Occupational skin diseases

T.L. Diepgen, L. Kanerva.

Summary: Occupational skin disease in a nutshell

1. An occupational skin disease is a skin disease to which occupational exposure is a major causal or contributory factor.

2. In many countries occupational contact dermatitis ranks first among all notified occupational diseases and constitutes up to 30% of all occupational diseases.

3. 90-95% of work-related dermatoses are skin contact reactions, mostly affecting young individuals (median age of notified occupational skin diseases in Germany 25 years).

4. The two most important types of OCD are irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD).

5. The most important risk factors for ICD are water (wet work), detergents and cleansing agents, hand cleaners, chemicals, cutting fluids, and abrasives. The most common causes of occupational ACD are rubber chemicals, plastic chemicals, metals, and antimicrobials.

6. Social and psychological implications of OCD as well as the total economic impact of OCD is high.

7. The total economic impact of OCD is very high due to direct cost of medical care, worker’s compensation or disability payments as well as indirect costs associated with lost workdays and loss of productivity and costs of occupational retraining.

8. National registries are usually incomplete as a result of underdiagnosis and underreporting of the disease. The incidence of occupational skin diseases in the Europe may be underestimated by 10 to 50 times.

9. Individuals with a personal history of atopy run a considerable risk of developing occupational skin disease, such as hand eczema when exposed to occupational agents.

10. The prognosis of OCD is poor. Therefore, prevention of OCD is of utmost importance.
90-95% of work-related dermatoses are contact reactions; the rest are other dermatoses such as oil- and chloracne, pigment disturbances such as chemically-induced leukoderma, infections and skin cancer. The two most important types of occupational contact dermatitis (OCD) are irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD). ICD results from contact with irritant substances, while ACD is a delayed-type immunological reaction in response to contact with an allergen in a sensitized individual. The majority of OCD are localized on the hands and face.

A special subtype of contact allergy is mediated by IgE, resulting in an immediate-type contact reaction and presenting itself as contact urticaria. The clinical picture of urticaria is different from eczema/dermatitis, but after repeated episodes on the hands this contact urticaria can gradually progress to hand eczema. Since 1989, the Finnish register of notified cases of occupational allergic contact dermatitis has distinguished contact urticaria as a separate entity [28].

The most common work-related skin diseases develop almost unnoticed as an accumulation of repeated minor damages caused by a variety of different factors to which the skin is exposed simultaneously or one after the other. In the initial stage, the damage is invisible to the human eye. This damage triggers the release of cytokines and these initiate and orchestrate an inflammatory reaction to restore the damage. However, the ongoing damage can exceed the skin’s ability to repair itself, and visible skin diseases then appear: erythema, scaling, swelling, vesicles, rhagades and papules. Damage to the skin can also be acutely overwhelming, with immediate severe damage as occurs with acute chemical burns.

The development of OCD is determined by a combination of individual susceptibility (endogenous factors) and exposure characteristics (exogenous factors). Apart from exposure to hazardous substances there are many endogenous factors that may influence the development of contact dermatitis, such as atopic constitution, the functional state of the epidermal barrier, sensitization, psychological factors, age, and gender. Environmental factors may play a role in this process by influencing the individual susceptibility and the characteristics of exposure.

Social and economic impact of occupational contact dermatitis

Minor degrees of contact dermatitis are often accepted as a normal hazard of life. Contact dermatitis does not usually lead to hospitalization. However, the occupational, domestic, social and psychological implications of OCD may be considerable, and the total economic impact of OCD is high. Occupational contact dermatitis is often localized on the highly visible areas of the body, namely the hands and face. Consequently, OCD limits the work ability and has a negative effect on social contacts. Sick-leave as the result of work-related skin diseases is mainly determined by (i) limitation of manual skills, (ii) acceptance of the disease by colleagues and the company, (iii) risk of spread of infection, e.g. skin infections in the healthcare, catering and food sectors, (iv) negative image, e.g. “weird” skin diseases on the hands and face. Consequently, a facial dermatitis will have different consequences for someone in a sales job compared with a worker on a building site. Furthermore, numerous allergens and irritants are present in daily household activities, hobbies and sports and interact with occupational skin diseases. Hand eczema may cause obligatory sick leave in the food sector, whereas hairdressers may regard this as “normal” and continue to work. Jowett and Ryan [27] found that 38% of patients with eczema noticed interference with social life. In a follow-up study of 954 patients with OCD, 61% reported that they had lost time from work due to their skin disease [48]. About 6% of all patients had been off work for longer than 12 months continuously.

