

ALLERGY TO CHROMIUM, COBALT AND NICKEL IN METAL AND ELECTRICAL INDUSTRY WORKERS

MARTA KIEĆ-SWIERCZYŃSKA, MD

Nofer's Institute of Occupational Medicine, Lodz, Poland

Key words: Allergy, Chromium, Cobalt, Nickel, Metal industry, Electrical industry

Abstract. Patch tests were carried out on 303 metal and electrical industry workers who were examined dermatologically. Allergy to chromium was diagnosed in 19.2% of metal industry and in 12.5% of electrical industry workers. Hypersensitivity to cobalt was observed in 9% of metal industry and in 5.9% of electrical industry workmen. Allergy to nickel was encountered more frequently in electrical industry workers than in metal industry employees (5.9% and 1.8%, respectively). Sensitization to chromium compounds prevailed among galvanizers. Hypersensitivity to metals was determined as an etiological agent of dermatitis in 29.4% of metal industry and 38.3% of electrical industry workers.

The most frequently encountered form of dermatitis is contact dermatitis brought about by the exposure of the skin to chemical compounds (1, 2, 14, 24). Allergy to metals dominates among people exposed to allergens responsible for occupationally-related skin changes (3, 8, 9, 10, 16, 23). About 70% of work-related dermatoses diagnosed in Lodz province between 1972 and 1976 resulted from allergy to chromium, nickel and cobalt compounds (11).

The increase of chemicalization of both the work environment and everyday life makes the risk of prevalence of occupational dermatoses greater.

The rising number of these diseases is confirmed by the everyday observations of occupational physicians and by literature concerning dermatology (6, 14). Data available in literature referring to the sources and the types of allergy to metals, and to their frequency in Poland, are based on the results of studies carried out in major dermatology centres

Address reprint requests to M. Kieć-Swierczyńska, Nofer's Institute of Occupational Medicine, 8 Teresy Street, P.O.Box 199, 90-950 Lodz, Poland



on patients with eczema, coming from different, rather compact occupational groups (19). Data on the results of analyses concerning allergies to metals of larger groups of workers, employed at various workplaces where they are exposed to metals, are not available.

The aim of the present study was an attempt to determine to what extent the exposure of the skin to metals, in the work environment of chosen metal and electrical industry plants, affects allergies to metal in workers.

MATERIAL AND METHOD

The population under study comprised 303 workers of the electrical and metal industries: 238 males (78.5%) and 65 females (21.5%), of whom 167 persons were employed in metal and 136 in electrical industry plants. Persons of 20 to 30 years of age (32.3%) dominated among metal industry workers, and in the groups of electrical industry employees, individuals aged from 31 to 40 (33.8%) prevailed. In both examined groups, persons with professional experience of 1—5 years were most numerous (32.3%). The possibility of the presence of skin changes was examined and patch test following the generally applied rules was carried out. Persons employed in sections exposed to the sensitizing activity of metals were included in the study. 167 metal industry workers employed as turners, grinders, fitters and mechanics were exposed to metals, greases and industrial oils, regardless of the job they did. 136 electrical industry workers were exposed to different concentrations of allergens present in the work environment. 36 persons out of this group were galvanizers working at chromium, nickel, silver, cadmium, zinc and copper plating. 43 examined persons worked as varnishers, being exposed to nitrocellulose lacquers, dilutents of these lacquers, chromate undercoaters, and to silicon, polyvinyl and chlorinated rubber enamels. 57 fitters of electronic systems were exposed to metals and epoxide resins.

RESULTS

Skin changes in general were reported in 177 persons (58.4%) including 142 (59.7%) men and 35 (53.8%) women. Data on the prevalence of skin changes such as dermatitis or oil acne and other dermatoses in metal and electrical industry workers are shown in Table 1. The group presented as "other dermatoses" comprised non-occupational skin changes.

The most common form of dermatitis was hand dermatitis; much less regular was that of the forearms. Moreover, minor skin injuries, erosions and small ulcerations of irregular shape found mainly on hands,



TABLE 1. Frequency of Skin Lesion Occurrence in Metal and Electrical Industry Workers

Skin lesions	Metal industry (n=167)		Electrical industry (n=136)		Total (n=303)	
	n	%	%	n	n	%
Hand dermatitis	34	20.4	47	34.5	81	26.7
Oil eczema	46	27.5			46	15.2
Other skin diseases	41	24.5	18	13.2	59	19.2
Total	121	72.4	65	47.7	186	61.4

but also on shanks and insteps were observed in galvanizers. None of these changes were characteristic of typical chrome ulcers. They might have been caused by acids and alkali. Hand dermatitis was observed most frequently in electrical industry workers, while oil acne, only in men employed in the metal industry.

