

## **Dermatitis from a Woman's Contaminated Slip**

Masaharu Naruse,<sup>1</sup> Mitsuko Aoyama,<sup>1</sup> Masahiko Iwama,<sup>2</sup> and  
Takehiko Matsushita<sup>2</sup>

<sup>1</sup>Department of Hygiene, Nagoya City University Medical School, Mizuho-ku,  
Nagoya 467, Japan and <sup>2</sup>Environmental Science Section, Nagoya City Health  
Research Institute, Mizuho-ku, Nagoya 467, Japan

A 49-year-old woman wearing a slip made of 100% acrylic fiber developed contact dermatitis, a form of inflammation, eczema and itching on her chest and back. She bought the slip at a dry goods store, and wore it after having washed it in a washing machine. As to the causes of dermatoses originating in clothes, various investigators have cited formaldehyde (O'Quinn et al. 1965; Schorr et al. 1974), softening agents (Aoyama et al. 1975), naphthol AS (Hayakawa et al. 1985) and other similar compounds.

The present study reports the results of investigation related to the slip extracts using laboratory animals for subcutaneous injection test. We also attempted to analyse the irritant and its source experimentally.

### **MATERIALS AND METHODS**

The following two slips were used for this investigation: one of them was the injurious slip which caused contact dermatitis, and the other slip was well-rinsed until its concentration of sodium n-dodecylbenzenesulfonate (LAS) was at sub-detectable level (<20 ppm). The former shall be abbreviated to "injurious slip" and the latter to "well-rinsed slip."

The following 11 sample solutions were used for the test:  
No. 1: One hundred mL of distilled water was added to 3 g of the injurious slip for a 24-hr extraction at 40 °C. Extract was then filtered (through a glass filter, porosity 2; membrane filter, 0.45 µm), the filtrate was concentrated to 1.5 mL with a rotary evaporator in a water bath maintained at 50 °C, and 13.5 mg of sodium chloride was added. The LAS amount was 0.32 mg/mL.  
No. 2: Extracting slip for No. 1 solution was changed to 3 g of the well-rinsed slip. The LAS amount was under the detectable level (<0.02 mg/mL).

---

Send reprint requests to M. Naruse at the above address.

No. 3-No. 8: To assess skin irritation with LAS independently, LAS was added to a physiological saline to yield solutions with the LAS of 0.02, 0.10, 0.20, 0.30, 0.40 and 0.50 mg/mL, respectively. No. 9: To assess the residual LAS at washing, the well-rinsed slip was washed with household detergent in a washing machine. The concentration of LAS in the detergent was 8.2 percent, and its consumption was 51 g per 18 L water. In order to duplicate normal washing conditions, 1.2 kg of clothes such as underwear or pajamas, etc. was washed together. After the first rinsing 3 g of the slip was extracted as extract for the No. 1 solution. The time schedule for the washing machine was as follows: adding water, washing (for 8 min 30 sec periods), draining, adding water, first rinsing (for 1 min 20 sec periods), draining, adding water, second rinsing (for 1 min 20 sec periods), draining, drying, adding water, third rinsing (for 2 min 40 sec periods), draining and drying. No. 10: Extracting slip for the No. 9 solution was changed to 3 g of the slip after the third rinsing. No. 11: Physiological saline solution.

Male ddY mice were housed in a wire cage under lighting of 12L12D (lights on 0600hr) and temperature at 22.5-26.6°C. Commercial diet (CLEA CE-2, CLEA Japan Inc., Tokyo, Japan) and tap water was given ad libitum. Thirty-three animals weighing approximately 20 g were divided into 11 groups of 3 and used for the study. Following the method of Sato et al. (1967), 0.2 mL of the respective test solutions was injected subcutaneously into the dorsal area of each mouse, immediately after intravenous injection of 0.1 mL of 1% Evan's blue in physiological saline. Three hours later, the mice were caused to expire by dislocation of the cervical vertebrae, the skin was removed and the subcutaneous reaction level was checked. The strength of the reaction in terms of skin irritation was rated as follows, by use of the relative concentration of extravasated dye times the dye diameter: 1, weak reaction; 2, intermediate reaction; and 3, strong reaction (unit for diameter in cm).

The concentration of LAS in the injurious slip, in the well-rinsed slip, in twelve pieces of underwear currently on the market and in five kinds of household detergents was analysed according to the high performance liquid chromatography (HPLC) method reported by Kunihiro et al. (1975).

