In many skin disorders, the barrier function is compromised. This is particularly important to consider in babies who have an unfavourable ratio between the potential skin area of resorption and the body volume. Higher body concentrations of toxic xenobiotics can accumulate in infants. Another example of higher risk is encountered in some occupational settings where mild abrasions of the skin are common and occupational dermatoses are prevalent. Manipulation of toxic compounds is more risky in these conditions if adequate protection is not maintained.

Conclusion

In many circumstances, environmental xenobiotics pose a threat to the skin and thus to the individual. While the stratum corneum barrier function usually offers a high degree of protection, it can be breached by both physical and chemical damage. The consequences for workers and consumers can be considerable, so that both continuing research and a refined regulatory approach are needed to minimize the social and economic effects of a disturbed interaction between the skin and the environment.

References

1. 7th Amendment of the European Cosmetic Directive: Directive 2003/15/EC of the European Parliament and of the Council of 27 February 2003 amending Council Directive 76/768/EEC on the approximation of the laws of the Member States relating to Cosmetic Products. Official Journal L 66/26, 11.3.2003.
2. Dangerous Preparations Directive (DPD): Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labeling of dangerous products. OJ L200, 30.7.1999.
3. Dangerous Substances Directive (DSD): Council Directive 67/548/EEC of the European Parliament and of the Council of 27 June 1967 on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labeling of dangerous substances. OJ 196, 16.8.1967.
4. The EEC Cosmetic Directive 76/768/EEC, Official Journal L 262, 27.9.1976.

2.4 Occupational skin diseases

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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 cleansers, 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 as well as the total economic impact of OCD are 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.

1. What is occupational skin disease?

The definition of work-related skin disease of the American Medical Association in 1939, "Work-related skin disease is a disease to which occupational exposure is a major causal or contributory factor", is still valid. The terms occupational skin disease and work-related skin disease are often used as synonyms. On the other hand, occupational skin disease is usually defined in the legislation; variable systems to define and compensate occupational skin disease exist in different countries.

In many occupations, the skin is exposed to damaging factors such as chemicals, biological materials and mechanical and physical forces. The sensitivity of the skin to damage and its ability to recover varies from one individual to another. Work-related skin disease develops if the balance between the resistance of the skin and the force of the damaging factors is disturbed. The severity and course of the skin disease is determined by the quality of the skin, the characteristics of the damaging factors and the medical treatment. The damage can range from a brief, burning sensation to a disabling chronic eczema. The clinical picture is a polymorphic pattern of inflammation of the skin characterized by a wide range of clinical features like itching, redness, scaling, erythema, vesiculation, and clustered papulovesicles. In chronic cases, fissuring, hyperkeratosis, and lichenification occur.

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.

2. 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 time 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.

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

• Direct cost of medical care, workers' compensation or disability payments
• Indirect costs associated with lost workdays and loss of productivity
• Costs of occupational retraining
• Costs attributable to the effects on the quality of life

3. 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 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.

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

Author/ Year/Country	Target population/ N	Method of case ascertainment	Outcome	Measures of prevalence	Rate	Comment
Funke et al. 2001 (19) Germany	Apprentices in the car industry N = 2078	Q, I, E	Hand eczema in metalworkers (apprentices) Hand eczema in blue-collar apprentices Hand eczema in white-collar apprentices	1-year 3-years 1-year 3-years 1-year 3-years	9.2% 15.3% 8.8% 14.1% 4.6% 6.9%	Prospective cohort study of high quality, follow-up rate 98.2%
Wallenhammer et al. 2000 (49) Sweden	Dentists N = 3080	Q, E	Hand eczema	1-year	14.9%	Cross-sectional study based on a postal questionnaire, response rate 88%
Paulsen et al. 1998 (40) Denmark	Gardeners and greenhouse workers N = 1958	Q, Patch test	Occupational dermatitis	Lifetime	19.6%	Cross-sectional study based on a postal questionnaire; response rate 84.6%
Gruvberger et al. 2003 (20) Sweden	Metalworkers N = 163	Q, E, patch test	Work-related contact dermatitis	Point	17.2%	Cross-sectional study
Livesley et al. 2002 (35) U.K.	Printing industry N = 1189	Q, E	Skin complaints Current hand problem	Lifetime Point	41.2% 10.7%	Cross-sectional study, response rate 62%
Susitaival et al. 2001 (45) California, USA	Veterinarians N = 1416	Q	Hand/forearm dermatitis	1-year	28%	Cross-sectional study, response rate 73%
Leino et al. 1998 (33) Finland	Hairdressers N = 355 N = 130	I, E, patch test	Hand eczema	Lifetime Point	16.9% 2.8%	Cross-sectional study, response rate 71%, selection bias due to healthy worker effect
Guo et al. 1999 (21) Taiwan	Cement workers N = 1147	I	Work-related skin problems in males and females	1-year men 1-year women	13.9% 5.4%	Cross-sectional study, response rate 68.2%

