

ORIGINAL ARTICLE

Occupational hand eczema among nursing staffs in Korea: Self-reported hand eczema and contact sensitization of hospital nursing staffs

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ABSTRACT

Occupational hand eczema is frequent in hospital workers, especially in nurses. A comprehensive understanding regarding hand eczema is essential for establishing proper prevention and treatment strategies. The purpose of this study was to identify the risk factors for hand eczema in hospital nursing staffs. A self-administered questionnaire study was performed on hospital nursing staffs at a single general hospital in Korea. In addition, 70 patients with hand eczema underwent patch testing. Five hundred and twenty-five of 700 invited nurses completed the study (response rate, 75.0%). The overall frequency of symptom-based hand eczema was 75.6%, and self-reported hand eczema was 31.0%. Risk factors for hand eczema were young age, history of atopic dermatitis, frequent hand washing (>20 times/day) and long duration of glove wearing (>5 min). Hand eczema was less frequent among frequent hand moisturizer users (>3–4 times/day). Positive patch test reactions were observed in 61.4%. Frequent allergens were nickel sulfate (35.7%), cobalt chloride (28.6%) and thiomersal (21.4%). Among various antibiotics, ciprofloxacin (11.4%), trimethoprim/sulfamethoxazole (11.4%) and gentamicin (7.1%) were revealed as common allergens, in order of frequency. Hand eczema is quite common among hospital nursing staffs. Proper preventive programs and educations are demanded.

Key words: hand eczema, nurses, occupational exposure, patch tests, risk factors, wet work.

INTRODUCTION

Occupational skin disease, especially hand eczema, is the most common work-related disease in industrialized countries.^{1–3} Risk factors of hand eczema can be classified as irritant, allergic, and endogenous factors such as atopic dermatitis. Exposure to skin irritants, such as water and detergents, is a major etiologic factor for developing occupational hand eczema (OHE) in people who perform wet work.^{4,5} Wet work is defined as a job requiring at least 2 h of water exposure daily, including hairdressers, cleaners, cooks, factory workers, and health-care workers.^{6,7} Frequent and prolonged exposure to wet work may damage the skin's protective barrier and increase the risk of allergic contact dermatitis (ACD). The reported rate of ACD among health-care workers ranges 16.5–74%. Metallic materials used in medical devices as well as rubber chemicals and disinfectants are the most frequently reported allergens along with drugs such as antibiotics which have recently gained attention as a source of allergens.^{8–13}

Occupational hand eczema often has a protracted course. Several previous studies have shown that OHE affects the patients' quality of life, with more than 20% of affected individuals having to leave their jobs either temporarily or

permanently.^{7,14,15} Therefore, a comprehensive understanding is required to prevent and reduce the prevalence of OHE.

The purpose of this study was to determine the prevalence, clinical characteristics and risk factors of OHE, and to reveal the frequency of ACD along with causative allergens in relation to OHE in nursing staffs.

METHODS

Questionnaire study

From May to December 2011, a self-administered questionnaire survey was conducted on 700 individuals consisting of nurses, assistant nurses and nurses' aides working in a Korean university hospital. With the purpose of establishing an accurate estimate of the prevalence of OHE, the participants were questioned for their opinions on whether or not they had hand eczema, and were allowed to compare and check their symptoms, if any, by proving a common list of symptoms of hand eczema. Additional information such as duration, site and treatment history was asked from those showing signs of the listed symptoms. The questionnaire also included general data such as work sector, age, sex, period of employment, level of education, working a night shift, history of atopic dermatitis,

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allergic rhinitis, asthma, hours of housework, working hours and occurrence of eczema in other sites. To determine the occupation-related risk factors, questions regarding hand washing with water and soap, alcohol-based hand rubs, protective gloves and other hand care products were asked, along with the frequency, time of use and type of material included. Additional questions addressed individual perception of the adverse effects of nursing work to hand eczema and their influence on the quality of life.

Patch testing

Considering previous study results by Kucenic *et al.*⁸ which showed the prevalence of ACD and irritant contact dermatitis in OHE to be 60% and 34% respectively, 10% non-inferiority in ACD was expected. With a 5% significance level, 80% power and 20% loss rate considered, 70 individuals with OHE, confirmed through clinical examination, were chosen and registered for further patch testing.

Through a published work search, 20 known allergens that were reported to be relevant to OHE in nurses⁸⁻¹² and 20 antibiotics that are currently used in hospitals were selected (listed in Table 3). Individuals were patch tested in a standard manner with Finn chambers (Epitest, Tuusula, Finland) on Scanpor tape (Norgesplaster Aksjeselskap, Vennesla, Norway). Test allergens were purchased from Trolab (Reinbek, Germany). Allergens were applied to the upper back and examined after 48 and 96 h by a dermatologist. Patch test reactions were graded based on the standardized International Contact Dermatitis Research Group scoring system. Reactions of +, ++ or +++ were considered allergic.

