

Occupational contact allergy in the building trade in Germany: influence of preventive measures and changing exposure

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Abstract

Purpose Since 1993, assiduous efforts have been made in Germany to lower the incidence of allergic cement dermatitis by reducing the content of hexavalent chromium (Cr VI). Usage of epoxy resin systems has considerably increased in the building trade in the same period. We analysed data of the Information Network of Departments of Dermatology (IVDK) to evaluate the influence of these changing occupational exposures on frequencies of sensitization.

Methods IVDK data of 1,153 men working in the building trade (bricklayers, tile setters etc.) presenting with occupational skin disease in the years 1994–2008 were analysed, taking into consideration not only the year of patch testing, but also beginning and duration of work in the building trade.

Results While contact sensitization to chromate decreased from 43.1 to 29.0%, sensitization to epoxy resin increased from 8.4 to 12.4%. Logistic regression analysis revealed that, compared to those who had already worked before 1994, patients having started to work in building trade after 1999 had a significantly decreased risk of chromate sensitization (odds ratio 0.42) and a significantly increased risk of sensitization to epoxy resin (odds ratio 2.79). Additionally,

risk of thiuram sensitization increased with the duration of employment.

Conclusion Our data confirm that reducing Cr VI content of cement is useful in preventing allergic cement eczema, as previously found in Scandinavia. In contrast, the increasing prevalence of contact sensitization to epoxy resin components in the building trade is alarming. Preventive measures, which have already been implemented, have to be enforced.

Keywords Bricklayers · Cement dermatitis · Chromate · Construction workers · Contact allergy · Epoxy resin · Occupational dermatitis · Prevention · Thiurams

Introduction

Occupational exposure of bricklayers, construction workers, tile setters etc. has changed considerably in recent years, partly due to preventive measures, partly due to technological progress. The two most important changes are probably the following.

Reduction of chromate in cement

Assiduous efforts have been made in Germany to reduce allergic cement eczema, i.e. contact allergy to chromate. In 1993, the technical rule for hazardous substances (Technische Regel für Gefahrstoffe; TRGS) 613 has been adopted, demanding the use of chromate-reduced cement and cement-containing products. However, the concentration limit of 2 ppm chromate given in this guideline was related to the total solid of the product (Anonymus 1993). This meant that, depending on the share of cement in the product, the cement could have had substantially more than

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2 ppm of chromate. It was not before October 2002 that this part of the TRGS 613 was changed, so that the 2 ppm chromate limit was now related to the dry cement contained in the product (Anonymus 2002). Chromate-reduced tile adhesives have been available in Germany since 1994, and chromate-reduced cement was available from 1997 on. However, only a part of the products on the market were chromate reduced. As a result of negotiations of all German associations and institutions involved in producing, processing, and handling cement, including the cement-producing industry and the statutory accident insurance, a “trade arrangement” was adopted. It said that, from January 2000 on, all manually processed cement and mortar in Germany had to be chromate reduced (Bock et al. 2004). At last, in June 2003, the EU directive 2003/53/EC has been adopted, stating that, from January 2005 on, cement and cement-containing products with a content of water-soluble hexavalent chromium of more than 2 ppm, related to the dry cement, may not be marketed in the European Union (Anonymus 2003).

Increasing use of epoxy resin systems

Synthetic resins, in particular epoxy resins, are increasingly used in various fields of application in the building trade. In spite of all efforts, skin protection at the workplace when handling epoxy resin products has been, and in many cases still is, insufficient at construction sites (Geier et al. 2004). It is clinical experience that occupational sensitization to components of epoxy resin systems (resins, hardeners, reactive diluents) is often acquired within a short period of time.

