

ORIGINAL ARTICLE

Presumptive frequency of, and review of reports on, allergies to household gloves

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Abstract

Background Allergies to latex or 'rubber chemicals' in medical or other occupationally used gloves are not uncommon. In contrast, very few articles have reported on latex allergy (type I) or allergic contact sensitization to additives (type IV) associated with household gloves, in spite of some 44 million pairs sold in Germany in, e.g., 2006.

Objective We seek to determine the frequency of allergies to household gloves by providing own data and we reviewed the literature.

Methods The study was based on 105083 consultations of patients with suspected contact allergy (Type IV) in the Information Network of Departments of Dermatology (IVDK) in Germany in the years 1995 to 2006 and on the PubMed databases (last access 7/2008).

Results 1221 patients were identified in whom protective gloves were considered as a possible cause of contact dermatitis and who did not work in occupations associated with above average risk of contact allergy to rubber chemicals. In 178 cases positive reactions to rubber components were reported, while 13 additional cases reacted only to a previously used rubber glove brand, but not to commercial allergens.

In the literature only two publications on type I and two on type IV reactions were found in which allergies to rubber household gloves were explicitly reported.

Conclusions Allergies to rubber household gloves seem to be rare. Factors presumably counteracting contact sensitization by household gloves, compared to occupational use, comprise short intermediate use, loose fitting and the incorporation of e.g. an inner cotton surface reducing skin contact with rubber chemicals.

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Keywords

allergy, household gloves, latex, rubber

Conflict of interest

Ehrhardt Proksch has acted as consultant to Wirtschaftsverband der deutschen Kautschukindustrie e.V. (WDK).

Introduction

Allergy to rubber continues to be an important occupational health problem as rubber products are used increasingly worldwide, particularly in health care.¹⁻⁴ These adverse health effects arise either from

^aIt is necessary to exclude occupationally exposed patients in order to focus on the effects originating from household gloves and not from professions associated skin exposure of irritants and allergens.

^bThe following occupations were excluded: paper and printing workers, metal workers, construction and mining workers, rubber and plastic materials manufacturers, health care workers, textile and leather processors, professional cleaners, meat and fish processors, florists, animal keepers and farmers, hairdressers and cosmetologists, food processors, transport labourers, salespersons, and persons with undefined exposures and a missing job title (see).

the latex proteins, generally causing a type I immediate hypersensitivity reaction, or from chemicals added to the latex during processing, causing a type IV delayed hypersensitivity reaction. The latex proteins may cause immunological contact urticaria (syndrome), whereas processing chemicals may induce allergic contact eczema. Thiurams, dithiocarbamates and benzothiazole derivatives are the most common allergens of the rubber additives.⁵ Regulation banning powdered latex gloves was implemented in Germany recently, and the incidence of cases decreased during the last 3 years.^{6,7}

While numerous reports on latex or rubber additive contact allergy to medical or other occupationally used gloves as well as other rubber items have been published, relatively few authors reported allergies to household gloves. This seems surprising, in

view of the amount of usage of household gloves. Thus, we analysed contact allergy data of a large network to confirm the notion of scarcity or otherwise.

Materials and methods

Data were obtained by the Information Network of Departments of Dermatology (IVDK; www.ivdk.org) which now comprises more than 45 departments of dermatology in Germany, Austria and Switzerland.⁸ In this study, only the 43 German departments were included. The patch test procedure follows international standards⁹ further refined by the German Contact Dermatitis Research Group (DKG).¹⁰ Standardized patch test data, along with basic demographic and clinical information is regularly collected in an anonymous format and analysed.^{11,12} All participants of the IVDK are members of the DKG. Among all patients patch tested in the German centres of the IVDK from 1995 to 2006 ($n = 105\,083$ consultations by 102\,040 patients), 'presumably non-occupational,' household glove-exposed' cases were identified by applying the following criteria:

- Work in an occupation not associated with a more than 10% increased risk of contact allergy to either mercaptobenzothiazoles or thiurams, relative to household workers,^b based on data from a previous multifactorial analysis.¹¹
- Protective gloves considered as a possible cause of current contact dermatitis.

