

Contact allergy in the cleaning industry: analysis of contact allergy surveillance data of the Information Network of Departments of Dermatology

Joanna Liskowsky¹, Johannes Geier² and Andrea Bauer¹

¹Department of Dermatology, University Hospital Carl Gustav Carus, Technical University Dresden, 01307 Dresden, Germany and ²Information Network of Departments of Dermatology (IVDK), University of Göttingen, 37075 Göttingen, Germany

doi:10.1111/j.1600-0536.2011.01937.x

Summary

Background. Occupational contact allergy is a common problem in the cleaning industry.

Objectives. To identify the most frequent occupation-associated allergens and time trends in contact allergy in female cleaners.

Methods. We analysed the patch test data concerning 803 female cleaners, who were evaluated for occupational contact dermatitis in 45 dermatological departments contributing to the Information Network of Departments of Dermatology (IVDK) from 1996 to 2009. Female patients, except cleaners, with occupational dermatitis ($n = 14\,494$) and female controls without occupational dermatitis ($n = 64\,736$) patch tested during this time period formed the control groups.

Results. One hundred and fifty-six (19.4%) cleaners had past or present atopic dermatitis. Six hundred and fifty-five (81.6%) cleaners suffered from occupational hand dermatitis. Allergic contact dermatitis was diagnosed in 249 (31%) of the cleaners. As compared with the control group without occupational dermatitis, female cleaners were significantly more often sensitized to occupationally relevant allergens such as rubber additives, especially thiurams [11.6%, 95% confidence interval (CI) 9.1–14.1 vs. 1.5%, 95% CI 1.4–1.6], zinc diethyldithiocarbamate (3.4%, 95% CI 2.1–4.7 vs. 0.4, 95% CI 0.3–0.4), and mercaptobenzothiazole (1.8, 95% CI 0.7–2.9 vs. 0.5, 95% CI 0.4–0.6), as well as formaldehyde (3.4, 95% CI 2.0–4.7 vs. 1.4%, 95% CI 1.3–1.5). No differences were seen in patterns of sensitization to occupational allergens in younger (≤ 40 years of age) and older (> 40 years of age) female cleaners.

Conclusion. Formaldehyde and rubber additives such as thiurams, zinc diethyldithiocarbamate and mercaptobenzothiazole are occupationally relevant allergens in female cleaners. Prevention strategies are needed to address the problem.

Key words: allergic contact dermatitis; cleaning industry; disinfectants; formaldehyde; mercaptobenzothiazole; patch testing; rubber ingredients; thiurams; zinc diethyldithiocarbamate.

Hand dermatitis is a major problem in the cleaning industry, and is reported to be present in 10–21% of

employees (1–6). The main risk factors, besides individual susceptibility, are wet work, including frequent contact with water and detergents, and the need to use occlusive gloves for long periods of time during cleaning. Jungbauer et al. give an excellent overview on exposure in cleaning. In all, 50% of working time in cleaning was spent in wet work. During a 3-hr observation period, approximately 70 wet work episodes occurred. Moreover, the skin was occluded by protective gloves for more than one-third of the time. However, cleaning personnel also

Correspondence: Andrea Bauer, Department of Dermatology, University Hospital Carl Gustav Carus, Technical University Dresden, Fetscherstr. 74, 01307 Dresden, Germany. Tel: +49-351-45812131; Fax: +49-351-4584228. E-mail: andrea.bauer@uniklinikum-dresden.de

Conflicts of interest: The authors have declared no conflicts.

Accepted for publication 18 April 2011

had direct skin contact with bathroom, furniture and kitchen cleaning agents (7). Irritant contact dermatitis is the major problem, but allergic contact dermatitis is reported in 21–32% of cases (1–3, 8). In several studies from the 1980s and 1990s, occupationally related sensitizations were reported to metal allergens, rubber chemicals, fragrances, and disinfectants (1–3, 6, 8, 9).

No recent data on sensitization rates and sensitization profiles, or time trends, for contact allergy in the cleaning industry are available. In order to give an update on the most frequent allergens causing allergic contact dermatitis in female cleaners, and to identify influencing factors and time trends, we analysed the data of the Information Network of Departments of Dermatology (IVDK; www.ivdk.org).

Patients and Methods

The IVDK is a cooperative study group of dermatological centres in German-speaking countries (Germany, Austria, and Switzerland) interested in epidemiological research in contact allergy. All of them are members of the German Contact Dermatitis Research Group [Deutsche Kontaktallergie-Gruppe (DKG)]. The organization, methods for data collection and processing, quality control, etc. of the IVDK are described elsewhere (10–15).

For the present analysis, data from 1996 to 2009, obtained from 61 IVDK patch test clinics, were analysed. The study group comprised 803 female cleaners patch tested for investigation of occupational contact dermatitis. To allow a comparison of frequencies of sensitization to allergens of the baseline series, two control groups were selected, consisting of: group I; female patients except cleaners with occupational dermatitis ($n = 14\,494$) and group II; all other female patients without occupational dermatitis ($n = 64\,736$) patch tested during the study period. Male cleaners were not considered, owing to the low numbers of males within the group of cleaners with occupational dermatitis ($n = 68$, i.e. 7.8% of 871).