In consideration of these changing exposures, changes in occupational sensitization in the building trade over the years can be expected. However, a time trend analysis merely considering the years of patch testing, and not the years in which the patients started working in the building trade and the duration of their employment, might fail to detect effects of exposure changes on sensitization frequencies, because, once acquired, sensitization can be confirmed by patch testing for many years. With this in mind, we have analysed data of the Information Network of Departments of Dermatology (IVDK) of the years 1994–2008 on contact sensitization in bricklayers, construction workers, tile setters etc. with occupational dermatitis.

Materials and methods

The IVDK is a surveillance system on contact allergy with more than 50 departments of dermatology participating (Schnuch et al. 2008a). Its routine way of data processing,

quality control etc. is described elsewhere (Uter et al. 1998, 2005). Briefly, clinical data and patch test results of all patients patch tested in the participating centres are collected and stored in a central database located at the department of dermatology of the University of Göttingen, Germany. Patch tests are performed and read according to the guidelines of the International Contact Dermatitis research Group (ICDRG), further refined by the German Contact Dermatitis Research Group (Deutsche Kontaktallergie-Gruppe; DKG) (Schnuch et al. 2008b). Data analysis was based on patch test reactions at day 3; in few cases, when no reading could be done at day 3, reactions at day 4 were considered instead. From the central IVDK database, 1994–2008 (in total, quality-controlled data of 140,840 patients), we selected data of all patients with one of the following past or present occupations: bricklayer, concrete worker, construction worker, floor layer, plasterer, terrazzo layer, tile setter. Among the 1,844 patients thus identified, 1,153 had occupational skin disease. These 1,153 patients (98% men, mean age 42 ± 13 years) were the basis of the present data analysis.

To allow a valid comparison of frequencies of sensitization in different subgroups, we restricted our analysis to allergens from the standard series, which had been tested in more than 90% of the patients. Regarding all other allergens, which are tested in special test series or even individually, the proportion of positive reactions is essentially determined by the indication for patch testing, so that any possible time trend may be obscured. First, we carried out a descriptive statistical analysis of the most frequent allergens in the total study group and in 5 subgroups of patients, defined by years of patch testing, each of them representing 3 years of the 15-year study period. However, as mentioned earlier, the year of patch testing does not reflect start and duration of exposure in the building trade. Therefore, in an alternative approach, subgroups of patients were defined according to the year in which they started to work in the building trade (before 1994, from 1994 to 1999, after 1999) and according to the duration of employment (less than 2 years, 2–5 years, more than 5 years). Time limits for the first set of subgroups were chosen according to the beginning of the above-mentioned preventive measures, i.e. first introduction of chromate-reduced tile adhesives in 1994 after adoption of the first TRGS 613, and broad availability of chromate-reduced cement after the “trade arrangement”, starting in 2000. The time period after 2000 was not differentiated further because the number of patients who started working in the building trade later was too small. Subgroups addressing different durations of employment were defined because it is well known that contact allergy to chromate is usually acquired after long-standing irritant cement dermatitis. In contrast, epoxy resin contact allergy is mostly acquired within a relatively short

period of exposure. For these subgroups, too, a descriptive statistical analysis of the most frequent contact allergens was performed.

As pointed out, differences in the proportion of sensitizations to chromate or epoxy resin between the latter subgroups of patients may be attributed to both, the beginning and the duration of employment in the building trade. To analyse the independent effect of these 2 factors, logistic regression analyses were performed, with positive patch test reaction to the respective allergen as target variable and the beginning and duration of employment in the building trade (each categorized in 3 subgroups as mentioned) as explanatory variables, thus controlling for the effect of the respective other explanatory variable. Data analysis was performed according to international guidelines (Uter et al. 2004b) using SASTM software (version 9.1, SAS Institute, Cary, NC).

Results

Table 1 shows the most frequent allergens found in the total study group ($n = 1,153$) and in the 5 subgroups

defined by years of patch testing. The composition of the DKG standard series changed over the years. Hence, some allergens were not continuously part of it during the total study period. It can be seen that the proportion of positive test reactions to potassium dichromate declined from 1994 to 2005 and increased again slightly in the last period (2006–2008). However, over the total study period, there was a significant trend towards lower proportions of patients sensitized to chromate (Cochran-Armitage trend test; $p < 0.0001$). With epoxy resin, a changing proportion of positive reactions were seen during the years, with an insignificant trend to increase from 2000 to 2008. Most other allergens showed either no continuous trend or no marked change at all.