On the basis of the positive results of patch tests, allergy to metals was diagnosed in 36 (21.6%) workers of the metal industry and in 25 (18.3%) electrical industry workers. In general, 83 positive results of patch test were obtained (Table 2). Mainly, allergies to chromium com-

TABLE 2. Frequency of the Occurrence of Allergy to Metals in Metal and Electrical Industry Workers

Allergens	Metal industry (n=167)		Electrical industry (n=136)		Total (n=303)	
	n	%	n	%	n	%
Chromium	32	19.2	17	12.5	49	16.2
Cobalt	15	9.0	8	5.9	23	7.6
Nickel	3	1.8	8	5.9	11	3.6
Total	50	30.0	33	24.3	83	27.4

pounds were reported. They were found more often in metal industry workers (19.2%) than in electrical industry workers (12.5%). On the other hand, hypersensitivity to nickel was more frequent in electrical industry workers. In both groups under study, allergy to chromium compounds prevailed. Allergy solely to chromium was diagnosed in 10% of the participants, while combined allergy to chromium and cobalt, in 4.3%; allergy to both chromium and nickel — in 1.6%; and allergy to chromium, cobalt and nickel, in 0.3%. Allergy only to cobalt was obser-



ved in 7 persons and only to nickel — in 3 persons. In 2 female electrical industry workers combined allergy to nickel and cobalt, and in 1 male worker, allergy to three metals was reported.

Allergy to chromium compounds in the electrical industry prevailed among galvanizers. 25% of them revealed hypersensitivity to this metal. In 4 of them, allergy to cobalt compounds and in 5, to nickel compounds was detected. 13.9% of the varnishers were sensitized to chromium; also there were 2 persons sensitized to cobalt and nickel (1 person to each). Allergy to metals occurred least frequently in fitters of electronic systems, among whom only 2 persons were sensitized to chromium, 3 to cobalt and 2 to nickel (Table 3). The prevalence of allergies to chromium,

TABLE 3. Frequency of the Occurrence of Allergy to Metals in Electrical Industry Workers Depending on the Employment at Different Work Stands

Work-stands		Allergens		
		Cr	Co	Ni
Galvanizers	n	9	4	5
(n=36)	%	25.0	11.1	13.9
Varnishers	n	6	1	1
(n=43)	%	13.9	2.3	2.3
Fitters of electronic systems	n	2	3	2
(n=57)	%	3.5	5.3	3.5
Total	n	17	8	8
	%	12.5	5.9	5.9

cobalt and nickel in galvanizers, varnishers and fitters of electronic systems was subjected to a statistical analysis using the Fisher test. A statistically remarkable difference in the prevalence of allergy to chromium between galvanizers ($p=0.003$) and varnishers ($p=0.06$), and the groups of fitters of electronic systems was found. No difference, however, was reported between the rates of allergy to cobalt and nickel in the two groups under investigation.

Allergy to metals in the metal and electrical industries was noticed mainly in workers suffering from dermatitis. Hypersensitivity to metals was indicated as an etiological agent of dermatitis in 29.4% of metal industry and in 38.3% of electrical industry workers. 29.4% of participants employed in metal and 23.4% in electrical industry plants suffering from dermatitis were sensitized to chromium. 14.7% of metal industry and 17% of electrical industry workers revealed an allergy to cobalt and 5.9% of examined metal industry and 14.9% of electrical industry workers with dermatitis were allergic to nickel.

DISCUSSION

Mineral greases and oils are among the noxious industrial agents which produce skin changes. The most widespread of these are oil and grease acnes (12). Oils may also evoke inflammatory skin changes resulting from irritation as well as from allergic dermatitis. Fresh oils are better tolerated by the skin than the used ones which contain metal impurities. Chromium may be found in oils either as a purposely added anti-corrosion agent or as an impurity formed as a result of friction of metal surfaces in worn out products. From the information collected by Rudzki (22) it follows that no domestic coolants should contain chromium; so it is found only as an impurity. Czernielewski et al (5) found chromium compounds in industrial greases and oils using two methods — the spot test method with diphenylcarbazine, and the atomic absorption method. Cobalt and nickel can also be found in industrial oils.