The DKG baseline series was tested in 754 patients (94% of the study population). The DKG rubber chemical series was tested in 523 patients (65%), the ointment base series in 350 patients (44%), the disinfectants series in 507 patients (63%), and the preservative series in 344 patients (43%). Additional test series and specific allergens were tested according to the patient's history. Patch test chambers were applied for 24 hr in 197 patients (25%), and for 48 hr in 606 patients (75%). Patch test substances were mainly obtained from Hermal (Reinbek, Germany). Tests were performed and read according to international recommendations (16), further refined by the DKG (17). For this analysis, readings on day 3 (72 hr) were

considered; in a minority of cases, when no reading was performed on day 3, reactions on day 4 were taken for data analysis. For characterization of the test population and the control groups, the MOAHLFA index was used (15).

For comparison of proportions in the different groups of patients, Fisher's exact test or the chi-square test were used, where appropriate. Age-standardized sensitization rates and 95% confidence intervals (CIs) of the sensitization rates were calculated. Stratified analysis was performed in female cleaners with occupational dermatitis for the age groups younger than 40 years ($n = 221$; 27.5%) and 40 years or older ($n = 582$; 72.5%) as compared with females without occupational dermatitis (control group II) of the respective age groups below 40 years ($n = 18\,648$; 28.8%) and 40 years or older ($n = 46\,088$; 71.2%). A p -value below 0.05 was considered to indicate significance. For comparability, patch test data were standardized by age following the recommendations on population-adjusted frequency of sensitization (14, 15), where appropriate. Data analysis was performed with SAS[®] software (Version 9.1; SAS Institute, Cary, NC, USA) at the IVDK headquarters.

Results

MOAHLFA index

The demographic profile (MOAHLFA index) of the test population and the control group is listed in Table 1. Owing to the selection criterion of occupational dermatitis, hand dermatitis frequencies differed significantly between female cleaners and the control group II without occupational dermatitis ($p < 0.0001$). Furthermore, these two groups differed significantly in the proportions

Table 1. Population characteristics of female cleaners and controls (MOAHLFA index) (15)

	Female cleaners with occupational dermatitis ($n = 803$) n (%)	Females (without cleaners) with occupational dermatitis ($n = 14\,494$) n (%)	Female controls without occupational dermatitis ($n = 64\,736$) n (%)
Male (M)	0 (0)*	0 (0)*	0 (0)*
Occupational (O)dermatitis	803 (100)*	14 494 (100)*	0 (0)*
Atopic dermatitis (A)	156 (19.4)	4166 (28.7)	11 383 (17.6)
Hand dermatitis (H)	655 (81.6)	11 780 (81.3)	8750 (13.5)
Leg dermatitis (L)	4 (0.5)	80 (0.6)	8479 (13.1)
Face dermatitis (F)	29 (3.6)	968 (6.7)	13 675 (21.1)
Age 40+ years (A)	582 (72.5)	5547 (38.3)	46 088 (71.2)

*Owing to study group/control group definition.

of leg ($p < 0.0001$) and face ($p < 0.0001$) dermatitis. The age distribution was significantly ($p < 0.0001$) different in the study group and control group I (female non-cleaners with occupational dermatitis): in the study group, 207 patients (26%) were between 20 and 39 years of age, and 551 patients (69%) were between 40 and 59 years of age; in control group I, the relative figures were 53% (7634 patients) and 35% (5102 patients), respectively.

Reaction frequencies

Five hundred and twenty-three (65%) of 803 patients reacted positively to at least one allergen. One hundred and eighty-two (23%) reacted to one allergen, 130 (16%) reacted to two allergens, 71 (9%) reacted to three allergens, and 140 (17%) reacted to four or more allergens.

Final diagnosis and patch test results

Irritant contact dermatitis ($n = 287$; 36%) was the most common diagnosis in female cleaners patch tested for suspected occupational contact allergy, followed by allergic contact dermatitis ($n = 249$; 31%). Further diagnoses were atopic dermatitis ($n = 61$; 8%), hyperkeratotic dermatitis ($n = 29$; 4%), vesicular (dyshidrotic) dermatitis ($n = 41$; 5%), nummular dermatitis ($n = 7$; 1%), and other dermatoses ($n = 129$; 16%).

Table 2 shows the standardized sensitization rates and 95% CIs for the most frequent allergens in female cleaners as compared with both control groups. For the baseline series allergens, a selection bias by patch test indication can largely be excluded, as the baseline series was tested in more than 90% of the patients of both the study and the control groups. Hence, in contrast to selectively tested allergens, a valid comparison of age-standardized reaction frequencies is possible. Allergens tested in less than 90% of the test population are marked with an asterisk.

As compared with control group II (female patients without occupational dermatitis), female cleaners were significantly more often sensitized to commonly occupationally relevant allergens such as rubber additives, especially thiurams (11.6%, 95% CI 9.1–14.1 vs. 1.5%, 95% CI 1.4–1.6), zinc diethyldithiocarbamate (3.4%, 95% CI 2.1–4.7 vs. 0.4, 95% CI 0.3–0.4), and mercaptobenzothiazole (1.8, 95% CI 0.7–2.9 vs. 0.5, 95% CI 0.4–0.6), as well as formaldehyde (3.4, 95% CI 2.0–4.7 vs. 1.4%, 95% CI 1.3–1.5).