Table 2 depicts the distribution of the beginning and duration of work in the building trade. Unfortunately, data on the beginning were missing in almost 22% of the patients. However, it can be seen that almost 60% started working before 1994, and only 5.6% (65 individuals) started working in the building trade after 1999. Logically, duration of work could not be calculated in those patients in whom the start date was unknown. As in some additional

Table 1 Percent positive reactions to the 20 most frequent allergens from the DKG standard series in the total study population and in subgroups defined by years of patch testing

Allergen	Total (1994–2008) ($n = 1,153$)	Year of patch test				
		1994–1996 ($n = 294$)	1997–1999 ($n = 273$)	2000–2002 ($n = 196$)	2003–2005 ($n = 210$)	2006–2008 ($n = 180$)
Potassium dichromate	36.8	43.1	41.7	37.1	26.9	29.0
Cobalt chloride	15.7	16.1	16.2	17.7	12.4	15.7
Thiuram mix	10.8	7.7	14.0	12.4	9.6	10.8
Epoxy resin	8.8	8.4	6.9	5.9	11.6	12.4
Nickel sulphate	7.2	6.6	10.7	4.8	5.8	6.7
<i>p</i> -Phenylenediamine base	NT	9.4	6.1	5.4	NT	NT
Fragrance mix	5.3	4.6	7.7	5.3	3.7	4.9
Balsam of Peru	4.8	4.2	5.7	4.8	4.2	4.8
Thimerosal	NT	5.7	6.9	NT	NT	NT
Colophony	3.7	1.0	5.0	4.3	3.2	6.1
Zinc diethyldithiocarbamate	2.9	2.2	2.6	2.7	3.2	4.8
(Chloro)-Methylisothiazolinone (MCI/MI)	2.8	1.9	3.1	4.8	1.1	3.6
<i>N</i> -Isopropyl- <i>N'</i> -phenyl- <i>p</i> -phenylenediamine	2.7	3.5	2.6	2.7	2.6	1.2
Wool alcohols	2.6	1.0	1.9	4.3	4.2	2.4
Methyldibromo glutaronitrile/ 2-Phenoxyethanol	NT	1.0	3.3	5.0	NT	NT
Methyldibromo glutaronitrile	NT	NT	NT	NT	NT	6.1
Mercury ammonium chloride	NT	2.4	3.1	1.6	NT	NT
Mercaptobenzothiazole	2.6	3.3	3.4	1.6	2.1	2.4
Mercapto mix	NT	NT	2.3	1.6	2.6	1.2
Formaldehyde	1.6	2.4	0	1.6	2.6	1.2

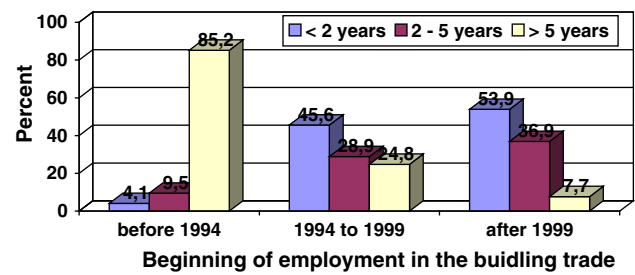
NT not (continuously) tested as part of the DKG standard series in the respective time period

Table 2 Distribution of beginning and duration of employment in the building trade in the total study population and in subgroups defined by years of patch testing

