

Prevalence of Cement Eczema in Denmark Before and Since Addition of Ferrous Sulfate to Danish Cement

CHRISTIAN AVNSTORP

Department of Dermato-Venereology, Gentofte Hospital, University of Copenhagen, Hellerup, Denmark

This is a study of the prevalences of chromate allergy and hand eczema among workers engaged in the manufacture of pre-fabricated concrete building components in Denmark in 1981 and again in 1987. In September 1981 the chromate content of cement manufactured and sold in Denmark was reduced to not more than 2 ppm (parts per million) of water-soluble chromate. This was accomplished by adding ferrous sulfate, thus increasing the cost of the cement by about 1%. There was a statistically significant decrease in the prevalence of chromate allergy and hand eczema following the addition of ferrous sulfate, but there was no change in the frequency of skin irritation. The economic benefit of adding ferrous sulfate was demonstrated by a decrease in the need for dermatological services and topical steroid treatment. Cement eczema as a result of chromate allergy is a common occupational dermatitis among workers in the building and construction industries and a reduction in the chromate content of cement would appear to be a reasonable preventive measure in areas where there is a large concentration of construction industries. *Key words: Chromate allergy; Ferrous sulfate.*

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C. Avnstorp, Dept. of Dermatovenereology, Gentofte Hospital, Niels Andersensvej 65, DK-2900 Hellerup, Denmark.

An association between cement eczema and chromate sensitization was established as early as 1950 (1). A practical solution to the problem, involving a reduction of the amount of water-soluble chromate in cement by adding ferrous sulfate to it, was suggested by Fregert et al. (2, 3).

In 1981, Aalborg Portland A/S, the sole manufacturer of cement in Denmark, patented a method for reducing the amount of chromate in cement. From September 1981, ferrous sulfate has been added to all cement produced and sold in Denmark, thus reducing the chromate content of the cement at a cost of about 10 million Danish kroner per yer. The total value of the cement used in Denmark was approximately 900

million Danish kroner the same year. Legislation was passed in Denmark in 1983 stating that the content of water-soluble chromate in cement must not exceed 2 mg per kg cement (2 ppm) (4).

The purpose of the current study was to estimate the prevalence of cement eczema and chromate allergy in Denmark before and since the reduction of chromate in the cement.

MATERIALS AND METHODS

Workers who had daily contact with wet cement and who were employed in five factories in Denmark which manufacture pre-fabricated concrete building components were examined in 1981. 190 of 196 workers were patch tested with potassium dichromate, nickel sulfate and cobalt chloride at that time. In 1987, 227 of 229 workers from the same factories were patch tested with the same substances, this making it possible to estimate prevalence values in 1981 and 1987. Workers who were available for investigation on both occasions were selected for another study (5).

A control group for the patch tests carried out in 1981 comprised of 172 workers from the same factories who had no contact with wet cement. 158 workers in the control group were patch tested with the substances listed above. A medical and occupational history was recorded for each worker. The records included all the variables listed in Table 1. The general condition of the skin and any sign of dermatitis on the hands or any other area of the body was recorded at the clinical examinations made in both 1981 and 1987. Hand eczema was defined as erythema as well as vesicles and/or hyperkeratosis of the palms, dorsal aspects of the hands or on the fingers. The designation 'skin irritation' was used if the worker reported itching on the hands and the clinical examination revealed erythema or hyperkeratosis. The patch testing was carried out at the factories, using 0.5% potassium dichromate in both petrolatum and water, 5% nickel sulfate in petrolatum, and 1% cobalt chloride in petrolatum (Hermal chemie, Reinbek, West Germany). Finn Chambers (Epitest OY, Helsinki, Finland) were fixed on the upper back with Scanpore (Norges plaster A/S, Oslo, Norway) for 48 h. Readings were made in accordance with the stipulations of the International Contact Dermatitis Research Group (ICDRG) (6) after 72 h; any doubtful positive reaction or possible irritant reaction was read again after 96 h and after one week. Identical criteria were applied for the readings made 1981 and again in 1987. A positive patch test was defined as erythema plus infiltration and/or vesicles.