Statistical analysis

Statistical analysis was conducted with SPSS ver. 18.0. Odds ratios (OR) with 95% confidence intervals (CI) were calculated through univariate and multivariate logistic regression models. A significance level of $P < 0.05$ was chosen.

RESULTS

A total of 700 individuals were enrolled in this questionnaire study, and 525 individuals completed the study (response rate, 75%). Women constituted 97.1% of the responders. The mean age was 30.8 years with a range of 21–58 years. Further characteristics of the study population are shown in Table 1.

Prevalence and characteristics of OHE

In order to determine the prevalence rate of OHE, participants who responded as having hand eczema in the past 12 months prior to testing were classified as self-reported hand eczema, whereas participants that replied positively to one of the six major symptoms of hand eczema – itching, burning/pain, scaling, blisters, rashes, cracks/fissures – were classified as symptom-based hand eczema. The prevalence rate of self-reported hand eczema was 31.0% (163/525) and symptom-based 75.6% (397/525). When handling irritating materials or when exposed to cold weather, 42.7% experienced occasional symptoms; 15.0% experienced symptoms unrelated to

weather or certain materials; 12.6% had frequent symptoms, over 3 months annually; and 5.3% responded to having continuous symptoms. The most common sites of symptom-based OHE were the fingers (47.1%), palm (37.8%), dorsum of hand (30.7%) and forearm (13.1%), in order of frequency, with overlaps in response. Common symptoms included cracks/fissures (45.3%), scaling (45.1%), itching (40.8%), burning/pain (35.3%), rash (19.9%) and blisters/vesicles (9.3%), with overlaps in response. As methods of treatment, most of the individuals used moisturizers (71.0%), topical ointment (21.9%) or oral medication (4.5%); while some resolved spontaneously (25.9%) or their symptoms did not improve after treatment attempts (1.3%) (Table 2).

Risk factors of OHE

The work sectors were classified into the outpatient department (OPD), regular ward (ward, dialysis room, delivery room) and special unit (emergency room, operating room, intensive care unit), according to the nature of the work (Table 1). Univariate analysis, with the OPD's OR as the measuring standard of 1, showed that workers in regular wards have a 2.229-times (95% CI, 1.203–4.127) higher probability of having OHE ($P = 0.011$). However, in the multivariate analysis, in which the influences of other conditions were revised, there was no correlation between work sector and the prevalence of OHE.

Univariate analysis regarding the participant's age showed that as the individual's age increased by 1, the risk of OHE decreased by 0.963 (95% CI, 0.939–0.988), which signifies that as people get older they have less risk of OHE ($P = 0.004$). Also, it should be noted that after correcting for confounding factors, such as period of employment and night shifts, the results were still statistically significant. Thus, the results suggest that young age acts as a risk factor for OHE (OR, 0.947; 95% CI, 0.899–0.998).

Period of employment was categorized into three groups: (i) less than 5 years; (ii) between 5–10 years; and (iii) over 10 years. Group (ii) had the highest OR of OHE, but it was not statistically significant. Group (iii) showed a statistically significant reduction in the OHE occurrence in the univariate analysis (OR, 0.611; 95% CI, 0.386–0.967), however, multivariate analysis did not show any significance. Night shift workers were 1.870-times (95% CI, 1.239–2.824) more likely to have OHE compared to day shift workers ($P = 0.003$), but after multivariate revisions, there was no correlation.

In the group with past or current medical history of atopic dermatitis, the OR of OHE was significantly high (OR, 2.830; 95% CI, 1.371–5.845), and still remained statistically significant even after the multivariate analysis (OR, 2.331; 95% CI, 1.055–5.5150). However, when medical history was categorized into subgroups of past and current history of atopic dermatitis, with the past history group further subdivided into infancy, childhood and school age, there were no statistically significant differences in the OR of OHE.