	Year of patch test											
	1994–1996 (<i>n</i> = 294)		1997–1999 (<i>n</i> = 273)		2000–2002 (<i>n</i> = 196)		2003–2005 (<i>n</i> = 210)		2006–2008 (<i>n</i> = 180)		Total (1994–2008) (<i>n</i> = 1,153)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Beginning of employment												
Before 1994	219	74.5	182	66.7	118	60.2	101	48.1	67	37.2	687	59.6
1994–1999	21	7.1	52	19.1	27	13.8	32	15.2	17	9.4	149	12.9
After 1999	–	–	–	–	6	3.1	24	11.4	35	19.4	65	5.6
Unknown	54	18.4	39	14.3	45	23.0	53	25.2	61	33.9	252	21.9
Duration of employment												
Less than 2 years	39	13.3	36	13.2	18	9.2	18	8.6	20	11.1	131	11.4
2–5 years	32	10.9	40	14.7	17	8.7	22	10.5	21	11.7	132	11.5
More than 5 years	166	56.5	156	57.1	115	58.7	115	54.8	75	41.7	627	54.4
Unknown	57	19.4	41	15.0	46	23.5	55	26.2	64	35.6	263	22.8

cases, the end date was unknown, too (but obviously before the date of patch testing), the proportion of patients with unknown duration of work summed up to almost 23%. The majority of patients (54.4%) had been working for more than 5 years in the building trade at the time of patch testing. However, beginning and duration of work are to some extent related, and the proportions of patients with different duration of work were not equally distributed in the subgroups formed by the beginning of work. This is depicted in Fig. 1. In the subgroup of patients who had started to work before 1994, the vast majority (85.2%) had been working more than 5 years, while only 4.1% had been working for less than 2 years at the time of patch testing. In contrast, only 7.7% of those having started to work after 1999 had been working for more than 5 years at the time of patch testing, while 53.9% had been working for less than 2 years.

Table 3 shows the most frequent allergens of the standard series in the 6 subgroups of patients formed by different years of beginning to work in the building trade and of duration of employment. Again, data analysis was limited to those standard series allergens, which were tested in more than 90% of the study group, to allow valid comparisons. Regarding the year of beginning of working in the building trade, descending time trends can be seen for potassium dichromate, cobalt chloride and thiuram mix. An increasing trend can be noted with epoxy resin only. All other allergens show no conclusive pattern. As far as duration of work is concerned, there is an increasing trend to sensitization to potassium dichromate, thiuram mix, nickel sulphate and mercaptobenzothiazole with increasing duration of work. Positive reactions to epoxy resin were most frequently seen in the subgroup of patients working for less than 2 years. However, there was no clear-cut

**Fig. 1** Duration of working in the building trade in subgroups of patients with different years of beginning of employment in the building trade

decreasing trend with increasing work duration. Adjusted logistic regression analysis (Table 4) revealed that patients having started to work in the building trade after 1999 had a significantly decreased risk of sensitization to dichromate (OR: 0.42, 95% CI: 0.20–0.90) and a significantly increased risk of sensitization to epoxy resin (OR 2.79, 95% CI: 1.03–7.29), compared to those having started to work in the building trade before 1994. Significant variation across the categories of work duration was found in two allergens: patients with work duration of 2–5 years had a significantly lower risk of epoxy resin sensitization (OR 0.39, 95% CI: 0.14–0.94), compared to those working for less than 2 years, and patients who had been working for more than 5 years in the building trade at the time of patch testing had a significantly increased risk of sensitization to thiurams (OR 3.20, 95% CI: 1.17–8.78).

Cobalt sensitization was strongly associated with sensitization to chromate, but not to nickel. While 93.6% of the patients reacting to cobalt chloride also reacted to potassium dichromate, only 15.6% of the cobalt positive patients had a positive test reaction to nickel sulphate.