There are only a few studies about the costs of OCD. Expenses are generated by: (i) direct cost of medical care, workers’ compensation or disability payments (ii) indirect costs associated with lost workdays and loss of productivity and quality (iii) cost of occupational retraining, and (iv) costs attributable to the effects on the quality of life (table 1). In Germany, retraining costs are 50,000-100,000 € per patient. The indirect costs are estimated to be 6 times higher than the costs of medical treatment. In the Netherlands, the direct medical costs were about 42 million € for about 15 million inhabitants in 1995 [38]. In spite of the poor clinical prognosis of OCD, there are no recent studies on the costs attributable to the effects on the quality of life or activities of daily living.

Prevalence of hand eczema

Recent epidemiological studies on the incidence and prevalence of work-related skin complaints (hand eczema (HE), contact sensitization and contact dermatitis) in different professions are summarized in table 2. Different prevalence rates are reported depending on the methodology. In most of the studies the prevalence among women is higher than among men. Irritant contact dermatitis is more common than allergic contact dermatitis.

In the prospective Audi cohort study (PACO study) 2078 apprentices were investigated at the start of their apprenticeship and systematically followed up over a 3-year period [3]. At the end of the study, information on 2042 (98.2% follow-up) was available. The main outcome variable was the incidence of work-related hand eczema in different apprenticeships. The 1-year cumulative incidences of hand eczema were 9.2% (95%-confidence interval 7.8-10.7) in metalworkers, 8.8% (95%-CI 7.0-10.7) in other blue-collar workers, and 4.6% (95%-CI 2.3-8.1) in white-collar apprentices. The 3-year cumulative incidences of hand eczema were 15.3% (95%-CI 13.6-17.2) in metalworkers, 14.1% (95%-CI 11.8-16.5) in other blue-collar workers, and 6.9% (95%-CI 4.0-10.9) in white-collar apprentices. In females, the cumulative incidence of hand

### Table 1. Reasons for the high economic impact of occupational contact dermatitis

<table>
<thead>
<tr>
<th>Reason</th>
<th>Description</th>
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<tr>
<td>Direct cost of medical care, workers’ compensation or disability payments,</td>
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<tr>
<td>Indirect costs associated with lost workdays and loss of productivity,</td>
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<tr>
<td>Costs of occupational retraining,</td>
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<td>Costs attributable to the effects on the quality of life.</td>
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eczema was higher compared to men (1-year incidence 10.1%, 95%-CI 7.7-13.0, versus 8.3%, 95%-CI 7.1-9.5; 3-year incidence 16.1%, 95%-CI 13.1-19.5 versus 13.6%, 95%-CI 12.2-15.2). The incidence was not uniformly distributed over the 3-year period. Within the first 6 months, a particularly high rate of hand eczema occurred, which then declined and remained steady at a lower rate over the 2nd and the 3rd years.

### Incidence of skin diseases in occupational disease registries

Registers of occupational diseases are kept in several European and Asian countries and in the United States. Most of these registers include all skin diseases, and do not distinguish between ICD and ACD. Skin diseases constitute up to 30% of all notified occupational diseases; ICD and ACD account for about 90%-95% of this group. Finland keeps also a record on occupational contact urticaria [28]. In Germany there is an additional record on occupational skin cancer [15].

National registries are usually incomplete as a result of underdiagnosis and underreporting of the disease. The incidence of occupational skin diseases in the USA and Germany is being underestimated by up to 50 times [14, 46], with milder cases not registered at all [2, 14, 36]. The extent of underreporting is likely to differ between countries, because each country has its own system of notification. Criteria for compensation, and thus criteria for notification of occupational diseases, depend on the legislation on occupational diseases in each country. Many employees carry on working for a long time with household remedies, medicines, periods of sick leave and adaptations at their workplace. This suggests that the official notification systems reveal only the tip of the iceberg and partly explains the differences in the official data between different countries.

Divergent compensation regulations between countries may further contribute to these differences in official registration data. Although the comparison of national data is hampered by differences across countries in reporting occupational diseases, the average incidence rate of registered occupational contact dermatitis in some countries lies around 0.5 to 1.9 cases per 1000 full-time workers per year [12]. In the Finnish register, which identifies contact urticaria as a special entity, bakers, preparers of food, animal handlers and dental personnel rank highest among cases notified with this disease [28]. In Denmark: the incidence was 17,700 cases in a workforce of about 2.6 million, i.e., about 7 per 1000 per year [22]. The 5 most frequent agents were detergents, water, metals, foodstuff and rubber, causing about half of the eczema cases. The most important irritant was wet work.