## RESULTS AND DISCUSSION

As shown in Table 1, the No. 1 solution extract group evidenced a strong reaction of 2.2 against the negative one of the physiological saline solution group (No. 11). However, in the No. 2 extract group, whose extracting slip was the well-rinsed slip, a negative reaction was found. To find out an irritant from the No. 1 solution extract, the component which was contained exclusively in the No. 1 solution extract was researched by HPLC. As shown in Figure 1, the LAS was found

Table 1. Results of skin irritation test by subcutaneous injection

No.	Test solution	Reactivity level			
		No. of mouse			Average
		1	2	3	
1	extract of injurious slip	2.3	2.3	2.0	2.2
2	extract of well-rinsed slip	0	0	0	0
3	LAS solution ( 0.02 mg/mL )	0	0	0	0
4	" ( 0.10 mg/mL )	0	0.3	0.1	0.1
5	" ( 0.20 mg/mL )	0.2	0.1	2.0	0.8
6	" ( 0.30 mg/mL )	1.5	1.3	2.0	1.6
7	" ( 0.40 mg/mL )	2.0	3.0	1.0	2.0
8	" ( 0.50 mg/mL )	3.4	3.0	2.2	2.9
9	extract after first rinsing	1.0	3.0	2.4	2.1
10	extract after third rinsing	0	0	0.3	0.1
11	physiological saline	0	0	0	0

See text for reactivity level.

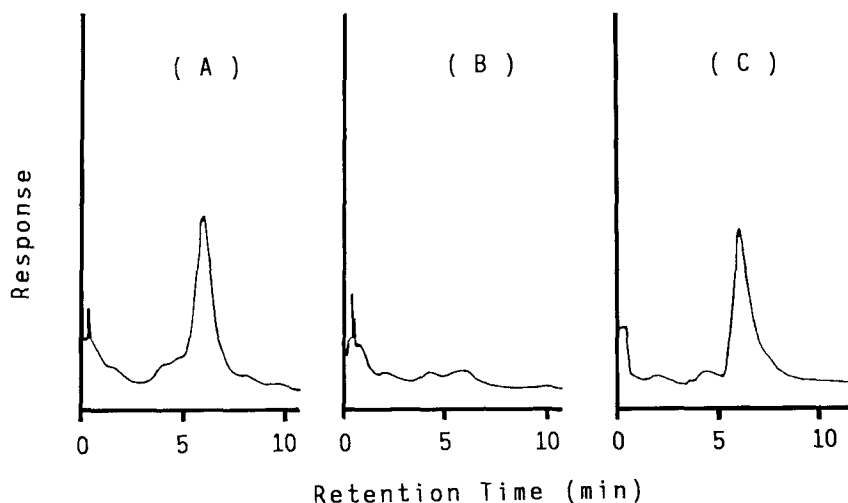


Figure 1. Chromatogram of the injurious slip(A), the well-rinsed slip(B) and LAS(C). Column: JASCO Fine SIL-10, 60 mm X 0.5 mm id. Mobile phase: 0.01% sulfuric acid in n-hexane-ethanol(8:2 v/v). Flow-rate: 8  $\mu$ L/min. Column temperature: 25°C Detector: UV, 225 nm.

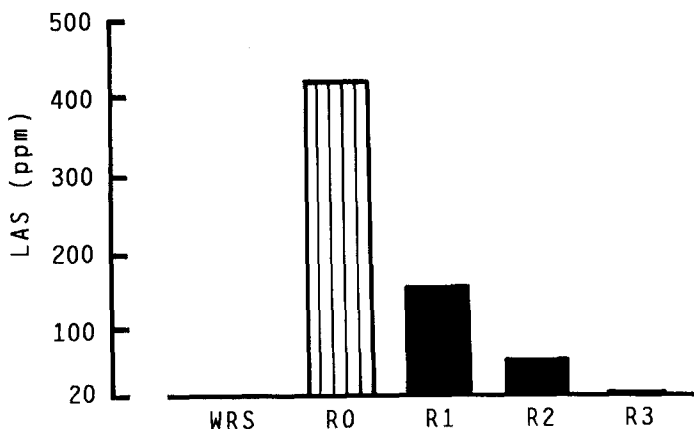


Figure 2. Concentration of LAS. WRS: the well-rinsed slip. R0: just before the first rinsing. R1: after the first rinsing. R2: after the second rinsing. R3: after the third rinsing

in the No. 1 solution extract, and its concentration was 0.32 mg/mL. But the LAS wasn't detected in the No. 2 solution extract ( $<0.02$  mg/mL).

