Bull. Environ. Contam. Toxicol. (1992) 48:843–849

Environmental Contamination and Toxicology

Dermatitis from Household Vinyl Gloves

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Some people wearing rubber gloves developed contact dermatitis, a form of inflammation, eczema and itching on their hands. As to the causes of dermatoses originating in gloves, various investigators have cited thiuram (Song et al. 1979), N-isopropyl-N'-phenyl-p-phenylenediamine (Kaniwa et al. 1982) and similar compounds. Vinyl gloves are known to provide more protection for human skin against contact dermatitis than rubber gloves (Ishihara 1969). Turjanmaa (1987) and Afsahi et al. (1988) reported that wearing vinyl gloves under rubber gloves was useful to avoid contact dermatitis. On the other hand, Ishihara (1969) reported that contact dermatitis from vinyl gloves was not rare because they were worn more often by Japanese housewives. In the previous paper (Aoyama et al. 1982), we investigated contact dermatitis on household gloves in about 792 subjects in Aichi, Japan. Some 61 women had experienced contact dermatitis from using the household gloves. As to the type of gloves causing the skin harm, vinyl gloves were cited as the source in 31 cases (50.8%), rubber gloves in 26 (42.6%), and 4 cases were unclear.

The present study reports the results of investigation related to conventional vinyl gloves sold on the market in Aichi, Japan using laboratory animals for subcutaneous injection test. We also attempted to analyse the substance causing the irritation in the vinyl gloves.

MATERIALS AND METHODS

Ten vinyl gloves bought at a dry goods store in Aichi, Japan were used for this investigation. They were shall be abbreviated to "glove no. 1" to "glove no. 10."

Male ddY mice were housed in a wire cage under lighting of 12L12D (lights on 0600 hr) and temperature of 22.5-26.6℃. Commercial diet (CLEA CE-2, CLEA Japan Inc., Tokyo, Japan) and tap water were given ad libitum. One hundred eighty animals weighing approximately 20 g were divided into 36 groups of 5 each for the study. Following the method described in the previous paper

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Table 1. Test solution

Test Solution	preparation
Solution no. G1	Two hundred mL of distilled water was added to 100 cm^2 of the glove no. 1 for a 24-hr extraction at 40 ℃ by the apparatus indicated in Figure 1. To obtain the contained substances, extract was then filtered (through a glass filter, porosity 2; membrane filter, 0.45 μm), the filtrate was concentrated to 5 mL with a rotary evaporator in a water bath maintained at 50 ℃, and 45 mg of sodium chloride was added.
Solution no. G2 ⟩ Solution no. G10	Glove no. 2 - glove no. 10 were used for the extraction.
Solution no. G9-1	Solution no. G9 was transferred to flask A. The Solution in flask A was dried with a rotary evaporator, and ten mL of chloroform was added to the flask. Chloroform layer was transferred to flask B. Chloroform in flask B was evaporated completely with a rotary evaporator. The residue was dissolved in 5 mL of physiological saline.
Solution no. G9-2	The residue in flask A was dissolved in 5 mL of physiological saline.
Solution no. P1	The chloroform-soluble components in flask B was developed to 13 cm by a preparative thin layer chromatography. Silica gel was divided into thirteen fractions. The lowest fraction shall be abbreviated to "PTLC-1" and the top fraction to "PTLC-13." PTLC-1 was shaved off from preparative thin layer, and silica gel was extracted with 20 mL of distilled water. The water layer and silica gel were separated by centrifugation. The supernatant was concentrated to 2.5 mL with a rotary evaporator, and 22.5 mg of sodium chloride was added.
Solution no. P2 ⟩ Solution no. P13	PTLC-1 for solution no. P1 was changed to PTLC-2 - PTLC-13.
Solution no. S1 ⟩ Solution no. S10	To assess skin irritation with ABS independently, ABS was added to a physiological saline to yield solutions with the ABS of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 mg/mL, respectively.
Solution no. 0	Physiological saline solution.