A questionnaire was sent to workers who could not be present for a clinical examination. There were no statistically

Table I. Variables recorded

Age
Duration of exposure to cement
Work processes (degree of exposure to cement)
Eczema or other types of skin changes: a) previously, b) during the past year, and c) at present
Itching, vesicles and fissures on the hands persisting at least 2 weeks during the past year, or currently
Use of soaps, detergents, gloves and creams ^a
Visits to physicians other than dermatologists, or to dermatologists
Treatment with topical steroids
Sick leave due to eczema.

^a Creams: emollient creams, barrier creams, protective creams, protective ointments.

significant differences between the group of workers actually examined and the questionnaire group with respect to exposure to wet cement and the reporting of skin conditions.

Statistical analysis included estimates of prevalences, relative risk and odds ratios. The confidence interval for relative risk was estimated using Miettinen's method (7). The confidence interval for the odds ratio was estimated using the method described by Bishop, Fienberg & Holland (8). Non-parametric tests and χ^2 -tests as well as logistic regression analyses were also carried out (9).

RESULTS

Only those workers who were present for a clinical evaluation were included in the analysis of results, which is presented in Table II. In general, the workers in the 1987 population were younger than those in the 1981 population.

A logistic regression analysis of the 1981 popula-

tion showed that the prevalence of chromate sensitization was significantly influenced ($p \leq 0.01$) by the following variables: previous or current eczema on the hands or forearms or eczema on the dorsal aspect of the right hand. A worker with all of these characteristics ran an 82% risk of becoming sensitized to chromate. The following variables significantly influenced the risk of actual hand eczema at the time of the examination ($p \leq 0.01$): itching, fissures, or vesicles on the hands for at least 14 days during the past year, previous eczema on the hands or forearms, and chromate sensitization. A worker with these conditions ran a 71% risk of developing hand eczema.

As shown in Table II, the prevalence of hand eczema and chromate allergy decreased from 1981 to 1987, this difference being statistically significant. There was no significant difference in the prevalence

Table II. Prevalences in the 1981 and 1987 populations of workers (percentages given in parentheses)

	1981	p-value	1987
<i>During the year prior to examination</i>			
Itching on hands	39/196 (19.9)	0.45	38/229 (16.6)
Frequent use of gloves	93/196 (47.4)	0.02	144/229 (62.9)
Sick leave due to hand eczema	5/196 (2.6)	0.15	1/229 (0.4)
Visited a dermatologist	22/196 (11.2)	0.007	9/229 (3.9)
Topical steroid treatment	29/196 (14.8)	0.009	15/229 (6.6)
<i>At the time of the examination</i>			
Hand eczema ^a	23/196 (11.7)	0.008	10/229 (4.4)
Chromate allergy	20/190 (10.5)	0.002	6/227 (2.6)
Skin irritation ^b	11/196 (5.6)	0.64	9/229 (3.9)
Age, in years (mean)	40.7		36.4
Age range, in years	(17.4-62.7)		(17.3-67.7)
Exposure time, in years (mean)	11.8		7.6
Range in exposure time	(1-46)		(1-31)

Yates' correction has been applied to all *p*-values.

^a Presence of redness and vesicles or hyperkeratosis on the hands and/or fingers. ^b Itching and presence of redness or hyperkeratosis on the hands and/or fingers.

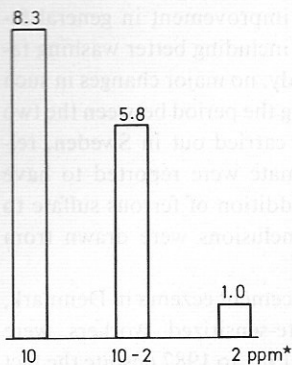


Fig. 1. Relative risk of chromate sensitization after exposure to cement containing: (a) 10 ppm of chromate, (b) 10 ppm or 2 ppm of chromate, and (c) 2 ppm of chromate or less.

of skin irritation or itching on the hands. The decline in the number of visits to a dermatologist and in the use of topical treatment from 1981 to 1987 was statistically significant. The number of workers on sick leave due to hand eczema was low in 1981, and was even lower in 1987.