This case definition yielded 1221 patients, while another 34\,317 fulfilled the first criterion only.

To obtain a gross estimate of the frequency of similar patients on a population level with or without proven contact allergy to rubber chemicals, the above results were extrapolated along the lines of the CE-DUR approach.¹³ Briefly, the CE-DUR approach is a combination of methods of the Clinical Epidemiology and Drug Utilization Research. It is used to extrapolate the frequency of specific contact sensitizations from clinical patients to the general population. For this purpose, two data sources are used:

- Patch test results of patients attending the IVDK dermatological departments. The IVDK patients represent approximately 2–3% of all patients patch tested in Germany. Characteristics such as gender, age, disease pattern or suspected causal exposure and the frequency of positive patch tests are considered to be largely representative of all German patients patch tested.
- Sales of patch test material in Germany, the latter representing a starting point for the estimation of the number of persons 'eligible' for testing at the population level because of a suspected contact sensitization.

The original sales figures are corrected for several factors (e.g. discarded test material, previous tests, see¹³) yielding three different scenarios offering a corridor for the estimation of morbidity. The frequencies of positive reactions to individual allergens obtained from the German IVDK centres are related to the corrected sales data of patch test material to arrive at gross estimates of the absolute number of contact sensitization cases to single allergens according

to the three scenarios in Germany. Given an average annual number of $n = 439\,650$ patch tests in the period¹² and of $n = 8757$ consultations in the German centres of the IVDK, the resulting extrapolations according to three scenarios are shown in Table 2.

In addition, we searched for literature regarding household gloves in the National Library of Medicine (PubMed, <http://www.ncbi.nlm.nih.gov/sites/entrez?db=PubMed>, last accessed 10/07/2008).

Results

IVDK data (Type IV allergy)

The 1221 'household glove-exposed' (referred to as 'cases') correspond to about 1.0% of all patients tested. Patch tests examining type IV allergens contained in the 'standard' or in the special 'rubber additives' series detected 490 positive reactions against at least one of several rubber chemicals in 178 patients – for further results, see Table 1. In a total of 236 cases, patch tests with own, previously used gloves or glove materials (samples from commercial gloves, in cases where the respective original gloves were not available) were performed. Thirty of these patients displayed positive reactions to glove material; 17 of these also showing positive patch test reactions to rubber chemicals (i.e. 13 reacting only to own material).

Incidence of rubber Type IV allergy

Extrapolating the annual number of cases 'non-occupationally exposed to household gloves' with proven contact allergy (type IV) to rubber components diagnosed in the German part of the IVDK network ($n = 16$, row 'd') in Table 2 to the level of the general population, the number of such cases is estimated to range between 1054 and 4345 (type I allergy is not included in the IVDK data; Table 2).

Literature review

In PubMed, case series of allergies (type I or IV) from rubber household gloves have been reported very rarely:

- In 1987, Frosch *et al.* described 71 patients with contact allergy to gloves made from rubber or vinyl. Tests were performed in 19\,200 patients during the years 1969–1984. In this period, sensitivity to rubber gloves used in the household and industry occurred most frequently, followed by health service workers. Only one person who worked as a cleaning woman and six persons who were housewives solely suffered from allergies to rubber gloves. Most patients reacted to several rubber chemicals. The main sensitizers were found to be the rubber accelerators of the thiuram and carbamate group.¹⁴
- Also in 1987, three atopic female patients suffering from contact urticaria caused by the use of rubber household gloves have been reported. In one case, the local urticaria reaction at the forearms was followed by asthma. In all three cases, type I allergy against latex was proven by radioallergosorbent test. Two patients were housewives solely and one patient was a physician, but the problems occurred during window cleaning while wearing household gloves.¹⁵