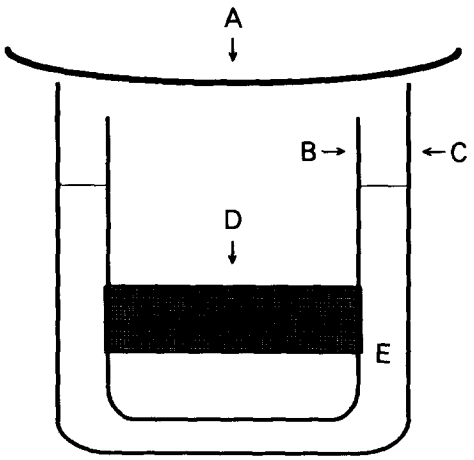

Figure 1. Extraction apparatus. A: watch glass B: 500 mL beaker C: 1000 mL beaker D: strip cut from gloves fits over beaker (outside). E: distilled water

(Naruse et al. 1991), a skin irritation test was performed with the 36 test solutions indicated in Table 1.

The concentration of ABS in solution nos. P1 to P13 indicated in Table 1 was determined by colorimetry according to Abbot (1962) and high performance liquid chromatography. We used a high performance liquid chromatograph (Jasco Trirotar; Japan Spectroscopic Co., Tokyo, Japan). The 125 x 4.6 mm (id) column was packed with Fine SIL C18 (5-µm particle diameter; Japan Spectroscopic Co., Tokyo, Japan). The effluent was monitored with a UV detector (235 nm). The mobile phase was prepared by mixing 40 mL of "HPLC grade" acetonitrile (Wako Pure Chemical Industries, Osaka, Japan) with 60 mL of the 50 mM/L sodium perchlorate. The flow rate was 1.5 mL/min.

RESULTS AND DISCUSSION

As shown in Table 2, the skin irritation test using solution no. G9 resulted in the most positive reaction of 3.9. The other solutions showed a negative or negligible reaction (<1.0). To determine the substance causing irritation in solution no. G9, the substances in it were investigated. Solution no. G9-1, the chloroform-soluble mixture in solution no. G9, resulted in a positive reaction, 4.0. Solution no. G9-2, the chloroform-insoluble mixture in solution no. G9, resulted in a negative reaction. It was assumed that the irritants in solution no. G9 were chloroform-soluble substances.

To determine the irritant in the chloroform-soluble mixture, the chloroform-soluble contents in solution no. G9-1 were divided into thirteen fractions by a preparative thin layer chromatography. As shown in Figure 2, solution no. P4 and solution no. P5, P4 and P5

Table 2. Results of skin irritation test by subcutaneous injection

Test Solution	Reactivity level					
	no. of mouse					Average
	1	2	3	4	5	
Solution no. G1	0	0	0.1	0	0	0
Solution no. G2	0.1	0	0.1	0.1	0	0.1
Solution no. G3	0.2	0	0	0	0.1	0.1
Solution no. G4	0.3	0.2	0.3	0.4	0.2	0.3
Solution no. G5	0.1	0.4	1.0	0.7	2.3	0.9
Solution no. G6	0	0.1	0.2	0.2	0.1	0.1
Solution no. G7	0.3	0.4	0.2	1.0	1.0	0.6
Solution no. G8	1.1	0.8	0.6	1.0	1.0	0.9
Solution no. G9	4.0	4.0	4.0	4.0	3.4	3.9
Solution no. G10	0	0	0	0	0	0
Solution no. G9-1	4.2	3.0	4.2	4.6	3.8	4.0
Solution no. G9-2	0	0	0	0	0	0
Solution no. 0	0	0	0	0	0	0

For the reactivity level, see the previous paper (Naruse et al. 1991).

on the abscissa, evidenced a strong positive reaction on the skin irritation test, against a negative or negligible reaction (<1.0) of the other solutions.

As shown in Figure 3, methylene blue active substances (MBAS) were found in solution nos. P4 and P5. Concentrations of the methylene blue active substances in solution nos. P4 and P5 were 0.43 and 0.76 mg/mL, respectively, but methylene blue active substances were not detected or negligible (<0.05 mg/mL) in the other solutions.

As shown in Figure 4, the high performance liquid chromatogram of solution no. P4 agreed with those of ABS in retention time and pattern, but differed from those of LAS. The retention time and pattern of solution no. P5 was the same as those of solution no. P4. It was assumed that the methylene blue active substance in solution nos. P4 and P5 was ABS. The ABS spot appeared to be divided into two fractions, PTLC-4 and PTLC-5, upon shaving off from the preparative thin layer.