The use of gloves had increased significantly from 1981 to 1987. Stratified analysis was used to remove this confounding factor from the statistics. Those workers from the 1981 and the 1987 populations who often used gloves were selected for this analysis. For these matched workers the statistical significance of the above-mentioned parameters remained unchanged.

In the control group the prevalence of chromate allergy was 1.3% (2 of 158 controls patch tested) and 2 other workers had hand eczema, giving a prevalence of 1.2% (2 of 172 control persons). The relative risk of chromate allergy in 1981 was estimated to be $20/190:2/158=8.3$ and in 1987, $6/227:2/158=2.1$ (odds ratio 0.23, standard error 0.11). The relative risk for hand eczema in 1981 was $23/196:2/172=10.1$ and in 1987, $10/229:2/172=3.8$ (odds ratio 0.33, standard error 0.13) (8). The two populations of workers who had daily contact with wet cement were matched with respect to an exposure time of 7 years. The prevalence of chromate allergy was then shown to be as follows: 4 of 75 persons had chromate allergy in 1981 and 2 of 172 had chromate allergy in 1987 ($p=0.05$, with Yates' correction $p=0.13$). 8 of 77 workers had hand eczema in 1981 while 6 of 181 workers had hand eczema in 1987 ($p=0.022$, with Yates' correction $p=0.046$).

In 1987 a group of 55 workers had been exposed to

wet cement containing 10 ppm before 1981 and since then to 2 ppm of chromate. 159 had been exposed only to cement with a chromate content of 2 ppm or less. In 1987, 4 of 55 (7.3%) of those exposed to cement containing both 10 ppm and 2 ppm of chromate were sensitized. 2 of 159 (1.3%) of those exposed to cement with a chromate content of 2 ppm or less were sensitized to chromate. In 1981, 20 of 190 (10.5%) workers exposed to cement with a chromate content of 10 ppm were sensitized to chromate. In the control group, 2 of 158 workers (1.3%) were sensitized to chromate. As illustrated in Fig. 1, the relative risk of chromate sensitization decreased from 8.3 in the most exposed group (10 ppm) to 5.8 in the moderately exposed group (10-2 ppm) and, finally, to 1.0 in the slightest exposed group (2 ppm or less). The 95% confidence interval for the relative risk value of 8.3 was estimated to be 2.6-26.9, and for the relative risk value of 5.8, the same interval was estimated to be 1.3-25.1 (7).

In the 1981 study, 2 workers were found to be sensitized to both cobalt and chromate. Two other workers were sensitized to both nickel and chromate.

In the 1987 study, no such double sensitization was found. The prevalence of nickel sensitization increased from 1.6% (3 of 190) in 1981 to 2.6% (6 of 227) in 1987, and, at the same time, the prevalence of cobalt sensitization decreased from 1.6% (3 of 190) to 0.4% (1 of 227). These changes were not statistically significant.

DISCUSSION

The prevalence of chromate allergy and hand eczema among workers in daily contact with wet cement was shown to have declined significantly 6 years after the chromate content of Danish cement was reduced. An economic benefit of the reduction in chromate content was demonstrated by the fact that fewer of these workers consulted dermatologists and that they made less use of topical steroid treatment.

Among 159 workers, exposed only to cement containing no more than 2 ppm of chromate, the prevalence of chromate allergy was equal to the prevalence in the control group. Among 55 workers who had previously had contact with cement containing more than 2 ppm of chromate, but who in the period 1981-87 had contact only with cement containing no more than 2 ppm of chromate, the relative risk of chromate sensitization decreased. The 95% confidence intervals were estimated using Miettinen's

method (7). This showed that the trend persisted, although the estimation of the relative risk for this group was rather uncertain.