Furthermore, higher sensitization rates were found for nickel sulfate (28.2%, 95% CI 24.5–31.9% vs. 22.4%,

95% CI 22.0–22.7%) and *N*-isopropyl-*N'*-phenyl-*p*-phenylenediamine (1.9%, 95% CI 0.8–3.0 vs. 0.5%, 95% CI 0.5–0.6).

Concerning other disinfectants such as glutaraldehyde (CAS 111-30-8; glutardialdehyde) (2.8% vs. 0.7%), glyoxal (3.7% vs. 0.8%), and benzalkonium chloride (3.5% vs. 0.9%), sensitization rates were higher in cleaners than in controls without occupational dermatitis. Comparisons between groups concerning these allergens must be performed with caution, because of selective testing (allergens were tested in less than 90% of the test population), which might have introduced bias (Table 2).

As expected, differences in sensitization rates between female cleaners and controls from other occupations, suffering from occupational hand dermatitis, were less pronounced. Female cleaners showed significantly higher rates of sensitization to thiurams than controls from other occupations with occupational dermatitis (11.6%, 95% CI 9.1–14.1 vs. 8.2%, 95% CI 7.7–8.7). However, sensitization to glutaraldehyde was more common in controls with occupational hand dermatitis than in cleaners (4.8%, 95% CI 4.3–5.3 vs. 2.8%, 95% CI 1.3–4.2).

Generally (in most allergens), reaction frequencies among women without occupational dermatitis were lower than among the two groups of women with occupational dermatitis. This points to less aimed patch testing (more liberal indication for patch testing) in women without occupational dermatitis. This is also reflected by the lower proportion of patients with at least one positive patch test reaction in this group (53%, as compared with 65% in the study group).

No significant differences for the above-mentioned commonly occupationally relevant allergens were seen in the sensitization pattern in younger (≤ 40 years of age) vs. older female cleaners (> 40 years of age). Female cleaners > 40 years of age were significantly less sensitized to nickel sulfate than younger cleaners (21.7%, 95% CI 18.3–25.5 vs. 34.8%, 95% CI 28.3–41.8). Frequencies of reactions to all other allergens, where valid comparisons were possible, did not differ significantly between the groups (data not shown).

Discussion

Our study provides a comprehensive overview of patch test data for employees in the cleaning industry. On analysis of this large group of cleaners in comparison with controls, rubber chemicals and disinfectants appeared to be the most frequent causes of occupationally relevant allergic reactions. Our findings are highly relevant, as allergic contact dermatitis is a prominent problem in the cleaning industry.

Table 2. Most frequent allergens among female cleaners with occupational dermatitis (n = 803) as compared with females (without cleaners) with occupational dermatitis (n = 14 494) and female controls without occupational dermatitis (n = 64 736). Information Network of Departments of Dermatology 1996–2009