The frequency of hand washing was divided into four groups: (i) less than 10 times a day; (ii) 10–19 times a day; (iii) 20–29 times a day; and (iv) over 30 times a day. Compared to group (i), the occurrence rate of OHE in group (iii) was

Table 1. Demographics and association between hand dermatitis and risk factors

Variables (n)	No. of patients (%)	Univariate analysis			Multivariate analysis		
		Odds ratio	95% Confidence interval	P value	Odds ratio	95% Confidence interval	P value
Work sector							
Outpatient department	56 (10.7)	1	–		1	–	
Special unit	205 (39.0)	1.812	0.968–3.391	0.063	1.063	0.477–2.368	0.881
Regular ward	264 (50.3)	2.229	1.203–4.127	0.011*	1.363	0.629–2.953	0.432
Age†		0.963	0.939–0.988	0.004*	0.947	0.899–0.998	0.042*
Periods of employment							
<5 years	217 (41.3)	1	–		1	–	
5–10 years	147 (28.0)	1.296	0.767–2.191	0.333	1.719	0.898–3.291	0.102
>10 years	161 (30.7)	0.611	0.386–0.967	0.036*	2.169	0.792–5.939	0.132
Night duty							
No	356 (67.8)	1	–		1	–	
Yes	169 (32.2)	1.870	1.239–2.824	0.003*	1.703	0.939–3.090	0.080
Atopic dermatitis							
No	446 (85.0)	1	–		1	–	
Yes	79 (15.0)	2.830	1.371–5.845	0.005*	2.331	1.055–5.150	0.036*
Hand wash frequency							
<10 times a day (79)	79 (15.0)	1	–		1	–	
10–19 times a day (261)	261 (49.7)	1.222	0.722–2.068	0.455	1.308	0.724–2.362	0.374
20–29 times a day (119)	119 (22.7)	5.172	2.438–10.969	0.000*	5.774	2.530–13.174	0.000*
>30 times a day (66)	66 (12.6)	12.180	3.506–42.313	0.000*	13.082	3.482–49.152	0.000*
Glove wearing time							
<1 min (160)	160 (30.4)	1	–		1	–	
1–5 min (256)	256 (48.8)	1.552	0.995–2.420	0.053	1.596	0.961–2.650	0.071
>5 min (109)	109 (20.8)	2.023	1.122–3.646	0.019*	1.988	1.008–3.920	0.047*
Hand moisturizer							
No use (112)	112 (21.3)	1	–		1	–	
1–2 times a day (189)	189 (36.0)	0.928	0.470–1.830	0.829	0.684	0.326–1.435	0.315
3–4 times a day (120)	120 (22.9)	0.321	0.165–0.624	0.001*	0.267	0.128–0.555	0.000*
5–10 times a day (61)	61 (11.6)	0.195	0.093–0.409	0.000*	0.134	0.058–0.311	0.000*
>10 times a day (43)	43 (8.2)	0.178	0.079–0.399	0.000*	0.118	0.046–0.300	0.000*

* $P < 0.05$. †Age was treated as continuous variable.

increased by 5.172 times (95% CI, 2.438–10.969), and by 12.180 times in group (iv) (95% CI, 3.506–42.313). Overall, when the frequency of hand washing was over 20 times daily, the risk of OHE was high ($P < 0.0001$), and remained statistically significant after considering for other revised factors ($P < 0.0001$). The time spent per wash and the types of soap used were not significant in causing OHE.

In order to determine the risk of OHE related to the use of gloves, the daily number of use and the duration per use were considered. The frequency of daily glove use was not correlated with the risk for OHE. The duration per use of gloves was classified into three groups: (i) less than 1 min; (ii) 1–5 min; and (iii) over 5 min. Compared to group (i), group (iii) had a 2.023-times higher risk (95% CI, 1.122–3.646) of OHE ($P = 0.019$), and even after revision of other factors, it still had a 1.988-times (95% CI, 1.008–3.920) higher risk ($P = 0.047$).

Furthermore, the prevalence of OHE was studied based on the use of hand moisturizers, with the following subdivisions: (i) non-users; (ii) 1–2 times daily; (iii) 3–4 times daily; (iv) 5–9 times daily; and (v) over 10 times daily. Compared to the group (i), the risk of OHE decreased significantly in groups (iii–v). Moreover,

significance remained even after the multivariate analysis; the occurrence rate decreased to 0.267 times (95% CI, 0.128–0.555) in group (iii), 0.134 times (95% CI, 0.058–0.311) in group (iv), and 0.118 times (95% CI: 0.046–0.300) in group (v).

Other factors such as sex, level of education, history of allergic rhinitis or asthma, hours of housework, working hours, eczema in other sites, and the frequency of use and type of alcohol-based hand rubs were not significantly related to the prevalence of OHE (data not shown).