Reports concerning the prevalence of allergy to metals in persons exposed to oils and greases are conflicting. Rudzki et al (20) examined 125 workers with dermatitis caused by the action of oils and diagnosed allergy to chromium in 13.6% of them. The results of a study performed in the same dermatology department on 54 mechanist millers, fitters, turners, welders and mechanics with dermatitis, indicated the existence of allergy to chromium in nearly all participants, allergy to cobalt — in 53.7% and to nickel — in 18.5% (21). Our own study made it possible to determine a high proportion of persons sensitized to metals contained in industrial oils and greases. Allergy to chromium among metal industry workers was found in 19.2% of participants, to cobalt — in 9% and to nickel — in 1.8%. Most often, hand dermatitis took the form of inflammation resulting from irritation (70.6%), although a large proportion of individuals with allergic dermatitis (29.4%) was also observed. All the persons with allergic dermatitis revealed hypersensitivity to chromium. Allergy to metals in the studied group of metal industry workers, both healthy and those with symptoms of oil acne, showed the characteristics of latent allergy without clinical symptoms of dermatitis.

A review of literature on dermatology did not reveal any reports concerning the complex evaluation of the health status of electrical industry workers, nor any results of dermatological examination or of patch tests using metals in the case of persons employed at various workposts. Single literature data refer to skin changes and allergies to metals only in galvanizers. German research workers, basing their views on the observation of 699 cases of occupational dermatitis, consider the work of galvanizers as the most hazardous as far as the possibility of the prevalence of work-related eczema is concerned (15). Kowalski et



al (13), examining 67 persons working in a galvanizing plant at chromium plating, diagnosed dermatitis in eight participants and did not determine the etiology of changes. Dornan (7) observed symptoms of dermatitis in 6 out of 150 examined galvanizers. Results of our own observations carried out on 136 currently working electrical industry employees indicate the prevalence of dermatitis in 34.5% of all participants. Dermatitis was encountered more frequently in female than in male workers employed in galvanizing plants and in the assembly of electronic elements. The observations confirm data provided by Laubstein and Mönnich (15).

Taking into account the results of patch tests, it was found that the majority of electrical industry workers were sensitized to chromium. Hypersensitivity to chromium compounds was diagnosed in 17 (12.5%) persons under study. Rudzki et al (17) found that 21.7% of examined electronic industry workers revealed allergy to chromium.

Assessing the prevalence of allergies to metals in the electrical industry according to the type of job performed at different workposts, it was proved that allergy to chromium, nickel and cobalt compounds prevailed among galvanizers. Allergy to metals was least common among the fitters of electronic systems.

Results of our own studies, defining the effect of metals on the prevalence of skin changes in electrical industry workers, are partly consistent with the reports presented by other authors. Examining the sources of occupational allergy to chromium in Poland, Rudzki et al (18) emphasize the importance of allergy to this metal in the etiology of work-related dermatitis of galvanizers. In England, where 25% of galvanizers suffer from eczema, the principal cause of allergy are chromium compounds (4). However, in this study allergy to nickel was not observed as frequently among galvanizers as it was reported by Laubstein and Mönnich (15). In the group of 39 galvanizers examined by these authors as many as 37 men were sensitized to nickel and only 4 to chromium and 2 to cobalt.

Similarly, a study carried out by the Warsaw Department of Dermatology (21) revealed that allergy to nickel prevailed (19%), although 9 out of 36 galvanizers, were found to be sensitive to chromium, and 5 to nickel, whereas no case of isolated allergy to this metal was found.

CONCLUSIONS

1. Occupational exposure of metal industry workers to greases and oils resulted in skin changes in the form of oil acne in 27.5% and of dermatitis in 20.4% of participants.
2. In the metal industry, allergy to chromium compounds was obser-



ved in 19.2% of persons and to cobalt compounds in 9.0% and to nickel in 1.8% of workers.

3. Galvanic fluids, lacquers and metals were the cause of dermatitis in 34.5%, i.e. in every third worker of the electrical industry.

4. Allergy to chromium compounds was observed in 12.5% of electrical industry workers, to cobalt compounds in 5.9% and to nickel compounds in 5.9%.

5. Chromium compounds were the principal allergens of the work environment in both industries, particularly in the galvanization section of the electrical industry.