Q: questionnaire, I: telephone interview, E: clinical examination

4. 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 adaptions 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 are 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.

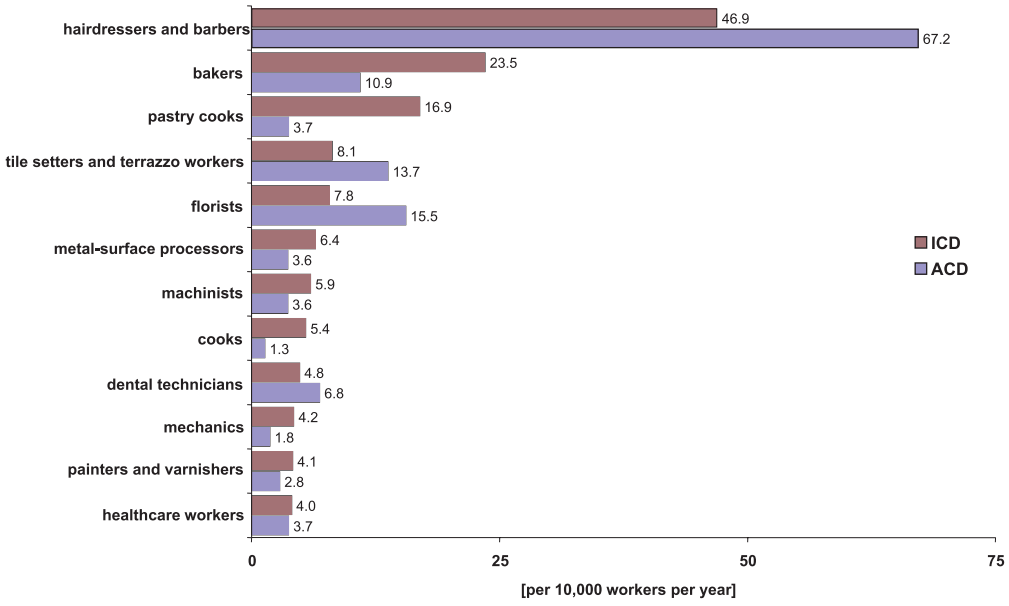

Figure 1 Incidence rates (per 10,000 employees) of irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD) in the 12 occupational groups with the highest risk for occupational skin diseases in North Bavaria (modified according to Diepgen 2003).

Occupational skin diseases account for 34% of all registered occupational diseases in Germany. In Northern Bavaria, a detailed population-based prospective study was performed to classify all cases of occupational skin diseases except skin cancer (3, 7, 8, 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 rank of occupations hazardous for the skin and are 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 metalworkers. 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.

5. 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 cleansers, chemicals, cutting fluids, and abrasives. In a study on hand eczema at least one of those irritants were 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 metalworkers 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-phenylendiamine, ammonium persulfate and toluylendiaminsulfate were the most frequent sensitizers and the most frequent relevant occupational allergens in this group.

6. 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 healthcare 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%).