Occupational skin diseases account for 34% of all registered occupational diseases in Germany. In Northern Ba-

### Table 2. Recent epidemiological studies (prospective cohort and cross-sectional studies) on the prevalence of work-related skin complaints (hand eczema, contact sensitisation and contact dermatitis) in different professions

<table>
<thead>
<tr>
<th>Author / Year / Country</th>
<th>Target population / N</th>
<th>Method of case ascertainment</th>
<th>Outcome</th>
<th>Measures of prevalence</th>
<th>Rate</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>Funke et al. 2001 [19] Germany</td>
<td>Apprentices in the car industry N = 2078</td>
<td>Q, I, E</td>
<td>Hand eczema in metalworkers (apprentices)</td>
<td>1-year</td>
<td>9.2%</td>
<td>Prospective cohort study of high quality, follow-up rate 98.2%</td>
</tr>
<tr>
<td>Gruvberger et al. 2003 [20] Sweden</td>
<td>Metallic workers N = 163</td>
<td>Q, E, patch test</td>
<td>Work-related contact dermatitis</td>
<td>Point</td>
<td>17.2%</td>
<td>Cross-sectional study</td>
</tr>
<tr>
<td>Livesley et al. 2002 [35] UK</td>
<td>Printing industry N = 1189</td>
<td>Q, E</td>
<td>Skin complaints</td>
<td>Lifetime</td>
<td>41.2%</td>
<td>Cross-sectional study, response rate 62%</td>
</tr>
<tr>
<td>Sussitaival et al. 2001 [45] California, USA</td>
<td>Veterinarians N = 1416</td>
<td>Q</td>
<td>Hand/forearm dermatitis</td>
<td>1-year</td>
<td>28%</td>
<td>Cross-sectional study, response rate 73%</td>
</tr>
<tr>
<td>Leino et al. 1998 [33] Finland</td>
<td>Hairdressers N = 355</td>
<td>I</td>
<td>Hand eczema</td>
<td>Lifetime</td>
<td>16.9%</td>
<td>Cross-sectional study, response rate 71%, selection bias due to healthy worker effect</td>
</tr>
<tr>
<td>Guo et al. 1999 Taiwan</td>
<td>Cement workers N = 1147</td>
<td>I, E, patch test</td>
<td>Work related skin problems in males and females</td>
<td>1-year men</td>
<td>13.9%</td>
<td>Cross-sectional study, response rate 68.2%</td>
</tr>
</tbody>
</table>

Q: questionnaire, I: telephone interview, E : clinical examination.
varia, a detailed population-based prospective study was performed to classify all cases of occupational skin diseases without skin cancer [3, 7-9]. Figure 1 shows the incidence rates of irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD) of employees of the twelve groups with the highest risk for an occupational skin disease are presented. The figure demonstrates the ranking of occupations hazardous for the skin and is helpful for defining target groups for prevention. The highest incidence rates were found in hairdressers, bakers, electroplaters, grinders and drillers. The median of age in hairdressers, the food industry, health service, and metal workers varied between 19 years and 33 years. The induction period was very short: about 2 years in hairdressers, 3 years in the food industry, and about 4 years in health service and in metal workers. In the food industry, bakers had a higher risk of occupational contact dermatitis compared with confectioners and cooks. Females had a considerably higher risk than men. The greatest number of new cases developed between the age of 15 and 24 years.

**Exposure to irritants and allergens**

The most important risk factor for OCD is the exposure to irritants. Well known irritants are water (wet work), detergents and cleansing agents, hand cleaners, chemicals, cutting fluids, and abrasives. In a study on hand eczema at least one of those irritants was always involved in ICD but also in 84% of ACD, and in 60% of atopic HE. According to a new German regulation of hazardous substances at the work place, “wet work” is defined if individuals have their skin exposed to liquids longer than 2 hours per day, or use occlusive gloves longer than 2 hours per day, or clean the hands very often (e.g. 20 times per day or less if the cleaning procedure is more aggressive). Wet work is the most important irritant. The most common causes of occupational ACD are rubber chemicals, plastic chemicals, metals and antimicrobials [29]. Occupational contact dermatitis in metal-workers is mostly caused by irritants even though chromium sensitization and eczema are still a problem in occupational and non-occupational contact dermatitis. Irvine et al. [26] described OCD among 1138 construction workers employed in the Channel Tunnel project: out of 180 patch tested workers with OCD, 53% had a positive reaction to chromate. Potassium dichromate is still the most important allergen in the construction industry of Northern Bavaria; there has been no significant decline during the 1990s [3]. This contrasts with the Scandinavian countries, where the prevalence of potassium dichromate sensitization declined following the reduction of chromium VI levels resulting from the addition of ferrous sulphate to cement. In many occupations, such as hairdressers, there is detailed knowledge about the work related allergens: glycerylmonothioglycolate (GMTG), p-phenylenediamine, ammonium persulfate and tolyldiaminsulfate were the most frequent sensitizers and the most frequent occupationally relevant allergens in this group.