Table 3 Percent positive reactions to the 20 most frequent allergens from the DKG standard series in the total study population and in subgroups defined by beginning or duration of working in the building trade

Allergen	Beginning of employment			Duration of employment		
	Before 1994 (<i>n</i> = 687)	1994–1999 (<i>n</i> = 149)	After 1999 (<i>n</i> = 65)	<2 years (<i>n</i> = 131)	2–5 years (<i>n</i> = 132)	>5 years (<i>n</i> = 627)
Potassium dichromate	40.4	28.4	20.0*	23.8	38.0	39.3
Cobalt chloride	16.5	11.3	10.7	13.7	10.7	16.4
Thiuram mix	11.7	9.2	7.1	5.0	7.4	12.8*
Epoxy resin	6.8	10.7	18.2*	15.7	5.9*	7.1
Nickel sulphate	7.5	4.9	8.9	5.6	5.8	7.7
<i>p</i> -Phenylenediamine base ^a	7.1	7.9	0	6.4	3.8	7.4
Fragrance mix	6.0	4.2	5.4	4.9	4.1	6.1
Balsam of Peru	5.0	1.4	3.6	2.4	2.4	5.0
Thimerosal ^a	5.3	11.6	0	8.5	7.2	5.5
Colophony	4.7	0.7	5.4	2.5	1.7	4.9
Zinc diethyldithiocarbamate	3.2	2.7	1.5	0	3.3	3.5
Methyldibromo glutaronitrile ^a	5.6	2.7	0	2.9	4.5	5.5
(Chloro)-Methylisothiazolinone (MCI/MI)	3.3	1.4	5.3	1.6	2.5	3.6
<i>N</i> -Isopropyl- <i>N'</i> -phenyl- <i>p</i> - phenylenediamine	3.2	2.1	1.5	3.2	1.7	3.2
Wool alcohols	3.2	1.4	0	0.8	0	3.7
Methyldibromo glutaronitrile/ 2-Phenoxyethanol ^a	2.9	2.5	0	1.9	2.0	3.1
Mercury ammonium chloride ^a	2.7	2.3	0	1.8	2.8	2.7
Mercaptobenzothiazole	2.9	0	1.5	0.8	1.7	2.6
Mercapto mix ^a	2.4	0.7	0	0.8	0.8	2.3
Formaldehyde	1.1	0.7	3.6	0.8	1.7	1.2

* Significant difference ($p < 0.05$) to reference category (“before 1994” and “<2 years”, respectively) according to logistic regression analysis

^a Allergen was not continuously tested as part of the DKG standard series during the total study period

These proportions did not differ between subgroups of patients patch tested in different years, having started their occupational career in different years or having worked in the building trade for different periods (data not shown in detail). The proportion of chromate allergic patients who also reacted to cobalt chloride was 38.4%. Although this share ranged from 31.0 to 51.1% among all of the subgroups of patients analysed, there was no significant difference, due to small sample sizes. However, highest proportions were seen in patients patch tested in 2000–2002 (43.9%) and 2006–2008 (51.1%), in patients who had started to work in the building trade after 1999 (45.5%) and in patients who had worked in this branch for less than 2 years at the time of patch testing (46.4%).

Discussion

Our data confirm the Scandinavian experience that reduction of hexavalent chromium in cement is an efficient measure to prevent chromate sensitization in construction

workers (Avnstorp 1992). All the arduous efforts described in the introduction of this paper eventually were successful. Bricklayers etc. with occupational dermatitis registered in the IVDK database who had started to work after 1999, when all manually processed cement and mortar in Germany had to be chromate reduced, had a significantly lower risk of chromate sensitization (odds ratio 0.42), compared to those who had started to work before 1994, when chromate content of cement was not regulated at all. At that time, a chromate content of up to 26.5 ppm was observed in German cement (Rühl and Kluger 1995). Additionally, our data demonstrate impressively that a time trend analysis of patch test data that just takes into consideration the year of patch testing does not necessarily reflect effects of preventive measures. Although a significant decline of dichromate sensitization can be observed in the course of (patch test) years, the slight rise in the last period (2006–2008) might have alarmed responsible institutions. However, when considering the much more meaningful year of beginning of working in the building trade instead of simply the year in which the patients were