Allergen	Female cleaners with occupational dermatitis				Females (without cleaners) with occupational dermatitis				Female controls without occupational dermatitis			
	No. tested	No. positive	Std. % positive	95% CI	No. tested	No. positive	Std. % positive	95% CI	No. tested	No. positive	Std. % positive	95% CI
<i>Nickel(II) sulfate</i>	734	185	28.2	24.5–31.9	12 843	3894	29.1	28.3–29.9	58 944	11 258	22.4	22.0–22.7
<i>Thiuram mix</i>	747	90	11.6	9.1–14.1	13 040	1003	8.2	7.7–8.7	59 057	975	1.5	1.4–1.6
<i>Tetraethylthiuram disulfide*</i>	514	52	9.8	6.9–12.6	7313	594	8.4	7.8–9.1	7627	215	2.6	2.3–3.0
<i>Fragrance mix I</i>	743	65	9.3	6.9–11.7	12 972	1399	11.5	10.9–12.0	58 969	6040	9.3	9.1–9.6
<i>Thimerosal*</i>	403	30	8.8	5.6–11.9	7770	823	9.3	8.7–9.9	31 502	2084	8.2	7.8–8.5
<i>Cobalt(II) chloride</i>	750	54	7.9	5.7–10.2	12 983	1332	10.1	9.6–10.7	59 186	3706	7.1	6.8–7.3
<i>Povidone iodine*</i>	522	47	7.8	5.3–10.2	5659	415	7.8	7.1–8.6	8659	645	6.5	6.0–7.1
<i>Tetramethylthiuram monosulfide*</i>	514	38	7.8	5.2–10.5	7343	496	7.0	6.4–7.6	7635	197	2.5	2.1–2.9
<i>Myroxylon pereirae</i>	748	55	7.6	5.5–9.8	13 104	827	7.1	6.6–7.5	58 938	5835	8.3	8.1–8.5
<i>p-Phenylenediamine*</i>	504	29	6.5	4.0–8.9	9524	814	8.3	7.7–8.9	38 255	1605	4.1	3.9–4.4
<i>Colophonium</i>	750	43	5.8	3.9–7.6	13 104	665	5.4	5.0–5.8	59 020	2716	4.4	4.2–4.6
<i>Potassium dichromate</i>	746	41	5.4	3.6–7.3	13 097	673	5.5	5.1–6.0	59 295	2515	4.1	3.9–4.3
<i>Methyldibromo glutaronitrile</i>	484	28	5.4	3.2–7.6	8111	386	5.2	4.7–5.7	36 907	1512	3.6	3.4–3.8
<i>Tetramethylthiuram disulfide*</i>	514	27	5.3	3.2–7.5	7325	379	5.3	4.8–5.9	7634	141	1.7	1.4–2.1
<i>Compositae mix</i>	309	10	4.2	1.2–7.2	4008	159	4.2	3.5–4.8	24 981	683	2.4	2.2–2.6
<i>Methyldibromo glutaronitrile/2-phenoxethanol</i>	468	21	4.2	2.3–6.1	8825	348	4.6	4.1–5.1	35 455	1250	3.2	3.0–3.4
<i>Glyoxal trimer (dihydrate)*</i>	440	20	3.7	1.8–5.5	4110	87	2.1	1.7–2.6	7708	54	0.8	0.5–1.0
<i>Benzalkonium chloride*</i>	581	18	3.5	1.7–5.3	8339	155	1.8	1.5–2.1	24 741	248	0.9	0.8–1.1
<i>Zinc diethyldithiocarbamate</i>	747	30	3.4	2.1–4.7	12 230	236	2.1	1.8–2.3	58 613	245	0.4	0.3–0.4
<i>Formaldehyde</i>	754	27	3.4	2.0–4.7	13 162	421	3.3	3.0–3.7	59 060	798	1.4	1.3–1.5
<i>Fragrance mix II</i>	283	12	3.3	1.2–5.4	4162	293	7.1	6.3–7.9	23 136	1169	4.7	4.4–5.0
<i>Dipentamethylthiuram disulfide*</i>	514	14	3.1	1.4–4.9	7341	286	4.1	3.6–4.5	7633	123	1.5	1.2–1.8
<i>Glutaraldehyde*</i>	589	17	2.8	1.3–4.2	7312	348	4.8	4.3–5.3	14 786	98	0.7	0.6–0.9
<i>Morpholinyl mercaptobenzothiazole*</i>	514	14	2.7	1.2–4.3	7364	129	1.9	1.5–2.2	7631	94	1.4	1.1–1.7
<i>t-Butylhydroquinone*</i>	555	12	2.7	1.1–4.4	8727	147	1.8	1.5–2.1	39 547	962	2.1	1.9–2.2
<i>1,3-Diphenyl guanidine*</i>	529	12	2.6	1.0–4.2	7688	123	1.6	1.3–1.9	10 774	260	2.2	1.9–2.5
<i>Lanolin (wool alcohols)</i>	750	18	2.4	1.2–3.6	13 134	293	2.3	2.0–2.6	58 964	2410	3.7	3.5–3.8
<i>Propolis</i>	670	14	2.3	1.0–3.7	9895	212	2.3	2.0–2.6	52 108	1399	2.4	2.3–2.6
<i>Amerchol® L-101*</i>	559	13	2.2	0.9–3.6	8549	255	3.0	2.7–3.4	39 888	2265	5.1	4.8–5.3
<i>N-Cyclohexyl-2-benzothiazyl sulfenamide*</i>	514	10	2.2	0.7–3.7	7399	105	1.5	1.2–1.8	7616	74	1.1	0.8–1.4
<i>Hydroxyisohexyl 3-cyclohexene carboxaldehyde</i>	485	13	2.1	0.8–3.3	6583	273	4.3	3.8–4.8	38 570	914	2.4	2.2–2.6
<i>Propylene glycol*</i>	563	10	2.1	0.6–3.5	9169	154	1.7	1.4–2.0	40 036	793	1.9	1.7–2.0
<i>Oil of turpentine</i>	744	17	2.0	1.0–3.1	12 837	270	2.3	2.0–2.6	58 925	1429	2.3	2.1–2.4
<i>Mecaptobenzothiazole</i>	692	13	2.0	0.8–3.2	11 201	149	1.4	1.2–1.7	45 984	219	0.5	0.4–0.6
<i>IPPD</i>	746	14	1.9	0.8–3.0	12 809	150	1.3	1.0–1.5	58 631	327	0.5	0.5–0.6

CI, confidence interval; IPPD, N-isopropyl-N'-phenyl-p-phenylenediamine; Std., age-standardized frequencies of sensitization.

Because not every patient was tested with the same set of allergens, the actual number of patients exposed to the different allergens varies. Allergens showing significant differences between cleaners with occupational dermatitis and female controls without occupational dermatitis are printed in italics. * Comparison might be biased, owing to selective testing.

Rubber chemicals

Type IV allergies to rubber chemicals continue to be a prominent occupational health problem. The most common allergen sources in wet work occupations are occupationally used gloves (18). The most common sensitizers in gloves are accelerators such as thiurams, dithiocarbamates, and mercaptobenzothiazole derivatives (18, 19). Relevant concentrations of rubber chemicals residues were shown to remain in natural and synthetic rubber gloves after vulcanization (20).