Imokawa et al. (1979) demonstrated that the pathogenesis of hand roughness is primarily related to the cumulative injury of the stratum corenum by adsorbed residual surfactant molecules. We

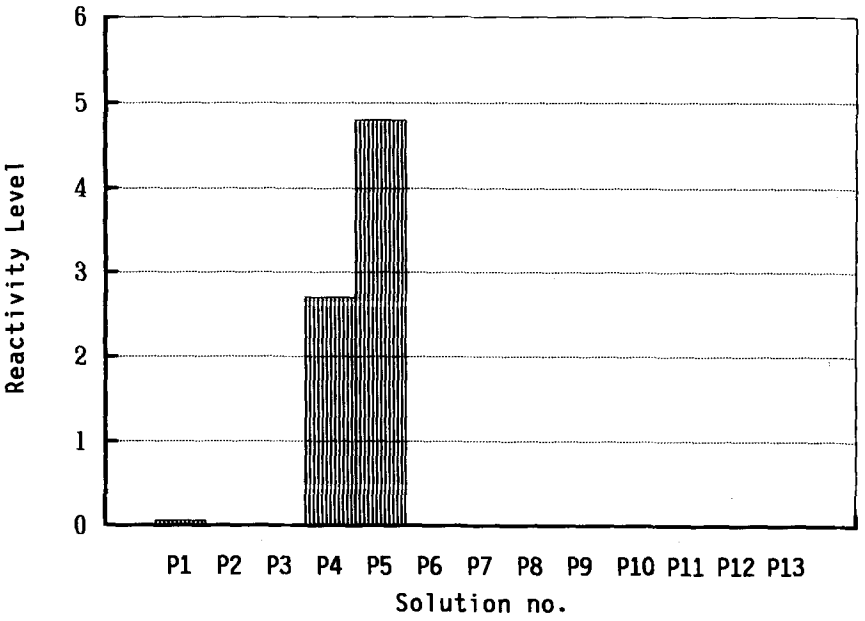

Figure 2. Results of skin irritation test by subcutaneous injection. P1 - P13 on the abscissa correspond to solution nos. P1 - P13 in Table 1. For the reactivity level, see the previous paper (Naruse et al. 1991)

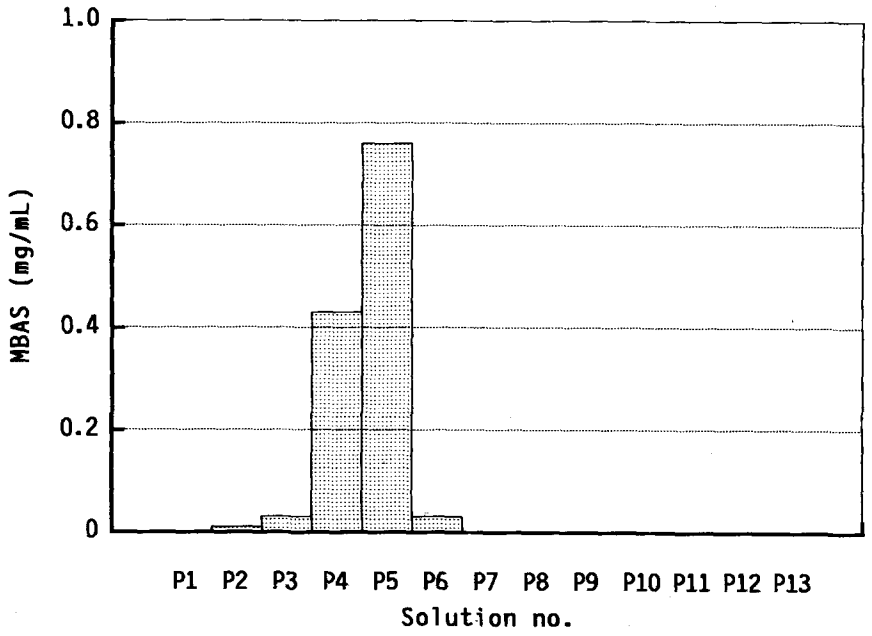

Figure 3. Methylene blue active substances. P1 - p13 on the abscissa correspond to solution nos. P1 - P13 in Table 1.