Table 4 Influence of beginning and duration of working in the building trade on sensitization to the most frequent allergens from the DKG standard series which have been tested continuously during the study period

Target variable: positive test reaction to allergen	Beginning of employment			Duration of employment		
	Before 1994	1994–1999	After 1999	<2 years	2–5 years	>5 years
Potassium dichromate	1 [reference]	0.630 [0.390–1.016]	0.422 [0.198–0.898]	1 [reference]	1.674 [0.942–2.973]	1.388 [0.805–2.392]
Cobalt chloride	1 [reference]	0.600 [0.293–1.166]	0.504 [0.158–1.344]	1 [reference]	0.666 [0.292–1.491]	0.881 [0.439–1.839]
Thiuram mix	1 [reference]	1.329 [0.640–2.760]	0.922 [0.246–3.453]	1 [reference]	1.636 [0.553–4.841]	3.204 [1.170–8.772]
Epoxy resin	1 [reference]	1.481 [0.658–3.192]	2.794 [1.034–7.286]	1 [reference]	0.386 [0.143–0.938]	0.655 [0.295–1.500]
Nickel sulphate	1 [reference]	0.725 [0.260–1.784]	1.145 [0.293–3.668]	1 [reference]	0.972 [0.313–3.010]	1.258 [0.474–3.745]
Fragrance mix	1 [reference]	0.808 [0.261–2.165]	1.108 [0.224–4.177]	1 [reference]	0.804 [0.219–2.822]	1.174 [0.403–3.906]
Balsam of Peru	1 [reference]	0.350 [0.050–1.413]	1.024 [0.136–5.102]	1 [reference]	0.831 [0.144–4.774]	1.444 [0.377–7.730]
Colophony	1 [reference]	0.219 [0.011–1.230]	2.158 [0.367–10.728]	1 [reference]	0.591 [0.073–3.832]	1.787 [0.414–10.919]
(Chloro)-Methylisothiazolinone (MCI/MI)	1 [reference]	0.697 [0.100–2.824]	3.351 [0.586–15.671]	1 [reference]	1.661 [0.261–13.136]	3.136 [0.607–25.354]
N-Isopropyl-N'-phenyl-p-phenylenediamine	1 [reference]	0.531 [0.102–2.094]	0.474 [0.023–3.350]	1 [reference]	0.403 [0.053–2.220]	0.629 [0.173–2.911]
Formaldehyde	1 [reference]	0.982 [0.046–7.031]	5.995 [0.570–50.494]	1 [reference]	2.442 [0.222–54.102]	3.084 [0.292–79.293]

Results of an adjusted logistic regression analysis presented as odds ratios (OR) with 95% confidence intervals (95%-CI) in square brackets. Significant differences to the reference group are printed bold. No calculations could be done with zinc diethyldithiocarbamate, wool alcohols and mercaptobenzo-thiazole, as validity of the model fit was questionable, due to almost complete separation of data points

patch tested, the beneficial effect of chromate reduction is revealed. The decline of the absolute number of bricklayers etc. with occupational dermatitis registered in the IVDK database (from 294 in 1994–1996 to 180 in 2006–2008) may be due to generally improved occupational hygiene, leading to less occupational skin diseases. However, an alternative or additional interpretation may be that in recent years, patients with occupational skin disorders do not seek medical help because they fear to lose their job.