The reduced chromate content in the cement was found to be of greatest significance in explaining the decrease in the prevalence of allergy and eczema. This supported the proposals made in previous reports (3, 10, 11). The reduced chromate content of cement was significantly more influential in preventing cement eczema than were such traditional methods as the wearing of gloves.

The previously stated, definitions of hand eczema and skin irritation were used to determine the presence of dermatitis. Itching was not considered to be a specific symptom of allergic eczema and was not a permanent symptom.

Chromate reduction had no influence on skin irritation nor on itching of the hands. These symptoms may have been induced in part by the wet work itself and by the handling of alkaline cement.

Workers are today more aware of the importance of protective measures than they were in the past, as was illustrated by the increased use of gloves. Fissures on the hands were improved by the frequent use of creams (data not shown). If this trend continues, fewer mild skin problems can be expected among workers who handle cement daily.

The older workers among the 1981 population had been exposed to cement for a longer period of time than the younger workers in the 1987 population. Age itself has a doubtful influence on the development of occupational hand eczema (12). Multi-variate analysis showed that the risk of development of chromate allergy or hand eczema was not influenced by age and exposure time to the same degree as by exposure due to certain work processes (13). In a German study, allergic cement eczema was found early in the workers' working life. Fourteen of 28 workers developed chromium dermatitis between the 18th and 25th year of life (14). Høvdning found that exposure time was associated with the development of chromate allergy. At the same time, he found no direct relationship between the time of onset of cement eczema and the duration of exposure (15). In the current study the two populations were matched with respect to exposure time in order to avoid the bias of different exposure times.

In Northern Ireland the number of claims filed for industrial injuries benefits because of cement dermatitis decreased from 1969 to 1975 (16). This decrease was attributed to the greater awareness of the problem

within the industry and improvement in general facilities on building sites, including better washing facilities. In the present study, no major changes in such facilities took place during the period between the two studies. In a pilot study carried out in Sweden, relevant reactions to chromate were reported to have decreased, prior to the addition of ferrous sulfate to Swedish cement. No conclusions were drawn from this study (17).

In a follow-up study of cement eczema in Denmark, very few new chromate-sensitized workers were found in the period from 1981 to 1987 despite the fact that no changes in working habits or in exposure to wet cement were noted (5). If a decrease in the prevalence of cement eczema and chromate sensitization could be explained solely by a change in the habits of and improved facilities for the new workers studied in 1987, the number of newly sensitized older workers should have increased.

The prevalence of cobalt sensitization decreased simultaneously with the prevalence of chromate sensitization. At the same time, nickel sensitization increased, although not significantly. In 1987, no workers had a simultaneous chromate and cobalt/nickel allergy. Cobalt and nickel were not found to be significant occupational allergens for workers in firms manufacturing pre-fabricated concrete building components.

The patch test results were highly significant, as illustrated by the fact that among the total of 26 workers with positive patch tests to potassium dichromate, 23 had complained of skin trouble. Patch testing was carried out with 0.5% potassium dichromate because an appreciable percentage of true positive reactions can be missed if 0.25% potassium dichromate is used (18). Furthermore, very few false-positive reactions are likely in a high-risk population.

Very few of the workers studied took sick leave due to hand eczema in 1981, and this number was even lower in 1987. This finding is in agreement with Høvdning's study of construction workers in Bergen, Norway in 1970 (15). Higher rates of sick leave due to occupational dermatitis have been reported in the building and construction industries in The Netherlands (19) and in Britain (20). Among workers in the construction industry in Singapore, absence due to occupational dermatoses was generally low, and allergic chromate dermatitis caused by cement was the only dermatosis severe enough to result in sick leave (10).

In areas with a large concentration of construction

industries, cement eczema and chromate allergy continue to be among the most common occupational dermatoses (11, 21). In such areas there is a need for preventive measures such as adding of ferrous sulfate to cement.

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