In industrial cleaning, protective gloves are used over long periods of time during working hours, and there is therefore prolonged skin contact with rubber chemicals (6, 21). Thick, reusable loose-fitting cotton-lined gloves are commonly recommended for skin protection in cleaning to prevent contact with aggressive cleaning products, surface disinfectants, and water. In a study by Knudsen et al. in 1993, reusable gloves were shown to release lower amounts of rubber chemicals than single-use medical gloves (20). However, many cleaners are supplied only with single-use medical gloves, which contain higher amounts of rubber chemical residues, and also lead to intensive skin contact with the allergens, owing to their tight fit. This complex situation might explain the constantly high rates of sensitization to rubber chemicals in many cleaners over recent decades (18). In our study population, 11.6% of female cleaners were sensitized to thiurams (thiuram mix), 3.4% to zinc diethyldithiocarbamate, and 2.0% to mercaptobenzothiazole. Female cleaners had a significantly higher risk of acquiring sensitization to thiurams, zinc diethyldithiocarbamate and mercaptobenzothiazole than controls without occupational dermatitis. These data are in accordance with the findings of Uter et al., who reported a 3.09-fold elevated risk for cleaners of acquiring sensitization to thiurams and no significant reduction of the sensitization rates since 1992 (18). In line with these data, we did not see significant differences in rubber chemical sensitization in cleaners <40 years of age as compared with cleaners 40 years of age and older. From these data, it would appear that exposure to rubber chemicals has not changed substantially over time and gloves containing high amounts of accelerator residues are still used in cleaning. Regulations on glove quality, which have been in place in healthcare for many years, have been shown to markedly reduce the rates of sensitization to rubber chemicals in healthcare personnel in different countries (18, 22–24), and should therefore also work in the cleaning industry. Preventive strategies would need to focus on the provision of improved quality, thiuram-free, reusable cotton-lined gloves to reduce allergen exposure.

Preservatives and disinfectants

Cleaning agents for occupational and non-occupational household use often contain preservatives and disinfectants (25–30). Like rubber chemicals, preservatives and disinfectants are common causes of allergic contact dermatitis in different occupational and non-occupational settings (31–35). As with other employees in wet work occupations, such as healthcare workers and food industry workers, cleaners are prone to sensitization, owing to daily skin contact with different floor and surface cleaners as well as surface disinfectants (6, 33, 34). In our study population, formaldehyde was the most common occupationally relevant sensitizer: 3.4% of female cleaners were sensitized, as compared with 1.4% of controls without occupational dermatitis. Other relevant allergens were glyoxal (3.7%), benzalkonium chloride (3.5%), and glutaraldehyde (2.8%). Rates of contact sensitization to formaldehyde and glyoxal in cleaning resembled those in healthcare workers, probably because of similar exposure (33). From a former IVDK study on occupational sensitization with more detailed documentation of occupational exposure, we know that, among cleaners with occupational dermatitis registered in the IVDK, a high proportion work in hospitals. Moreover, hospital cleaners might be more likely to seek dermatological advice than others, because access to it seems to be easier for this group of cleaners. Therefore, increased frequencies of sensitization to formaldehyde, glyoxal, benzalkonium chloride and glutaraldehyde in cleaners are plausible. In non-cleaners with occupational dermatitis, sensitization to formaldehyde and glutaraldehyde was observed equally or even more frequently than in cleaners with occupational dermatitis. This is probably because of the significant proportion of medical professionals such as nurses and technical assistants in this group (33). High sensitization rates might result from the fact that employees in healthcare, as in cleaning, often use medical examination gloves for single use (material thickness approximately 0.1–0.18 mm), not only for patient care, but also for cleaning and disinfection. These gloves are certified according to European standard EN 455 1-3 or EN 374-1, and are therefore suitable only for protection against infections, and are not resistant to chemicals (36). Quality tests for these gloves do not include tests for chemical and mechanical resistance. Glutaraldehyde and formaldehyde are able to break through gloves made from natural rubber within a few minutes up to hours, depending on the material thickness (37–39). In a recent study on glutaraldehyde-induced and formaldehyde-induced allergic contact dermatitis in dental hygienists and dental assistants, all glutaraldehyde-sensitized subjects had worn either single-use rubber latex or vinyl gloves

for both patient care and disinfection procedures (40). Mäkalä et al. showed that even surgical gloves, which appear to be made from thicker materials (0.17–0.3 mm) than medical examination gloves, showed breakthrough times for formaldehyde of between 17 and 67 min when tested according to the American standard ASTM (39). Material safety data sheets for formaldehyde, glyoxal, glutaraldehyde, quaternary ammonium compounds and polymethylurea derivatives containing disinfectants recommend the use of gloves made from nitrile (0.4 mm), chloroprene (0.5 mm), fluorinated rubber (0.7 mm), or butyl rubber (0.5 mm) (41, 42). Prevention strategies should aim at persuading employees to use the above-mentioned chemical-resistant, protective gloves for these purposes.

As for rubber chemicals, there were no differences in rates of sensitization to preservatives/disinfectants between cleaners <40 years of age and cleaners 40 years of age and older, indicating that exposure to those allergens had not changed over time. In particular, the persistent high rates of sensitization to formaldehyde in cleaners might be explained by the frequent use of formaldehyde-releasing preservatives in cleaning agents (26–28).