Imokawa et al. (1979) demonstrated that the pathogenesis of hand roughness is primarily related to the cumulative injury of the stratum corneum by adsorbed residual surfactant molecules. Because it was assumed that the LAS detected in the No. 1 solution extract was the cause of the positive reaction, a skin irritation test with the LAS solution was conducted. Results of the test revealed a positive reaction at the concentration of 0.20 mg/mL and beyond. The intensity of the skin reaction was increased with the concentration of LAS. The reaction was virtually the same between the No. 1 solution extract (LAS 0.32 mg/mL) and the No. 6 LAS solution (LAS 0.30 mg/mL); these results suggest that LAS was the most plausible irritant in the injurious slip extract.

It was indispensable to elucidate the source of the LAS detected in the injurious slip. The concentration of LAS in twelve pieces of underwear currently sold on the market was determined by HPLC, because it was assumed that the injurious slip contained LAS as a cloth-treating agent. Neither of them contained LAS ( $<20$  ppm). These results suggested that the LAS detected in the injurious slip was not used as a cloth-treating agent. On the other hand, the sufferer wore the slip after washing her own slip in a washing machine. Thus, it was supposed that the LAS detected in the injurious slip was the LAS which was contained in the household detergent; and the concentration of LAS in five kinds of household detergent was examined by HPLC. The LAS was detected in all samples, and its concentration averaged 7.9% (3.6, 7.8, 8.2, 9.0 and 10.9%

respectively). Suzuki et al.(1980) investigated the actual consumption of household detergents by about 1123 subjects in Fukuyama, Japan. They reported that the mean dose of consumed detergent at washing was 1.7 times as much as the indicated dose in its information-label, and the mean rinsing period was 5 minutes. They also cited the fact that contact dermatitis in subjects related to the alkylbenzene sulfonate which was contained in their own underwear. In order to determine the concentration of the residual LAS in the injurious slip after the usual washing, the well-rinsed slip was washed in a washing machine with household detergent (LAS 8.2%). Then, its solution extracts were used for the skin irritation test. As shown in Figure 2, the concentration of LAS in the slip after the third rinsing which was usually the last rinsing step was 21 ppm; its skin irritation test revealed a negative reaction, but the concentration of LAS in the slip after the first rinsing was 160 ppm, and the skin irritation test revealed a positive reaction of 2.1. The LAS concentration in the No. 9 and No. 10 solution extracts were 0.32 and 0.04 mg/mL respectively. These results seemed to suggest that the LAS detected in the injurious slip was residual LAS from washing.

## REFERENCES

- Aoyama M, Rokushika T (1975) Investigation of the skin: disturbances caused by clothing. *Nagoya Med J* 20: 145-151
- Hayakawa R, Matsunaga K, Kojima S, Kaniwa M, Nakamura A (1985) Naphthol AS as a cause of pigmented contact dermatitis. *Contact Dermatitis* 13: 20-25
- Imokawa G, Mishima Y (1979) Cumulative effect of surfactants on cutaneous horny layers: Adsorption onto human keratin. *Contact Dermatitis* 5: 357-366
- Kunihiro K, Nakae A, Muto G (1975) Determination of trace amounts of alkylbenzenesulfonates by high performance liquid chromatography. *Bunseki Kagaku (Jap. Anal.)* 24: 188-192
- O'Quinn SE, Kennedy CB (1965) Contact Dermatitis Due to Formaldehyde in Clothing Textiles. *JAMA* 194: 593-596
- Sato N.L, Himuro I, Shioya A (1967) A Photoelectric Method for Estimating Inflammatory Intensity in Mice and its Application to the Anti-Inflammatory Evaluation of Glucuronic Acid Derivatives. *Jap J Pharmacol* 17: 557-571
- Schorr WF, Keran E, Plotka E (1974) Formaldehyde Allergy. The Quantitative Analysis of American Clothing for Free Formaldehyde and its Relevance in Clinical Practice. *Arch Dermatol* 110: 73-76
- Suzuki M, Kawakami Y (1980) Study on the Disorder of Sodiumalkylbenzene Sulfonate in the Skin Disease and Liver Cell Trouble. *J Child Health* 38: 489-492

Received November 21, 1989; accepted June 5, 1990.