

Occupational irritant and allergic contact dermatitis among healthcare workers

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Contact dermatitis is the most frequent occupational dermatosis and non-specific irritants in addition to specific Type IV sensitization are involved. We reviewed our database for data from 1994 to 1998 and selected 360 consecutive patients working in healthcare environments and experiencing contact dermatitis at their hands, wrists and forearms. We found that allergic contact dermatitis and irritant contact dermatitis were considered to be work-related in 16.5% (72/436) and 44.4% (194/436) of diagnoses, respectively. Occupational irritant contact dermatitis is due to exposure to a wide range of irritants in the workplace, such as soaps, solvents, cleansers and protective gloves, which conspire to remove the surface lipid layer and/or produce cellular damage. In this study the major relevant aetiological agents that induced occupational allergic contact dermatitis were: nickel sulphate (41 patch positivities), components of disinfectants [glutaraldehyde (5) and benzalkonium chloride (7)] and rubber chemicals [thiuram mix (15), carba mix (9) and tetramethylthiuram monosulphide (6)]. The best treatment for allergic contact dermatitis is to avoid those allergens causing the rash. Whenever this is not possible, contact with them needs to be reduced using properly selected protective gloves. Finally, subjects with atopic dermatitis should avoid 'wet work' and contact with irritants, because atopic dermatitis is significantly associated with irritant contact dermatitis.

Key words: allergic contact dermatitis; biocides; detergents; healthcare workers; irritant contact dermatitis; nickel; rubber chemicals; rubber gloves; © Blackwell Munksgaard, 2002.

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Contact dermatitis is the most frequent occupational dermatosis (1). Non-specific irritants are frequently involved, although allergic contact dermatitis from occupationally encountered allergens is sometimes also found. Irritant and allergic contact dermatitis, both work-related and non-work-related, may occur in the same person. Commonly used disinfectants may display irritating activity. Components of protective rubber gloves and other rubber products, and metals in medical instruments are examples of allergens. A common factor contributing to the development of allergic contact dermatitis is a pre-existing skin condition, such as irritant contact dermatitis, because this disrupts the skin barrier and leads to increased penetration of allergenic substances. However, in this study, we focussed on the role of atopic dermatitis in contact dermatitis, since there are contrasting opinions about this relationship (2–4).

The aim of this study was to assess the source of occupational dermatitis among healthcare workers undergoing medical examination and patch testing,

in order to improve the scientific database on the spectrum of allergens encountered in healthcare environments.

Patients and Methods

Study group

The present retrospective study was based on analysis of data from a database of 360 consecutive patients, working in healthcare environments, referred from 1994 to 1998 to the Section of Allergy with skin disease localized to their hands, wrists and forearms, in whom finally, on the basis of anamnesis, clinical examination and test results, contact dermatitis was diagnosed.

The group consisted of 280 females, 80 males, mean age 37.8 years, ranging in age from 22 to 74.

At the time of their examination, after anamnesis, including history of atopic dermatitis, and clinical evaluation, patients were patch tested with a standard series, 'health' screening and rubber allergens when necessary. All subjects were tested

for IgE-mediated allergy to natural rubber latex, 358 by CAP-FEIA and 335 by prick test.

Patch testing

Patch testing was performed with the GIRDCA (Gruppo Italiano Ricerca Dermatiti da Contatto e Ambientali, Hermal-Trolab, Braeco, Milan, Italy) standard series (Hermal-Trolab) and 'health' screening series (FIRMA Diagent, Florence, Italy) comprising benzalkonium chloride (0.1% aq.), bergamot oil (1% petrolatum (pet.)), caine mix (1% dibucaine hydrochloride, 1% tetracaine hydrochloride, 5% benzocaine all in pet.), chloramine-T (0.5% aq.), chlorhexidine gluconate (0.5% pet.), p-chloro-m-xenol (1% pet.), glutaraldehyde (0.5% aq.), BHA (2% pet.), lemon oil (2% pet.), methyl salicylate (2% pet.), o-phenylphenol (1% pet.), Ponceau Red 4R (2% pet.), propylene glycol (10% aq.), benzoyl peroxide (2% pet.), sorbic acid (2% pet.), dihydroxydiphenyl (0.1% pet.), and mercuric chromium (0.1% aq.).