Table 1 Patch test results with a rubber series and selected standard series allergens in 1221 patients, 1995–2006

Allergens of the 'rubber series'	Conc. (%)	N (test)	% (pos.)	% (pos.) std.	(95% CI)
Tetraethylthiuramdisulphide	0.25	721	6.10	6.16	(4.39–7.92)
Tetramethylthiurammonosulphide	0.25	721	5.55	5.65	(3.95–7.34)
1,3-Diphenylguanidine	1.00	715	3.92	3.86	(2.46–5.25)
Tetramethylthiuramdisulphide	0.25	718	4.18	4.27	(2.78–5.76)
Morpholinylmercaptobenzothiazole	0.50	723	3.04	3.05	(1.79–4.32)
Dipentamethylen-thiuramdisulphide	0.25	721	2.64	2.69	(1.50–3.89)
N-Cyclohexyl-2-benzothiazylsulfenamide	1.00	730	2.05	2.08	(1.03–3.12)
Dibenzothiazylidysulphide (MBTS)	1.00	731	1.64	1.65	(0.72–2.59)
p-tert.-Butylcatechol	0.25	270	1.11	1.13	(0.00–2.45)
N,N'-Diphenyl-p-phenylenediamine	0.25	715	0.84	0.79	(0.16–1.41)
Cyclohexylthiophthalimide	0.25	110	0	0	–
Cyclohexylthiophthalimidee	0.50	448	0.89	0.90	(0.01–1.79)
Cyclohexylthiophthalimide	1.00	157	1.91	2.19	(0.00–4.74)
Zinkdibenzylidithiocarbamat	1.00	271	0.74	0.64	(0.00–1.53)
Ethylendiamin-di-HCl	1.00	697	0.72	0.73	(0.09–1.36)
Monobenzone	1.00	698	0.72	0.71	(0.09–1.33)
Methenamine	1.00	707	0.42	0.42	(0.00–0.89)
Phenyl-beta-naphthylamine	1.00	554	0.54	0.56	(0.00–1.19)
Zink-dibutylidithiocarbamate	1.00	701	0.43	0.45	(0.00–0.95)
Diphenylthiourea	1.00	719	0.28	0.29	(0.00–0.69)
Dibutylthiourea	1.00	716	0.14	0.13	(0.00–0.37)
Di-beta-naphthyl-p-phenylenediamine	1.00	200	0	0	–
4,4'-Dihydroxydiphenyl	0.10	698	0	0	–
Ethoxyquine	1.00	122	0	0	–
Allergens contained in the standard series					
Thiuram Mix	1.0	1125	7.20	7.52	(5.94–9.10)
Mercapto-Mix without MBT	1.0	1104	2.36	2.33	(1.43–3.22)
Mercaptobenzothiazole	2.0	1011	2.18	2.18	(1.27–3.09)
N-Isopropyl-N'-phenyl-p-phenylenediamine	0.1	1138	2.37	2.31	(1.44–3.18)
Zink-diethylidithiocarbamate	1.0	1137	2.02	2.11	(1.25–2.96)

Number of tested [N(test)], crude [% (pos.)] and standardized* [% (pos.) std.] percent positive, the latter with 95% confidence interval (95% CI)

All allergens in petrolatum.

*Standardization weights: 32.5% females < (≥) 40 years, 17.5% males < (≥) 40 years.

- In contrast, Sussman *et al.* studied 50 members of professional housekeeping staff at a Toronto hospital regarding the prevalence of latex allergy. All housekeepers wore yellow rubber latex gloves (not powdered and un-lined). Patients with possible atopy or symptoms suggestive of latex allergy were skin tested with latex. Four of 20 tested persons had a positive latex prick skin test representing an 8% overall prevalence within this group and 4/20 among atopic housekeepers. For comparison, the expected prevalence in the general population is 1% (as stated by the authors at that time). Latex-positive patients had extensive exposure to high-protein unlined latex gloves. Positive patients had a similar yet completely unique immunoblot pattern of IgE binding. All four positive patients had unrecognized latex allergic symptoms (hand dermatitis, rhinoconjunctivitis). The authors

concluded that the 8% prevalence of a positive latex skin test in regularly exposed hospital housekeepers is similar to that observed among healthcare workers.¹⁶ This shows that the allergy rate is higher were professional, i.e. regular and prolonged, use of latex rubber gloves is necessary.