Other allergens

Nickel is the most common contact allergen. Commonly, nickel is a non-occupational allergen. However, our data indicate that female cleaners (28.2%) and female controls with occupational dermatitis (29.1%), independently of their occupation, had significantly higher rates of nickel sensitization than women without occupational dermatitis (22.4%). In different studies, an association between nickel contact allergy and hand dermatitis was assumed (43, 44). Especially for female patients suffering from atopic dermatitis and nickel allergy, a pronounced increase in the risk of developing hand dermatitis was suspected (45). Recent data of a population-based study in 30–40-year-old females from Sweden could not confirm this association. No significant differences were shown between nickel-positive and nickel-negative women concerning the occurrence of hand dermatitis. The authors conclude that the association between nickel sensitization and hand dermatitis might have been overestimated during the last decades (46). However, in a recently published small study, Jensen et al. showed that nickel contamination of the hands in 6 patients with vesicular hand dermatitis was higher than expected (47). Thus, it seems possible that low-grade nickel exposure may have contributed to the development of occupational hand dermatitis in our patients with current occupational dermatitis and previously acquired nickel sensitization,

leading to a higher proportion of nickel allergy in these groups. Age-dependent differences in nickel sensitization rates in cleaners <40 years of age as compared with cleaners >40 years of age mirrored the picture in the female population (48–50).

Conclusions

Female cleaners seem to have a higher risk of developing occupationally relevant sensitizations to rubber chemicals and active ingredients in disinfectants. No time trend in sensitization pattern was found. The presented results indicate that exposure had not changed substantially, or prevention strategies been effective so far. Our findings may help in the elimination of relevant allergens from the workplace and in the development of targeted primary and secondary prevention strategies.

Acknowledgements

The following departments of dermatology and members of the IVDK contributed to this study (centres in alphabetical order; responsible physicians).

Aachen (H. Dickel, S. Erdmann, C. Schröder, J. M. Baron), Augsburg (A. Ludwig), Basel (A. Bircher), Berlin B.-Frank. (B. Tebbe, R. Treudler), Berlin Charité (B. Laubstein, T. Zuberbier, M. Worm), Berlin UKRV (T. Zuberbier), Bern (D. Simon), Bielefeld (I. Effendy), Bochum (Ch. Szliska, M. Straube, H. Dickel), Bochum BGFA (M. Fartasch), Buxtehude (P. Große-Hüttmann, P. Hausenblas), Dermatologikum (K. Reich, V. Martin), Dessau (U. Lippert, A. Jung), Dortmund (B. Pilz, P. J. Frosch, C. Pirker, R. Herbst, K. Kügler), Dresden (G. Richter, R. Aschoff, P. Spornraft-Ragaller, A. Bauer), Duisburg (J. Schaller), Erlangen (K.-P. Peters, T. L. Diepgen, M. Fartasch, M. Hertl, V. Mahler), Essen (H.-M. Ockenfels, U. Hillen), Falkenstein (H. Schwantes), Freudenberg (Ch. Szliska), Gera (J. Meyer, H. Grunwald-Delitz), Graz (B. Kränke, W. Aberer), Greifswald (M. Jünger), Göttingen (Th. Fuchs, J. Geier), Halle (G. Gaber, D. Lübke, B. Kreft), Hamburg (D. Vieluf, M. Kiehn, R. Weißbecher, E. Coors), Hamburg BUK (K. Breuer, U. Seemann, C. Schröder-Kraft), Hannover (T. Schaefer, Th. Werfel), Heidelberg (A. Schulze-Dirks, M. Hartmann, U. Jappe, K. Schäkel), Heidelberg AKS (H. Dickel, T. L. Diepgen, E. Weisshaar), Heilbronn (H. Löffler), Heise Rostock [H. Heise (†)], Homburg/Saar (P. Koch, C. Pföhler), Jena (M. Gebhardt, A. Bauer, W. Wigger-Alberti, M. Kaatz, S. Schliemann), Kiel (J. Brasch), Krefeld (A. Wallerand, M. Lilie, S. Wassilew), Leipzig (R. Treudler), Lippe Detmold (St. Nestoris), Lübeck (J. Kreusch, J. Grabbe, I. Shimanovich), Magdeburg (R. Vetter), Mainz (D. Becker), Mannheim (Ch. Bayerl, H. Kurzen, D. Booken, C.-D. Klemke), Marburg (I. Effendy, H. Löffler, M. Hertl, W. Pfützner), Minden (R. Stadler), München LMU

(T. Oppel, B. Przybilla, P. Thomas, T. Schuh, R. Eben), München Schwabing (M. Agathos, K. Ramrath, M. Georgi, G. Isbary), München TU (J. Rakoski, U. Darsow), Münster (B. Hellweg, R. Brehler), Nürnberg (I. Müller, D. Debus, A. Bachtler), Osnabrück [W. Uter, S. M. John, H. J. Schwanitz (†), N. Schürer, H. Dickel, Ch. Skudlik], Rostock [H. Heise (†), Ch. Schmitz, M. A. Ebisch, J.

Trcka], Stuttgart (T. Plaza, G. Nist), Tübingen (G. Lischka, M. Röcken, T. Biedermann, J. Fischer), Ulm [H. Gall (†), G. Staib, P. Gottlöber], Ulm BWK (H. Pillekamp), Ulm Univ.-Klinik (G. Staib, R. Hinrichs, J. Weiss), Wuppertal (O. Mainusch, J. Raguz), Würzburg (J. Arnold, A. Trautmann), Zwickau (B. Knopf, D. Teubner), Zürich (B. Ballmer-Weber).