**Atopy and occupational contact dermatitis**

Individuals with a personal history of atopy run a considerable risk of developing hand eczema when exposed to occupational agents [5, 10]. Atopics are at especial risk of developing ICD or immediate allergy e.g. to natural rubber latex in gloves used by health-care personnel, or alpha-amylase in yeast and flours used by bakers, or food proteins in caterers [31, 41]. In bakers, atopic skin diathesis is the most important endogenous risk factor [47]. Assuming different frequency figures of atopic skin diathesis in the general population, the relative risk for atopic subjects to develop occupational contact dermatitis ranges between 4.6 and 18.8. Atopic eczema (AE) in childhood is a risk factor for hand eczema in adults [32, 42]. In a prospective study among 1,564 new employees of an automobile factory, on average 4.4% acquired hand eczema during the first year of employment [30]. The risk was significantly higher in individuals with previous hand eczema (21%), atopic dermatitis (14%), wool intolerance (11%), and hay fever (9%).

Smit et al. [44] followed 74 apprentice hairdressers and 111 apprentice nurses from the start of first occupational exposure until the end of their apprenticeship. The average incidence rate of hand dermatitis was 32.8 cases/100 person-years in hairdressers and 14.5 cases/100 person-years in nurses.

The risk of developing occupational contact dermatitis in hairdressers, nurses and metal-workers was investigated by Funke et al. [19] and Diepgen et al. [11]. In the first year of apprenticeship 68% of the hairdressers developed mild, moderate or severe hand eczema. Atopic skin diathesis, wet work (more than 4 hours daily) and permanent waves (more than 1 hour daily) were the most important, independent risk factors.

In a study of 3730 individuals with a confirmed occupational skin disease, 1366 (37%) had an atopic skin diathesis [10]. Assuming a background risk of atopic skin diathesis of 20% in the total population, an additional 21.6% (95% confidence interval 19.4; 23.7) of cases may be ascribed to this endogenous risk factor. The attributable risk of atopic skin diathesis helped to explain a large proportion of occupational skin diseases. Empirical evidence supports the
importance of surveying atopic skin diathesis as part of an occupational skin disease prevention strategy.

**Prognosis of occupational contact dermatitis**

The prognosis of OCD is poor. The outlook for ACD is worse than for ICD. In one study, around half of the patients had healed after several years of follow-up [25]. Shah et al. [43] reported that most metal-workers remained symptomatic even if they no longer had occupational exposure to metals or oils. Out of 51 patients, 82% still had hand eczema. Some retrospective studies found a better prognosis: In a questionnaire study with a response rate of 68%, out of 201 workers with OCD, 76% noted improvement and 40% reported that they were currently free of any eruption [39]. Approximately one- third noted that their skin disease interfered with household, work, or recreational activities; 37% of this group still had problems with their skin at the time of follow-up. In a Swiss study, 72% out of 88 construction workers with occupational dichromate dermatitis healed in the first few years after declaration of medical inability [34]. These workers mostly changed their job and strictly avoided all contact with cement or chromium salts. Strict allergen avoidance and financial support in the case of job change are important factors in improving the prognosis of OCD.

Among the 1238 patients with hand dermatitis who were identified in a population-based study in Gothenburg, 22% reported five or more medical consultations for their condition [37]. Sick leave due to hand dermatitis was reported by 21%. The mean duration of sick leave was four weeks. Wall and Gebauer [48] followed 954 patients with occupational skin diseases diagnosed between 1980-1987. The period from original diagnosis until review varied from 0.5 to 8 years. 61% reported that they had lost time from work as a result of their skin disease. About 6% had been off work for longer than 12 months continuously.

**Prevention of occupational contact dermatitis**

For human, social, and economic reasons, it would be of great benefit if people exposed to harmful chemicals and products, physical factors and biological agents could be protected from developing occupational skin diseases. A distinction is usually made between primary prevention, i.e. inhibition of the induction and onset of a disease, and secondary prevention, i.e. inhibition of relapses. Tertiary prevention aims at preventing the disease from getting even worse and at enhancing the quality of life. The value of disease prevention to individuals, the community and the medical profession is evident.

