived allergens</td>
<td></td>
</tr>
<tr>
<td>Grain dust (hops)</td>
<td></td>
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<tr>
<td>Champignon mushroom</td>
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<tr>
<td>Flour (wheat, rye, soya)</td>
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<tr>
<td>Latex</td>
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<tr>
<td>Garlic</td>
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<tr>
<td>Pine</td>
<td></td>
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<td>Sawdust</td>
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<td>Cinnamon</td>
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postauricular sites. A further suspicion of airborne exposure is the presence of symmetric lesions on anatomically occluded areas of the body such as eyelids, area behind the ears, scalp covered by hair and area under the chin. The upper eyelids are particularly susceptible to airborne agents and may at times be the only site affected.11

**Diagnostic work-up**

Cases of airborne dermatoses have mainly been reported in the context of occupational settings. Although dermatologists and occupational medical practitioners are becoming increasingly aware of the airborne source of contact dermatitis, it remains greatly underestimated due to the misunderstanding between the route of exposition and relation to the clinical picture. It is therefore important for clinicians to perform an extensive history when lesions are located on air-exposed areas.38 To make the clinical diagnosis four fundamental criteria must be considered: 1) the presence of airborne exposure, 2) clinical symptoms, 3) the history of patient, and 4) the results of epicutaneous tests.39

**Patch tests**

One of the challenges in the diagnosis is the availability of biologically-derived agents in the commercial patch test screening series. Patch tests can be carried out with the airborne extract by soaking small pieces of filter paper in the extract solution. Extracts should be checked for sterility and lack of toxicity before fixing to the patients’ back for 48 hours using patch test chambers. The reading of the reaction should be carried out at 48 and 72 hours. Controls should be carried out on healthy individuals.23 The limitation of using an extract is that it may contain a mixture of substances. However, a positive reaction is indicative of the presence of the causative agent. Subsequent characterisation may be pursued to identify the specific agent in question.

In the case of protein contact dermatitis, negative patch-test results could occur because large protein-based molecules cannot penetrate intact, uninvolved skin. Another possibility is that the type I histamine response may block the detection of a type IV response. This is supported by experimentation of chronic dermatophytosis, wherein *Trichophyton mentagrophytes* induces an immediate type I reaction with no subsequent delayed type IV response. However, when the antihistamine chlorpheniramine is injected, blocking the type I reaction, a positive delayed type IV reaction is uncovered.12 In such cases, the prick testing and scratch testing methods may be of more value.

**Prick tests**

Prick testing involves placing one drop of diluted test allergen, negative control, and positive control (histamine) onto the volar forearm of the patient. The test sites are pricked with lancets to introduce the allergen into the dermis. The results are read at 15-minutes after introduction of allergen. A positive reaction is a wheal of at least 3 mm in diameter after subtracting the wheal size of the positive control, in the absence of a reaction in the negative control.12

**Scratch tests**

Scratch testing involves placing one drop of diluted test allergen, negative control, and positive control (histamine) onto the volar forearm and scratching the skin lightly with a needle. The test sites are read at 15-minute intervals over 1 hour. A positive reaction is a wheal that is at least half the diameter of the histamine control in the absence of a reaction in the negative control.12

**Contemporary and emerging issues**

Occupational skin diseases frequently remain undiagnosed for years due to a lack of awareness. Furthermore, the coexistence of a non-occupational disease such as rosacea can mask an occupational skin disease which can often then be missed.15 In addition, the disease may be misconstrued as non-occupational if the work-related dermatitis started after the onset of the non-occupational condition. In fact, the coexistence of both diseases of the same organ should not affect one’s compensation rights, irrespective of the possible difficulties in determining which part of the impairment was actually work-related.40 One also needs to be alerted to multiple adverse reactions occurring in the work environment. An example is an allergic reaction superimposed by an irritant component of a biological substance – garlic. In this case, the worker was diagnosed with occupational airborne contact dermatitis from garlic powder used to manufacture margarine containing garlic, with concurrent IgE mediated or type I allergy.26

The role of airborne agents in occupational contact dermatitis is important for the management of the worker. A case that stands out is that of a nurse using vinyl gloves due to contact dermatitis from latex rubber gloves. Her colleagues continued wearing latex gloves. Skin prick test using commercial latex extract, specific IgE for latex and glove use test were all negative, whilst delayed readings for latex hapten using patch tests were positive.16 This case report describes hypersensitivity type IV reaction to latex without direct contact and also highlights the challenges in managing such workers due to airborne exposure.

Employers should make efforts to reduce exposure and provide personal protective equipment. However, in the case of occupational airborne contact dermatitis provision of the latter may be insufficient as it may be impractical to cover the entire skin. Unfortunately if symptoms persist after reduction of exposure (where reasonably practical) the worker would need to be relocated.11,26

**Conclusion**

Cases of occupational airborne contact dermatitis to biological agents or varying origin are well documented. The onus is on the clinician to make the link between exposure and skin symptoms which forms the basis for the management of the patient and the establishment of adequate prevention.
LESSONS LEARNED

- Biological agents play a role in occupational airborne contact dermatitis.
- Hazardous biological airborne agents that settle on the skin can initiate an inflammatory reaction of exposed skin areas.
- A variety of reactions may occur, depending on the nature of the airborne agent.
- Non-occupational disease e.g. rosacea can mask the occupational skin disease and lead to misdiagnosis.
- Patch tests can be performed using extracts to make a diagnosis.
- Recognising the characteristic nature of the reactions can facilitate the diagnosis.

REFERENCES

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