An additional patch test with rubber allergens was applied when necessary (5). Patch testing was conducted with Finn Chambers affixed with Scanpor tape applied to the upper back (6). Patches were removed after 2 days (D), and reactions were interpreted at D2 and D4. All reactions were scored in accordance with the recommendations of the International Contact Dermatitis Research Group (7). Ambiguous or irritant reactions were regarded as negative. The patch test results, diagnoses and relevance of positive patch test reactions were collectively reviewed for each case. This study was based only on relevant positive patch tests, namely, on reactions to allergens present in products to which patients were exposed and in whom reaction was known (in the case of occupational allergic contact dermatitis the substance found at the workplace coming into contact with the areas of dermatitis).

Diagnoses

The diagnosis of allergic contact dermatitis required a positive patch test and a history of present exposure to the allergen. The diagnosis of irritant contact dermatitis required a history of contact with irritant substances and a period of eczema related in time to such exposure. The diagnosis of occupational contact dermatitis was established on the basis of the patient's history, physical examination, and patch testing, using the following criteria (8–10):

1 onset of the eruption after the patient began work;

- 2 exposure to the aetiological factor at workplace;
- 3 exposure of the site of onset to the causative agent;
- 4 time between the beginning of exposure and the development of the dermatitis appropriate to pathophysiology involved. This means that allergy will not be manifest until at least 2 weeks after the introduction of a new allergen in the workplace (where the individual has not been exposed to it before), or exposure of a new worker to a new environment, since this is the minimum induction period for allergens. In contrast, reactions to strong irritants do not require an induction period and can be seen within minutes to hours. Weak irritants may mimic allergens in that a period of exposure is required to culminate in dermatitis;
- 5 clinical appearance and the distribution of the skin lesion consistent with the type of dermatitis known to be caused by a suspect agent;
- 6 exclusion of non-occupational aetiology;
- 7 positive patch test reaction(s) to a non-irritating concentration of an allergen present at workplace in the case of allergic contact dermatitis.

Prick testing and serum analysis

Prick tests with a commercial extract of nonammoniated latex (Stallergènes, Paris, France) were performed in four subjects. Prick tests with extemporaneous extracts prepared as previously reported (11) were performed in eight subjects; 335 subjects underwent both prick tests with commercial extract of latex and extemporaneous extract. Histamine dihydrochloride (10 mg/mL) was used as positive control, and physiological saline as negative control. A prick test was considered positive if the wheal size was 3 mm larger in diameter than the wheal of the negative control.

Specific IgE to latex was measured in serum of 358 subjects with a FEIA assay (Pharmacia CAP System; Uppsala, Sweden). A positive reaction was defined as a value >0.35 kU/L.

Clinical records

Patients' clinical data, information concerning medical examinations, history of atopic dermatitis, test reactions and diagnoses were collected in a database used for this study.

Statistical analysis

Proportions were compared by chi-square test. Means of continuous variables were compared by Student's *t*-test. In all instances, a probability value <0.05 was considered to be statistically significant.

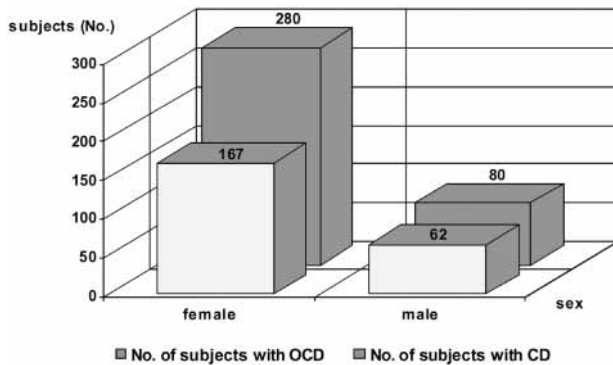


Fig. 1. Distribution of 360 subjects with contact dermatitis and 229 workers with occupational contact dermatitis in relation to sex.