Approaches to the prevention of work-related dermatoses are analogous to the prevention of other work-related diseases. In Table 3 the principles and range of prevention measures for OCD are presented. The highest priority should be given to elimination or replacement of harmful exposures to irritants and allergens. Strategies in the prevention of occupational contact dermatitis include identifying allergens and irritants, substituting chemicals that are less irritating or allergenic, establishing engineering controls to reduce exposure, and organizing the work in a way that all employees are exposed to the same degree. Personal protection, for example using gloves, should be one of the last options, but is often selected in the first place. Selection of less susceptible individuals has to be the last measure. Epidemiological studies on the prevention of contact dermatitis in the work environment are needed to prove the effectiveness of preventive measures and interventions [6]. Clinical observations indicate that many personal protective measures do not have the desired effect, but epidemiological evidence for or against is still lacking. Protective gloves, for example, are widely recommended, but may well contribute to increased risk of contact dermatitis: inside gloves the micro-environment is drastically changed and faulty gloves are worse than no gloves at all. In some work processes (machine operation) the use of gloves can even be harmful by causing accidents.

Several studies have shown that a skin care protection program might be helpful in prevention of OCD in wet work [23, 24] and in metal workers [16]. In a metal-working plant, the prevalence of occupationally-related hand eczema was significantly reduced by setting up and providing instruction in a skin protection concept matched to the hazards. The rate of work related hand eczema was reduced from 26% to 8.8% within one year. Emollient creams and ointments used during and after work are also supposed to be effective in preventing contact dermatitis of the irritant type, but more epidemiological studies should be performed. In the population-based register study in Northern Bavaria, a significant decline in the incidence of occupational skin disease among hairdressers could be demonstrated from 1990 to 1999 [8, 9]. This empirical evidence supports a probable “intervention effect” by legislative and preventive measures that came into effect over the last decade for hairdressers.

Scandinavian countries introduced the addition of ferrous sulfate to cement as mandatory to reduce the prevalence of chromate allergy in bricklayers [18]. A historical cohort, studied during the transition to chrome-free cement in Denmark, was reconstructed by Avnstorp [1] from two cross-sectional studies in the same cement factory. The prevalence of chromate allergy in cement workers decreased from 11% to 3% in Denmark [1]. The data of this

<table>
<thead>
<tr>
<th>Table 3. Prevention of occupational contact dermatitis (after Diepgen and Coenraads 2000)</th>
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<tr>
<td>1. Identification of allergens and irritants.</td>
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<tr>
<td>2. Labeling of chemicals; use of material safety data sheets.</td>
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<tr>
<td>3. Elimination or replacement of harmful substances.</td>
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<tr>
<td>4. Technical measures (e.g. encapsulation of the process, automation, efficient ventilation).</td>
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<td>5. Organization (e.g. wet work distributed among all employees).</td>
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<tr>
<td>7. Personal protection (e.g. gloves, barrier creams, after-work creams, soaps, aprons, sleeves, boots, glasses, masks).</td>
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<tr>
<td>8. Training of industrial physicians and nurses, as well as safety engineers.</td>
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<td>9. Pre-employment screening.</td>
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<tr>
<td>10. Information for patients, consumers, workers, supervisors through videos, pamphlets.</td>
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<tr>
<td>11. Research on prevention; dissemination of results obtained.</td>
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</table>
Table 4. Ten key determinants of occupational contact dermatitis

1. Exposure, especially wet work, is the most important determinant of risk.
2. Quantitative techniques of exposures and their association with disease risk are virtually absent.
3. Extremes in the micro-environment (dryness, humidity, occlusion) are important effect modifiers.
4. Atopic skin diathesis is an important endogenous risk factor, or atopic dermatitis is activated by exposure.
5. Dry skin is probably a risk factor, a proxy for atopic dermatitis.
6. An allergic patch test reaction may be of no importance for OCD.
7. Contact allergy is an important risk factor in specific circumstances.
8. Within the time span of employment life, age is not a risk factor.
9. Gender is not a risk factor, but is associated with exposure.
10. There is no other known personal skin characteristic associated with risk.

A study was mostly derived from two different populations and, therefore, the evidence is only indirect. Zachariae et al. [50] confirm that chromium eczema due to occupational cement contact is now a rare disease in a Danish region where the chromate content in wet cement has been reduced to below a level of 2 ppm, but chromium eczema from other causes, particularly from leather is still a problem in the same area. However, chromate allergy seems to have decreased in countries which did not introduce this measure [4] and in Sweden before the change [17]. Key determinants of occupational contact dermatitis are shown in table 4.

References


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