Up to now, only few reports on the time course of chromate sensitization in construction workers in Germany have been published, even fewer considering the last years, when an effect of the preventive measures could have been expected. Bock et al. (2003) analysed data from the Northern Bavaria register of occupational skin disease (Berufskrankheitenregister Haut Nordbayern; BKH-N), 1990–1999. In their sample of 177 construction and cement workers (including bricklayers, unskilled workers etc.) and 52 tile setters with occupational skin disease (98% men; mean age 39 years), potassium dichromate was by far the most frequent allergen, eliciting positive reactions in 147 patients (64%), with a largely unchanged incidence during the study period. The authors gave no data on the beginning and duration of employment in the building trade; they just stated that their patients developed skin problems after a median of 12 years in their occupation. As can be seen from our data, beginning and duration of employment in the building trade largely influence the frequency of sensitizations diagnosed. Hence, differences in sensitization frequencies, compared to our data, may be due to differences in these items. In our study group, 39.3% of

those patients who had been working for more than 5 years were sensitized to chromate. This is in accordance with findings reported by a previous study (Condé-Salazar et al. 1995). However, one has to be aware that the duration of occupational exposure is correlated with the start of exposure, resulting in some association (and mutual confounding) of these 2 factors, as seen in our study group (Fig. 1). This is probably the reason why a long time of working in the building trade as a single factor had no significant effect on sensitization to chromate in the adjusted analysis, while in the bivariate, unadjusted comparison, the odds of chromate sensitization are about doubled in the longest, compared with the shortest, occupational exposure group (Odds ratio 2.8; 95% confidence interval 1.33–3.25).

Despite the first preventive efforts, the German statutory accident insurances of the building trade found the incidence of allergic cement eczema caused by chromate to be continuously increasing in the 1990s (Bock et al. 2004). A change was noted around the turn of the millennium, and a recent analysis of their database revealed that the incidence declined from 471 cases in 1997 to 252 in 2006 (Kluger 2007). However, these analyses did not regard beginning and duration of employment in the building trade; they were just based on the years of registration in the occupational skin disease register, the years of recognition of an occupational skin disease in the legal sense, or the years of patch testing. To our knowledge, our present analysis of sensitizations in the building trade is the first to take into consideration the beginning and duration of working in this field of occupation. As pointed out

previously, the importance of this approach is evident. When simply regarding the year of patch testing, in our data, a decline of chromate sensitization can be seen from the first three-year period, 1994–1996, to 2003–2005, followed by a slight (insignificant) increase in 2006–2008 (Table 1). The consideration of beginning and duration of employment in the building trade gives a much more valid impression of the effect interventions have had so far.

Contact allergy to chromate acquired by handling wet cement has been the most frequent sensitization in bricklayers, construction workers and tile setters for many years (Avnstorp 1989, 1991, 1992). Scandinavian countries drew adequate conclusions already 20 years ago by limiting the content of hexavalent chromium in cement to 2 ppm (Avnstorp 1992; Roto et al. 1996). By adding ferrous sulphate, water-soluble hexavalent chromium is reduced to trivalent chromium, which, in the alkaline environment of cement, is present as hardly soluble chromium hydroxide or chromium oxide (Avnstorp 1992; Fisher 1986; Fregert et al. 1979). By wearing gloves alone, no reduction in allergic cement eczema can be achieved. In the best case, irritant skin damage can be reduced (Avnstorp 1992). This is not surprising when having in mind that at construction sites, usually textile/leather gloves were worn, which are penetrated easily and do not protect against liquids or moist materials (Struppek and Ludwig 1999). Nitrile-coated cotton gloves are an appropriate alternative recommended for construction work (Struppek and Ludwig 1999). In Denmark, ferrous sulphate is added to cement since 1981, and hereby, the prevalence of allergic cement eczema among workers with daily contact to cement could significantly be reduced from 8.9% in 1981 to 1.3% in 1987 (Avnstorp 1992). The frequencies of sensitization to chromate we observed in our current data analysis were considerably higher, due to patient selection. While Avnstorp performed an intervention study on construction workers, regardless of their skin condition, our study population were bricklayers, tile setter etc. with occupational skin disease presenting in dermatological hospitals. Thus, a higher prevalence of chromate sensitization was to be expected. Additionally, it has to be considered that in these patients, cement is not the only possible occupational exposure to chromate. Leather goods (gloves, shoes) can be important chromate sources, too, and may explain why sensitization to chromate will continue to occur (Thyssen et al. 2009).