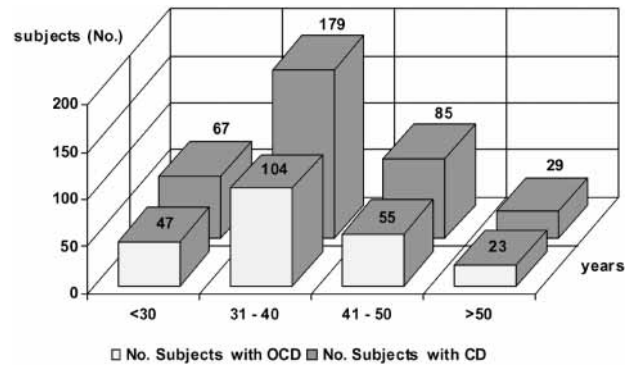


Fig. 2. Distribution of 360 subjects with contact dermatitis and 229 workers with occupational contact dermatitis in relation to age.

Results

In the study group, clinical presentation of contact dermatitis was variable, ranging from transient redness (38 cases) to xerotic dermatitis characterized by dryness, pityriasiform scaling and/or fissuring (52 cases), keratotic fissured type (10 cases), erythematousquamous (235 cases), erythematous-exudative (7 cases) and dyshidrotic eczema (18 cases). Lesions were located on the hands in 356 workers, among whom 22 and 12 subjects had lesions additionally on their wrists and forearms, respectively. In three subjects, lesions were located only on the wrists, while in one subject, lesions occurred only on the forearms. Contact dermatitis was more frequent among personnel working in the field of internal medicine (50.3%) than in other fields, among nurses (51.7%) and among workers aged 31–40 years (49.7%), as shown in Table 1. The distribution in relation to sex and age is shown in Figs 1 and 2.

Based on anamnestic data and clinical examina-

tion results, contact dermatitis was considered occupational in 229/360 (63.6%) cases (62 males, or 77.5% of examined males, and 167 females, or 59.6% of examined females). Subjects who exhibited occupational dermatitis significantly were more likely males ($p < 0.05$) and working in surgical fields ($p < 0.001$), more frequently nurses ($p > 0.05$) and aged 31–40 years ($p > 0.05$).

As to the cause of the dermatitis, the final diagnoses were allergic contact dermatitis in 32.6% (142/436 diagnoses) and irritant contact dermatitis in 67.4% (294/436 diagnoses): 66/360 persons (18.3%) had only allergic, 218/360 (60.5%) persons had only irritant and 76/360 (21.1%) persons had both irritant and allergic contact dermatitis as concurrent diagnoses.

History of atopic dermatitis was found in 25/360 (6.9%) patients. It was more frequent among subjects with only irritant (21/218, 9.6%) than in subjects with only allergic (1/66, 1.5%) or with concomitant irritant and allergic contact dermatitis (3/76, 3.9%) ($p < 0.05$).

Table 1. Distribution of 360 subjects with contact dermatitis and 229 subjects with occupational contact dermatitis in relation to sex, age and occupational field

	Subjects with contact dermatitis (<i>n</i> = 360)		Subjects with occupational contact dermatitis (<i>n</i> = 229)	
	<i>n</i>	%	<i>n</i>	%
<i>Occupational field</i>				
Internists	181	50.3	116	50.6
Surgeons	79	21.9	64	28
Radiologists	37	10.3	22	9.6
Laboratory	13	3.6	8	3.5
Others	50	13.9	19	8.3
<i>Job title</i>				
Doctors	37	10.3	25	10.9
Nurses	186	51.7	134	58.5
Cleaners	37	10.3	21	9.2
Others	100	27.7	49	21.4

Allergic contact dermatitis and irritant contact dermatitis were considered to be non-occupational in 16.05% (70/436) and 22.9% (100/436) of diagnoses, respectively. Non-occupational ACD was induced by: nickel sulphate 5% aq. (53 positive patch tests), thimerosal 0.1% pet. (11), cobalt chloride 1% pet. (8), potassium dichromate 0.1% pet. (7), 4,4-diaminodiphenylmethane 0.5% pet. (6), 4-phenylenediamine base 1% pet. (2), with 1 patch test positivity each for balsam of Peru (Myroxylon Pereirae Resin) 25% pet., colophonium 20% pet., fragrance mix 8% pet., imidazolidinyl urea 1% pet., mercapto mix 2% pet., mercuric chloride 1% pet., N-cyclohexylbenzothiazyl sulfenamide 0.5% pet., primin 0.01% pet., tetramethylthiuram monosulphide 0.25% pet., tetramethylthiuram disulphide 0.25% pet..