- Leis-Dosil presented a 38-year-old non-atopic woman with mildly pruritic, erythematous and oedematous plaques involving her hands and forearms. Some of the lesions had a target-like appearance. The patient had been using a new rubber gloves brand for housework for one month before onset. Skin prick tests and latex-specific IgE were negative. Patch tests revealed positive results to carbamates mix and to thiuram mix. The diagnosis of erythema multiforme-like contact dermatitis was established. Lesions cleared after substitution of suitable gloves.¹⁷

Table 2 CE-DUR extrapolation of average annual number of female patients with suspected dermatitis to household gloves (with positive reactions to rubber chemicals) and underlying presumptive populations

Scenario	IVDK	Worst	Best	Medium
(a) Number of Patients with patch test (PT)	8757		439 650	
(b) Number of Persons eligible for PT	–	2 374 110	575 942	998 006
(c) Number of persons non-occupationally exposed to household gloves	*102 (1.16%)‡	27 540	6 681	11 577
(d) Number of 'c' with positive PT reactions to rubber chemicals or own gloves	†16 (0.183%)‡	4 345	1 054	1 826

**n* = 1221 divided by the number of years (12) covered by study period.

†*n* = 191 rubber positive cases divided by the number of years (12) covered by study period.

‡Percent of (a) in column 'IVDK', used to derive numbers (c) and (d) in the three scenarios.

Discussion

In the present study, we showed that contact allergies to rubber household gloves are rare: 191 cases of positive reactions to rubber components or gloves 'as is' were identified among those patients of the IVDK in the years 1995–2006 who presumably represent a non-occupational 'low-risk' exposure group. This figure is possibly a lower limit of the true frequency, as a rather conservative case definition had been employed, excluding, for example, all patients working in any occupation associated with an increased risk of contact allergy to rubber additives¹¹ (about two thirds of all patients patch tested) who, most likely, additionally perform household work to some extent. Moreover, protective gloves as potential cause of dermatitis may not have been documented in each case where this would have been appropriate, leading to a further underestimation of the number of affected cases.

Extrapolating the number of 'rubber positive, non-occupationally household glove exposed' patients (type IV allergy) to the population level yields gross estimates from one to a few thousand cases per year (see Table 2). A survey from the German rubber industry revealed that in 2006, 44×10^6 pairs of household gloves for repeated use were sold. The proportion of natural rubber latex gloves was estimated to be 91%.¹⁸ Sales figures for 2005 and earlier years were somewhat lower, but with a similar distribution of glove types.

It is unfortunately not possible to relate this figure, as an exposure estimate, to the above numerator of population-wide morbidity in the particular subgroup we addressed, as a certain proportion of these gloves will have been sold to persons not eligible as case here, such as professional kitchen or cleaning personnel. As a consequence, sensitization risk will be underestimated if subgroup-specific morbidity is related to overall exposure. Generally, valid risk assessment is possible only if exposure to allergens can be pin pointed to identifiable products, used by (an identifiable subgroup of) the general population.

Regarding immediate (type I) hypersensitivity, systematic data (e.g. on allergy to latex proteins) are lacking. Hence, this aspect of allergic skin reactions to natural rubber containing household gloves cannot be addressed. Therefore, we rely on reports in the literature.

Rubber or latex allergy to household gloves (non-occupational) seems to be a rare event based on reports in the literature. Up to

February 2008 only four publications have been found. The first report was written in 1987 and the last in 2006. The special inner surfaces containing cotton flocks or inner cotton linings in household type gloves presumably reduce skin contact to latex allergens and to rubber chemicals. Also, new production techniques, in particular leaching, have been introduced to reduce the allergen content. Some manufacturers claim that the latex allergen content on the inner side of the gloves has been greatly reduced by special production techniques.