ACKNOWLEDGEMENT

The work was performed within the programme CPBR 11.11.52 "Principles of dermatological prophylaxis of occupational dermatoses induced by allergy to chromium, cobalt and nickel". In charge of the topic: M. Kieć-Świerczyńska, MD

REFERENCES

1. Baginsky E.: Occupational disease in California. Division of Labor Statistics and Research. California Department of Industrial Relations. San Francisco, 1982. — 2. Baginsky E.: Occupational skin disease in California. Division of Labor Statistics and Research. California Department of Industrial Relations. San Francisco, 1982. — 3. Brun R.: Epidemiology of contact dermatitis in Geneva (1000 cases). *Contact Dermatitis*, 1, 214, 1975. — 4. Burrows D. and Cooke M.: Trivalent chromium plating. *Contact Dermatitis*, 6, 222, 1980. — 5. Czernielewski (et al): The evaluation of patch tests for detecting occupational exposure to the sensitizing action of chromium and nickel compounds, *Med Pracy*, 28, 505, 1977 (in Polish). — 6. Czernielewski A.: The outline of occupational dermatoses, PZWL, Warsaw, 1980 (in Polish). — 7. Dornan J.: Occupational dermatoses amongst chrome platers in the Sheffield area 1977—80. *Contact Dermatitis*, 7, 354, 1981. — 8. Fregert S.: Occupational dermatitis in a 10-year material. *Contact Dermatitis*, 1, 96, 1975. — 9. Grubska-Suchanek E., Paszkiewicz H. and Szarmach H.: Allergy to chromium, nickel and cobalt in patients with contact eczema in Gdansk province between 1979—1983. *Przegl Dermatol.*, 72, 37, 1985 (in Polish). — 10. Kieć-Świerczyńska M.: Occupational dermatoses diagnosed in Lodz province between 1977—1978, *Zdrowie Publ.*, 91, 573, 1980 (in Polish).
11. Kieć-Świerczyńska M. and Czernielewski A.: Causes of occupational dermatoses in Lodz throughout 1972—1976. Evaluation of occupational allergies occurring at that time, based on materials from the dermatological dispensary, Institute of Occupational Medicine, Lodz. *Stud. Mat. Monogr. IMP Lodz.*, 4, 3, 1980 (in Polish). — 12. Kieć-Świerczyńska M.: Occupational diseases in the workers of motor-car accessories plant „Polmo” in Lodz, *Med Komunik.*, 18, 75, 1985 (in Polish). — 13. Kowalski Z., Głuszczoła M. and Sułkowski W.: Evaluation of occupational exposure of galvanizers to chromium compounds. *Med Pracy*, 20, 130, 1969 (in Polish). — 14. Kubasiewicz M., Starzyński Z. and Szeszenia-Dąbrowska N.: Occupational dermatoses caused by irritating and sensitizing substances



found in Poland between 1971 and 1977. *Przegl Dermatol.*, 66, 361, 1979 (in Polish). — 15. Laubstein H. and Mönnich H.: Zur Epidemiologie der Berufsdermatosen (II). *Dermatol Monatsschr.*, 160, 305, 1974. — 16. Rudner E. (et al): The frequency of contact sensitivity in North America 1972—1974. *Contact Dermatitis*, 1, 277, 1975. — 17. Rudzki E. (et al): Occupational and non-occupational sources of allergy to chromium. *Przegl Dermatol.*, 57, 305, 1970 (in Polish). — 18. Rudzki E., Kozłowska A. and Rebandel P.: Occupational allergy to chromium. *Przegl Dermatol.*, 68, 45, 1981 (in Polish). — 19. Rudzki E.: Unsolved problems of occupational dermatology in Poland. *Przegl Dermatol.*, 68, 179, 1982 (in Polish). — 20. Rudzki E. (et al): Allergy to industrial oil compounds. *Med Pracy*, 33, 109, 1982 (in Polish).

21. Rudzki E. (et al): Dermatoses characteristic of particular jobs. *Med Pracy*, 34, 445, 1983 (in Polish). — 22. Rudzki E.: Occupational dermatoses. PZWŁ, Warsaw, 1986 (in Polish). — 23. Szarmach H., Poniecka H. and Kosińska M.: Problems of contact allergy to metals. *Przegl Dermatol.*, 50, 317, 1973 (in Polish).

Received for publication: 21.06.1988

Accepted for publication: 8.11.1988

SHORT COMMUNICATION No 4

The Chief Board of the Polish Association of Occupational Health kindly informs that XVII International Congress on Occupational Health in the Chemical Industry

MEDICHEM '89

will be held in Cracow, from 26 — 29 September, 1989. Main themes of the Congress:

- Targetted Health Surveillance and Biological Monitoring in the Chemical Industry
- Hygiene Standard Setting — International Differences in Philosophy and Practice
- Occupational Health Problems in the Pharmaceutical Industry
- Current Problems in the Chemical Industry.

If you wish to participate in the Congress, please write to:

Medichem '89

Institute of Occupational Medicine

8 Teresy Str.

90-950 LODZ

tel. 552250; 574293

telex 885360 imp pl

Professor Janusz Indulski MD, PhD
President, Polish Association
of Occupational Health