It is important to note that in all analyses of subgroups of our patients, according to year of patch testing, beginning, or duration of working in the building trade, no uniform trend concerning sensitization could be seen across all of the allergens tested. Hence, differences between these subgroups are in no case due to a general increase or decrease in sensitization, irrespective of the allergen.

The changing occupational exposure, with increasing use of epoxy resin systems in the building trade, is impressively reflected by our data. In the last 2 three-year periods of patch testing, we found markedly more patients sensitized to epoxy resin than in the periods before. To our knowledge, no other time trend studies on epoxy resin sensitization in the building trade have been published. In our data, patients who started to work after 1999 had higher percentages of epoxy resin sensitization than those with an earlier start (18.2%, compared to 10.7% (start in 1994–1999) and 6.8% (start before 1994)), and patients with a duration of employment in the building trade of less than 2 years were more often sensitized than those who already had been working for a longer time. All these findings together strongly indicate that the risk of getting sensitized to epoxy resin when working in the building trade has increased in recent years. Additionally, it confirms clinical experience that epoxy resin allergy is acquired within a very short time. Therefore, effective measures to prevent epoxy resin sensitization in the building trade are urgently needed. The most important factors are information and education of the workers concerning hazards and occupational hygiene (i.e. avoidance of contamination), wearing of adequate gloves and protective clothes and supply of technical equipment allowing contamination-free handling of epoxy resin systems. In Germany, corresponding programs have been initiated by the statutory accident insurance of the building trade, in cooperation with companies producing chemicals for the construction industry.

The observation of patients working in the building trade for more than 5 years having a significantly increased risk of thiuram sensitization (OR 3.2) was somewhat surprising. In all reports on sensitizations in this occupational field, thiuram sensitization has been reported as a frequent event (Bock et al. 2003; Geier and Schnuch 1995, 1998; Uter et al. 2004a). However, while a slight general decline of thiuram sensitization has recently been reported (Uter et al. 2010), a time trend or an association with the duration of this specific occupational exposure has never been addressed. The finding seems plausible, because, in the building trade, besides the “traditional” textile/leather gloves (not useful at all, but widely used), cheap latex or rubber gloves are worn frequently, and most of the cheap rubber gloves on the market are produced with thiurams. Nitrile-coated cotton gloves, which are recommended for handling wet cement, usually do not contain any thiurams. However, these gloves are not suitable for handling epoxy resins or other resin systems. For this exposure, gloves made from pure nitrile or butyl rubber can be recommended; in view of our findings, modern high-quality gloves, which are thiuram- and carbamate-free, should be chosen for this purpose.

As observed in earlier IVDK data analyses (Geier and Schnuch 1995, 1998, Uter et al. 2004a) and reported from other investigators, cobalt sensitization was strongly associated with dichromate sensitization in our patients, irrespective of beginning or duration of employment in the building trade. Like chromate sensitization, cobalt sensitization is acquired by handling wet cement. Fregert et al. (1979) described the phenomenon that cobalt ions in cement penetrate pre-damaged skin more easily thus leading to co-sensitization in patients suffering from chronic cement eczema. Hence, the proportion of cobalt allergic patients among patients with cement eczema sensitized to chromate depends on the duration of disease, a factor that we could not consider because it is not routinely documented in the IVDK. This explains why there is no constant proportional relationship between cobalt sensitization and chromate sensitization. Concomitant sensitization to cobalt and nickel was rare among our patients, illustrating that costume jewellery was not the major source of cobalt sensitization in this particular group of patients.

Conclusion

Preventive measures to reduce allergic cement eczema by reducing Cr VI content of cement and cement-containing products are effective. This experience, well known in Scandinavia for more than 20 years, has now been confirmed for Germany. In contrast, the increasing prevalence of contact allergy to epoxy resin in the building trade is alarming. In this regard, the set of preventive measures already conceived and implemented has to be enforced.

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