References

- Hansen K S. Occupational dermatoses in hospital cleaning women. *Contact Dermatitis* 1983; **9**: 343–351.
- Lammintausta K, Kalimö K, Havu V K. Occurrence of contact allergy and hand eczemas in hospital wet work. *Contact Dermatitis* 1982; **8**: 84–90.
- Lammintausta K. Hand dermatitis in different hospital workers, who perform wet work. *Derm Beruf Umwelt* 1983; **31**: 14–19.
- Gawkroder D J, Lloyd M H, Hunter J A. Occupational skin disease in hospital cleaning and kitchen workers. *Contact Dermatitis* 1986; **15**: 132–135.
- Nielsen J. The occurrence and course of skin symptoms on the hands among female cleaners. *Contact Dermatitis* 1996; **34**: 284–291.
- Stingeni L, Lapomarda V, Lisi P. Occupational hand dermatitis in hospital environments. *Contact Dermatitis* 1995; **33**: 172–176.
- Jungbauer F H, Van Der Harst J J, Schuttelaar M L, Groothoff J W, Coenraads P J. Characteristics of wet work in the cleaning industry. *Contact Dermatitis* 2004; **51**: 131–134.
- Singih S I, Lantinga H, Nater J P, Woest T E, Kruyt-Gaspersz J A. Occupational hand dermatoses in hospital cleaning personnel. *Contact Dermatitis* 1986; **14**: 14–19.
- Darsow U, Geier J, Struppek K, Rakoski J, Ring J. Kontaktallergien bei raumpflegerinnen. *Derm Beruf Umwelt* 1997; **45**: 221–225.
- Uter W, Mackiewicz M, Schnuch A, Geier J. Interne qualitätssicherung von epikutantest-daten des multizentrischen Projektes 'Informationsverbund Dermatologischer Kliniken' (IVDK). *Derm Beruf Umwelt* 2005; **53**: 107–114.
- Uter W, Schnuch A, Gefeller O. Guidelines for the descriptive presentation and statistical analysis of contact allergy data. *Contact Dermatitis* 2004; **51**: 47–56.
- Uter W, Schnuch A, Geier J, Frosch P J. Epidemiology of contact dermatitis. The Information Network of Departments of Dermatology (IVDK) in Germany. *Eur J Dermatol* 1998; **8**: 36–40.
- Schnuch A. Der IVDK – eine kurze synopsis. *Aktuelle Derm* 2009; **35**: 94–98.
- Schnuch A. PAFS: population-adjusted frequency of sensitization (I). Influence of sex and age. *Contact Dermatitis* 1996; **34**: 377–382.
- Schnuch A, Geier J, Uter W et al. National rates and regional differences in sensitization to allergens of the standard series. Population-adjusted frequencies of sensitization (PAFS) in 40.000 patients from a multicenter study (IVDK). *Contact Dermatitis* 1997; **37**: 200–209.
- Wahlberg J E, Lindberg M. Patch testing. In: *Contact Dermatitis*, 4th edition. Frosch P J, Menne T, Lepoittevin J P (eds): Berlin, Heidelberg, Springer-Verlag, 2006: pp. 365–390.
- Schnuch A, Aberer W, Agathos M et al. Performing patch testing with contact allergens. *J Dtsch Dermatol Ges* 2008; **6**: 770–775.
- Uter W, Hegewald J, Pfahlerberg A, Lessmann H, Schnuch A, Gefeller O. Contact allergy to thiurams: multifactorial analysis of clinical surveillance data collected by the IVDK network. *Int Arch Occup Environ Health* 2010; **83**: 675–681.
- Geier J, Lessmann H, Uter W, Schnuch A. Occupational rubber glove allergy: results of the Information Network of Departments of Dermatology (IVDK), 1995–2001. *Contact Dermatitis* 2003; **48**: 39–44.
- Knudsen B B, Larsen E, Egsgaard H, Menné T. Release of thiurams and carbamates from rubber gloves. *Contact Dermatitis* 1993; **28**: 63–69.
- Lopes R A, Benatti M C, Zollner R de L. A review of latex sensitivity related to the use of latex gloves in hospitals. *AORN J* 2004; **80**: 64–71.
- Gibbon K L, McFadden J P, Rycroft R J, Ross J S, Chinn S, White I R. Changing frequency of thiuram allergy in healthcare workers with hand dermatitis. *Br J Dermatol* 2001; **144**: 347–350.
- Bhargava K, White I R, White J M. Thiuram patch test positivity 1980–2006: incidence is now falling. *Contact Dermatitis* 2009; **60**: 222–223.
- Knudsen B, Lerbaek A, Johansen J D, Menné T. Reduction in the frequency of sensitization to thiurams. A result of legislation? *Contact Dermatitis* 2006; **54**: 170–171.
- Kleinhans D, Dayss U. Formaldehyde contact allergy. *Derm Beruf Umwelt* 1980; **28**: 101–103.
- Flyvholm M A. Contact allergens in registered cleaning agents for industrial and household use. *Br J Ind Med* 1993; **50**: 1043–1050.
- Flyvholm M A, Andersen P. Identification of formaldehyde releasers and occurrence of formaldehyde and formaldehyde releasers in registered chemical products. *Am J Ind Med* 1993; **24**: 533–552.
- Flyvholm M A. Preservatives in registered chemical products. *Contact Dermatitis* 2005; **53**: 27–32.
- Magnano M, Silvani S, Vincenzi C, Nino M, Tosti A. Contact allergens and irritants in household washing and cleaning products. *Contact Dermatitis* 2009; **61**: 337–341.
- de Groot A C, Flyvholm M A, Lensen G, Menné T, Coenraads P J. Formaldehyde-releasers: relationship to formaldehyde contact allergy. Contact allergy to formaldehyde and inventory of formaldehyde-releasers. *Contact Dermatitis* 2009; **61**: 63–85.
- Rietschel R L, Mathias C G, Fowler J F Jr et al., North American Contact Dermatitis Group. Relationship of occupation to contact dermatitis: evaluation in patients tested from 1998 to 2000. *Am J Contact Dermat* 2002; **13**: 170–176.
- Geier J, Lessmann H, Schnuch A, Uter W. Contact sensitizations in metalworkers with occupational dermatitis exposed to water-based metalworking fluids: results of the research project 'FaSt'. *Int Arch Occup Environ Health* 2004; **77**: 543–551.
- Schnuch A, Uter W, Geier J, Frosch P J, Rustemeyer T. Contact allergies in healthcare workers. Results from the IVDK. *Acta Derm Venereol* 1998; **78**: 358–363.