Allergic contact dermatitis and irritant contact dermatitis were considered to be work-related in 16.5% (72/436) and 44.4% (194/436) of diagnoses, respectively. Comparisons were then made between individuals who had occupational irritant contact dermatitis diagnoses and the other subjects. Workers with occupational irritant contact dermatitis diagnoses were more frequently exposed to soaps, detergents and antiseptics (94.2%) and daily use of latex gloves (93.1%) ($p < 0.001$). The mean period of daily glove usage was highest among subjects with occupational irritant contact dermatitis (4.4 h vs. 3.5 h) ($p < 0.001$).

The patterns of positive patch test results and the frequency of allergens responsible of occupational allergic contact dermatitis are shown in Table 2.

Thirty-eight patients had a positive prick test to commercial extract and/or to extemporaneous extract, and 31 patients had a positive CAP-FEIA. The diagnosis of clinical Type I latex allergy was made when the patient had a definite history of reactions to latex exposure and a positive IgE test. By this definition, 53 patients were considered to be latex allergic.

Discussion

In this study, occupational irritant contact dermatitis was found to be a more frequent skin disorder than occupational allergic contact dermatitis; as has previously been reported (1, 12). It is important to realize that occupational irritant contact dermatitis generally results from exposure to a wide range of irritants in the workplace, such as soaps, solvents, cleansers and protective rubber gloves. The irritancy of a particular substance, such as detergents and antiseptics, depends on its ability to remove the surface lipid layer (the intracellular lipids of the stratum corneum) and/or the

ability to produce cellular damage. Once surface corneocytes are damaged, the potency of irritant required to sustain the damage is considerably less than that required to provoke damage in the first place. Besides, fissuring and defatting of the keratin layer leads to increased permeability and can lead to sensitization with resultant allergic contact dermatitis subsequent to the original irritant effect (13).

Among other causes of occupational irritant contact dermatitis are rubber gloves. The increased utilization of latex gloves in the workplace to protect against the occupational hazards of HIV infection and hepatitis has brought to light the problem of both allergic and non-allergic reactions to these products (14). Rubber gloves may provoke direct cutaneous irritation related to powder; irritant contact dermatitis may also be related to occlusion, friction and maceration from gloves that dramatically increase skin damage from other irritants (15).

Damage in irritant contact dermatitis depends upon three factors: duration of contact, strength of irritant and frequency of contact. As shown in our results, workers with occupational irritant contact dermatitis are more likely to use soaps, detergents and antiseptics frequently and to wear gloves daily for a number of hours.

That the use of latex gloves is associated with an increased number of adverse reactions to their constituents among healthcare workers is confirmed by our findings, showing a frequency of immediate latex hypersensitivity among our study group of 14.7%, compared to a world-wide frequency among healthcare workers, depending on cohort examined, of 3–12% (16). Likely, latex sensitization occurred in the healthcare environment where latex gloves, the main source of exposure, have been known to contain high levels of allergens (17, 18).

In this study, nickel sulphate, components of disinfectants (glutaraldehyde and benzalkonium chloride) and rubber chemicals (thiuram mix, carba mix and tetramethylthiuram monosulphide) are the major aetiological agents that induce occupational allergy. This is in accordance with a previous investigation (19). Such a frequent occurrence of allergy to nickel in our patients (20.6% of patch test positivities) was presumably caused by contact with nickel-plated instruments at the workplace (e.g. surgical instruments) (20), although today's surgical instruments are made of stainless steel and would not be expected to release much nickel. Moreover primary sensitization to nickel, especially in females, is thought to be mainly non-occupational, e.g. from cheap jewelry.

Table 2. Positive patch test reactions in 72 health care personnel with occupational allergic contact dermatitis

Allergens	Concentration (%)	No. of positive reactions
nickel sulphate	5 †	41*
thiuram mix	1	15
carba mix	3	9
thimerosal	0.1	9**
benzalkonium chloride	0.1	7
tetramethylthiuram monosulphide	0.25	6
glutaraldehyde	0.5†	5
fragrance mix	8	4
mercaptobenzothiazole	2	4
colophonium	20	4
4,4-diaminodiphenylmethane	0.5	4****
balsam of Peru (Myroxylon Pereirae Resin)	25	3****
benzoyl peroxide	2	3
N-cyclohexylbenzothiazyl sulfenamide	0.5	3
dibutylthiourea	1	3
hexamethylenetetramine	1	3
mercapto mix	2	3
tetramethylthiuram disulphide	0.25	3
tetraethylthiuram disulphide	0.25	3
cobalt chloride	1	2***
dibutylthiourea	1	2
dipentamethylenethiuram disulphide	0.25	2
1,3-diphenylguanidine	1	2
diphenylthiourea	1	2
N-isopropyl-N-phenyl-4-phenylenediamine	0.1	2
methyl (chloro)isothiazolinone	0.01†	2
potassium dichromate	0.5	2