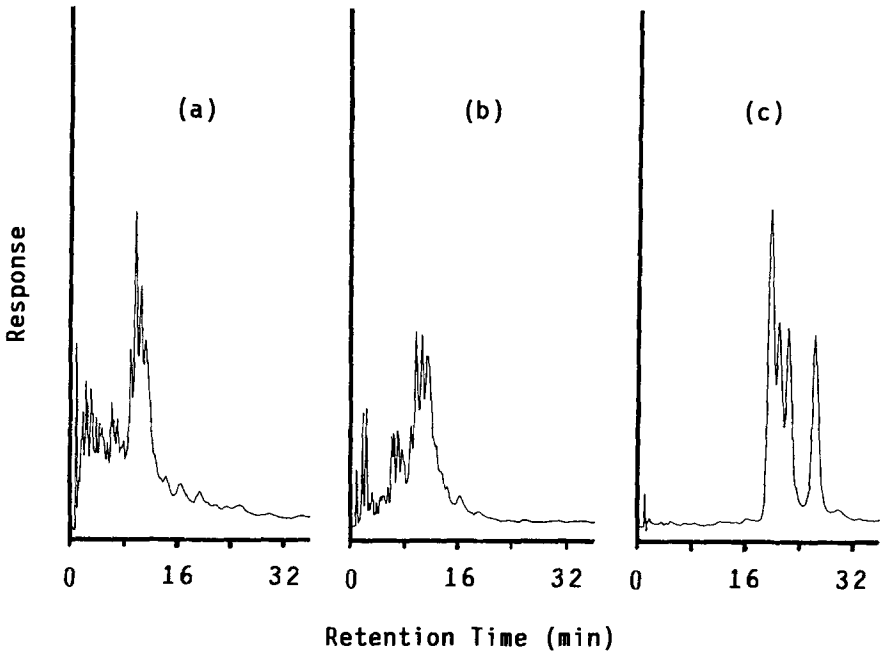

Figure 4. High performance liquid chromatogram of solution no. P4 (a), ABS solution (b) and LAS solution (c).

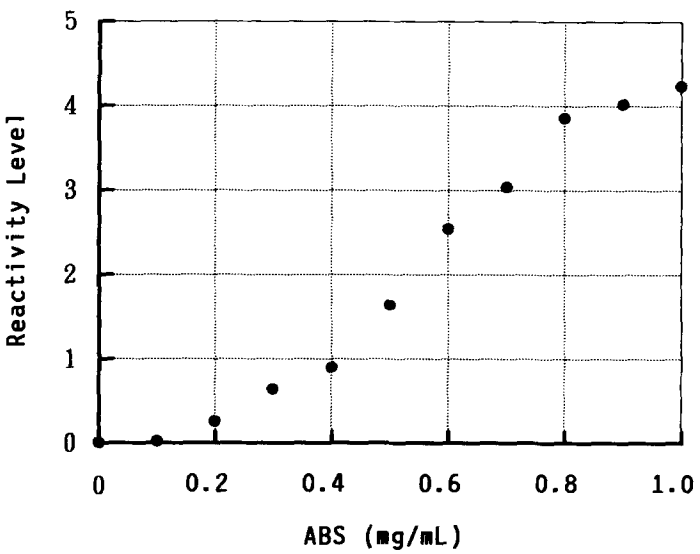

Figure 5. Results of skin irritation test by subcutaneous injection. Each point corresponds to solution no. S1 to S10 in Table 1. Original point is solution no. 0 (saline) in Table 1. For the reactivity level, see the previous paper (Naruse et al. 1991)

earlier reported that LAS was the most plausible irritant in the injurious slip which caused contact dermatitis (1991). Because it was assumed that the ABS detected in solution no. G9 was the cause of the positive reaction, a skin irritation test with the ABS solution was conducted in the present study. As shown in Figure 5, results of the test revealed a positive reaction at the concentration of 0.2 mg/mL and beyond. The intensity of the skin reaction increased with the concentration of ABS.

These results indicated that ABS was one of the irritants in the household vinyl gloves.

Acknowledgements. We wish to thank Dr. M. Aoyama, Mr. T. Matsushita and Dr. K. Kodama for their valuable advice and assistance.

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Received September 26, 1991; accepted January 5, 1992.