- 34 Bauer A, Geier J, Elsner P. Type IV allergy in the food processing industry: sensitization profiles in bakers, cooks and butchers. *Contact Dermatitis* 2002; **46**: 228–235.
- 35 Wilkinson J D, Shaw S, Andersen K E et al. Monitoring levels of preservative sensitivity in Europe. A 10-year overview (1991–2000). *Contact Dermatitis* 2002; **46**: 207–210.
- 36 Standard: DIN EN 374-3, 2003-12. *Protective Gloves Against Chemicals and Micro-organisms – Part 3: Determination of Resistance to Permeation by Chemicals*, German version EN 374-3, 2003.
- 37 Lehman P A, Franz T J, Guin J D. Penetration of glutaraldehyde through glove material: tactylon versus natural rubber latex. *Contact Dermatitis* 1994; **30**: 176–177.
- 38 Mäkelä E A, Vainiotalo S, Peltonen K. The permeability of surgical gloves to seven chemicals commonly used in hospitals. *Ann Occup Hyg* 2003; **47**: 313–323.
- 39 Carl Roth GmbH+Co. Beständigkeit von chemikalienschutz-handschuhen. Katalog labor- und chemikalienbedarf, 2010: p. 438. Available at: <http://www.carlroth.com/website/de-de/sdpdf/artikel.pdf> (last accessed 1 February 2011).
- 40 Ravis S M, Shaffer M P, Shaffer C L, Dehkhaghani S, Belsito D V. Glutaraldehyde-induced and formaldehyde-induced allergic contact dermatitis among dental hygienists and assistants. *J Am Dent Assoc* 2003; **134**: 1072–1078.
- 41 GisChem Sicherheitsdatenblatt. Desinfektionsmittel auf Aldehydbasis (mit formaldehyd) im labor, 2011. Available at: http://www.gischem.de/download/01_4-00000509011-000000_1_1_1.PDF (last accessed 1 February 2011).
- 42 GisChem Sicherheitsdatenblatt. Desinfektionsmittel auf Aldehydbasis (ohne formaldehyd) im labor, 2011. Available at: http://www.gischem.de/download/01_4-00000509012-000000_1_1_1.PDF (last accessed 1 February 2011).
- 43 Josefson A, Färm G, Stymne B, Meding B. Nickel allergy and hand eczema – a 20-year follow up. *Contact Dermatitis* 2006; **55**: 286–290.
- 44 Thyssen J P, Linneberg A, Menné T, Nielsen N H, Johansen J D. The association between hand eczema and nickel allergy has weakened among young women in the general population following the Danish nickel regulation: results from two cross-sectional studies. *Contact Dermatitis* 2009; **61**: 342–348.
- 45 Meding B, Lidén C, Berglind N. Self-diagnosed dermatitis in adults. Results from a population survey in Stockholm. *Contact Dermatitis* 2001; **45**: 341–345.
- 46 Josefson A, Färm G, Magnuson A, Meding B. Nickel allergy as risk factor for hand eczema: a population-based study. *Br J Dermatol* 2009; **160**: 828–834.
- 47 Jensen P, Thyssen J P, Johansen J D, Skare L, Menné T, Lidén C. Occupational hand eczema caused by nickel and evaluated by quantitative exposure assessment. *Contact Dermatitis* 2011; **64**: 32–36.
- 48 Nielsen N H, Menné T. Allergic contact sensitization in an unselected Danish population. The Glostrup Allergy Study, Denmark. *Acta Derm Venereol* 1992; **72**: 456–60.
- 49 Uter W, Pfahlberg A, Gefeller O, Geier J, Schnuch A. Risk factors for contact allergy to nickel – results of a multifactorial analysis. *Contact Dermatitis* 2003; **48**: 33–38.
- 50 Schnuch A, Geier J, Lessmann H, Uter W. Informationsverbund dermatologischer Kliniken. Decrease in nickel sensitization in young patients – successful intervention through nickel exposure regulation? Results of IVDK, 1992–2001. *Hautarzt* 2003; **54**: 626–632.