The importance of technical changes for the spectrum and frequency of rubber allergies was shown by a recent publication from the IVDK. About 21% of the patients with occupational contact dermatitis registered in the in the years 1995–2006 were patch tested owing to suspected rubber glove allergy. Thiurams were by far the most frequent rubber allergens in these patients (16.2% positive reactions, age and sex standardized), and the reaction frequency showed a decline from 20.9% in 1997 to 12.8% in 2000, in accordance with another multifactorial analysis.¹¹ However, this trend was not statistically significant and was followed by an increase to 16.5% in 2001. Although, according to manufacturers' information, the use of dithiocarbamates and mercaptobenzothiazol derivatives in rubber glove production increased in recent years, these allergens elicited positive reactions in only about 3% of the patients tested, and showed no increasing trend.⁵

Another possible reason why allergies to household gloves seem to be rare compared to allergies to medical or other occupational gloves is the difference in use conditions. The typical rubber household gloves are used many times during several weeks. In contrast, only single-use disposable gloves are in use for medical care. The highest amount of allergens from a rubber glove reaches the skin during the first wearing and decline thereafter. Also, household gloves often have a loose fitting, which reduces the skin contact and allows even for low ventilation and water evaporation. In contrast, medical gloves often fit tightly to achieve high tactile sensitivity during manual work.

Moreover, household gloves are often used for a short time only, possibly less than an hour a day. Medical or occupationally used gloves are often worn for the whole day (e.g. 20–30 h a week) by hospital cleaning staff.³ This could contribute to a lesser risk of contact sensitization in occasional, more intermittent use in the

domestic setting, which is possibly mediated by a lesser perturbation of the epidermal barrier.

In medical care, the hands are intensively cleaned and disinfected before surgery. This irritates the skin and disturbs the permeability barrier. Thereafter, fresh disposable gloves with their fresh, un-diminished allergen content get in contact with the skin and penetration of allergens into the living epidermal layers occurs. Medical gloves often are changed several times a day, and always, new gloves with a fresh allergen load are used. Permanent use of latex gloves for several hours leads to occlusion, sweating, and hyper-hydration, which also irritates the skin. Recently, the disruption of the stratum corneum barrier function by hyper-hydration has been shown by ultra-structure examinations.¹⁹ In contrast, with the short-term use of gloves in the household irritation is much less.

A further explanation for the differences in allergies when comparing household to medical gloves is given by Knudsen *et al.* The authors determined thiuram and carbamate derivatives released from five rubber surgical gloves and five households gloves into synthetic sweat. Each of the natural rubber gloves released varying amounts of thiurams (0–4.3 mg) as well as carbamates (0–8.1 mg). Twenty-two thiuram-sensitized patients were patch tested with pieces of the gloves. Gloves releasing considerable amounts of thiurams and/or carbamates caused more positive patch test reactions in these patients than gloves releasing smaller amounts. Household gloves made from natural rubber released a lower amount of thiurams and carbamates and caused a significantly smaller number of positive patch test reactions than surgical gloves.²⁰

The IVDK data do not include type I allergy. Due to the generally lower incidence of type I allergy when compared to type IV allergy from rubber products, we suggest that type I (latex) allergy from household gloves is low, too. This is supported by the fact that only two publications reported type I allergy from household gloves. It seems that latex allergy from household gloves is very rare. Since 2005, the level of extractable proteins from household gloves has been limited to 200 p.p.m., which is significantly lower than previously found in the German market, but also significantly higher than regulated for medical gloves. That means that we expect an even lower rate of type I (latex) allergy from household gloves since that date.

In summary, our data and data from the literature indicate that contact allergies to household gloves are infrequent, in apparent contrast to, for example, medical gloves, possibly due to different use conditions and different material properties.

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