bis (dibutylthiocarbamate) zinc (1%), bis (diethylthiocarbamate) zinc (1%), caine mix‡, dibenzothiazyl disulphide (0.5%), diethylthiourea (1%), dihydroxydiphenyl (0.1%), dithiomorpholine (1%), formaldehyde (1%†), BHA (2%), morpholinyl mercaptobenzothiazole (0.5%), mercaptobenzothiazole (0.5%), mercuric chromium (0.1%†) (1 positivity each).

4-phenylenediamine base (1%), primum (0.01%), triethylenetetramine (1%), lanolin alcohol (30%) (1 not relevant positivity each).

‡1% dibucaine hydrochloride, 1% tetracaine hydrochloride, 5% benzocaine.

*14 not relevant, **7 not relevant, ***not relevant in 1 case, ****not relevant.

†aq.; others pet.

Rubber chemicals are important occupation allergens and, as reported above, the increased use of rubber gloves is one of the most important routes of sensitization to them (21), as is probably the case in the present study. However, many articles currently used in the healthcare sector contain rubber chemicals (e.g. syringes, tracheal tubing, elastic bands, catheters) that can sensitize workers. This study shows a similar frequency of thiuram mix allergy in healthcare workers to that found by Gibbon et al. (22). Testing with thiuram mix proved to be a good indicator of allergy to rubber chemicals; 40.7% of subjects with allergic contact dermatitis that was rubber chemicals-related, reacted to thiuram mix (data not shown).

Biocides, such as glutaraldehyde and benzalkonium chloride, have long been associated with the causation of allergic contact dermatitis (23–25). Glutaraldehyde is commonly used as a sterilizing agent in medical facilities; it is effective against most microorganisms, including viruses. Glutaraldehyde has been introduced partly to substitute for formaldehyde as a disinfectant; however, it has been found that it has considerably greater poten-

tial for skin sensitization than formaldehyde (26). These findings might explain why allergy to formaldehyde is less frequent than allergy to glutaraldehyde. Although benzalkonium chloride displays primarily irritant activity, it may also produce allergic contact dermatitis of the hands (27, 28). In our study, 9.7% of health-care workers with occupational allergic contact dermatitis reacted to this compound; this is a higher frequency than that previously found by Shaffer et al. (24).

The best treatment for allergic contact dermatitis is to avoid those allergens causing the rash. Whenever this is not possible, contact with them needs to be reduced using properly selected protective gloves. There are alternative gloves that could substitute for latex gloves, such as tactylon, nitrile, styrene and butadiene gloves, even if their use may involve some sacrifices in terms of barrier protection, performance characteristics (grip, flexibility, comfort) and cost.

Several studies have tested the efficacy of moisturizers and suggested regular use of barrier creams and intensive skin care after work for the prevention of contact dermatitis (29–31). How-

ever, further studies are necessary since barrier creams do not shield as well as protective clothing and results have been contradictory. Recently, Held et al. (32) suggested that the use of a moisturizer under occlusive gloves may diminish irritation and risks of allergic contact dermatitis from exposure to both the glove itself and to substances, such as detergents, used thereafter. Moisturizers create a barrier that protects the skin against friction from gloves, invasion of glove allergens and damage from irritants.

Finally, atopic dermatitis has not been associated with allergic contact dermatitis for some time. This could be due to two factors:

- 1 patients with atopic dermatitis may be less likely to develop allergic contact dermatitis because of a depression of the cutaneous delayed-type hypersensitivity response, as shown previously (4);
- 2 the low frequency of atopic dermatitis among subjects with allergic contact dermatitis might not be related to an altered cell-mediated immunity, but, rather because subjects often use an allergic substance at so high a concentration that it becomes irritant and all predisposing characteristics lose their importance.

Individuals with a history of atopic dermatitis should be discouraged from doing 'wet work' and they should make appropriate use of gloves and disinfectants.

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