Perception of the relation between nursing tasks and OHE

When questioned about the possibility of correlation between nursing tasks, which include wet work (hand washing, use of alcohol-based hand rubs, other nursing jobs with exposure to liquids and detergents) and OHE, 64.0% replied that they were “strongly associated” and 32.2% “moderately associated”. Moreover, as the most influential cause of OHE, 63.0% selected alcohol-based hand rubs, 57.7% washing with water and soap, 39.2% glove wearing, 23.4% handling chemicals and 12% chose other nursing work (multiple answers possible,

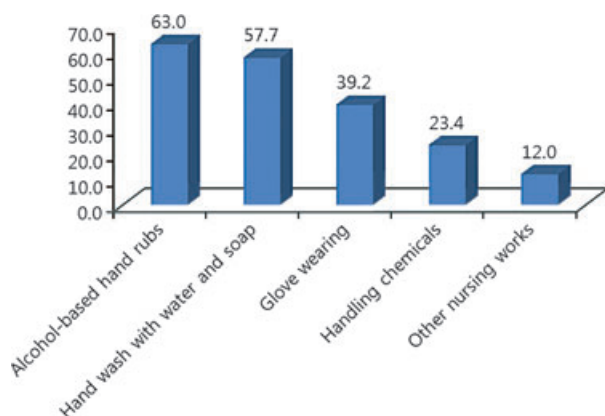
Table 2. Characteristics of hand dermatitis (symptom-based hand dermatitis, $n = 397$)

	No. of patients (%)
Symptom (multiple choice)	
Cracks/fissures	180 (45.3)
Scaling	179 (45.1)
Itching	162 (40.8)
Burning/pain	140 (35.3)
Rashes	79 (19.9)
Blisters/vesicles	37 (9.3)
Frequency	
Occasionally	224 (42.7)
Sometimes	79 (15.0)
Frequently (>3 months/1 year)	66 (12.6)
Almost always	28 (5.3)
Sites (multiple choice)	
Fingers	187 (47.1)
Palms	150 (37.8)
Dorsum of hands	122 (30.7)
Arms	52 (13.1)
Treatments (multiple choice)	
Spontaneous resolution	103 (25.9)
Moisturizer	282 (71.0)
Topical ointment	87 (21.9)
Oral medication	18 (4.5)
No improvement	5 (1.3)

Fig. 1). Additionally, in regards to the effect of OHE on quality of life, 50.1% believed that OHE affected daily lives and 30.1% believed it affected leisure activities.

Patch test results

Among 70 patients with OHE, 43 patients (61.4%) had one or more positive reactions to reported relevant allergens in OHE. Common allergens were nickel sulfate (35.7%), cobalt chloride (28, 6%), thiomersal (21.4%), ammoniated mercury (20.0%) and potassium dichromate (12.9%), in order of frequency. Among the antibiotics tested, ciprofloxacin and sulfamethoxazole/trimethoprim were the most frequent (both 11.4%) (Table 3).

**Figure 1.** Cognition of the causes of hand dermatitis in nursing practices.

DISCUSSION

Occupational hand eczema is considered one of the most common occupational diseases, especially for health-care workers.⁷ The reported prevalence rate of OHE in previous studies were varied ranging 22.8–69.7%.^{1,3,5,16} The varying results are due to different definitions and research methods, as well as race, region and type of work. According to this study, self-reported hand eczema was reported to be 31.0%, while symptom-based hand eczema was 75.6%, predicting the prevalence rate to be between 31.0% and 75.6%. The reason for the relatively high prevalence rate compared to previous studies is because of the high exposure to wet work brought by the increase in hand sanitation monitoring due to the Joint Commission International's international certification during the time of study. The fact that Korea does not yet have a system for hand eczema prevention may also have contributed to this high prevalence rate in our study. Further observational study is necessary to investigate a more accurate prevalence rate.

Risk factors for OHE were young age, history of atopic dermatitis, washing hands more than 20 times a day and wearing gloves for more than 5 min a day; frequent use of hand moisturizers decreased the risk of hand eczema (Table 1). Atopic dermatitis and the frequency of hand washing are known to be the relative coherent risk factors for hand eczema.^{2, 6} In atopic dermatitis patients, alterations of skin barrier function and the immune system may contribute to OHE.¹⁷ Similarly, frequent hand washing also induces barrier dysfunction and OHE. On the other hand, moisturizers are known to restore the function of the skin barrier and to prevent eczema.

The prevalence rate of hand eczema was 0.947 for an increase of 1 year of age, implying that hand eczema risk is higher for younger individuals ($P = 0.042$). Flyvholm *et al.*¹ also suggested age as a risk factor for hand eczema, although they did not treat age as a continuous variable. However, as the mechanism has not yet been determined, more research is needed on this topic.

When gloves were worn for more than 5 min a day, the degree of risk increased 1.988 times compared to when gloves were worn for less than 1 min. There is a controversy regarding the effect of glove use on hand eczema. Wetzky *et al.*¹⁸ reported that the glove itself did not cause the dysfunction of the skin barrier. On the other hand, Jungbauer *et al.*⁴ showed when wearing gloves after washing hands with water and soap, the residue from the soap remained on the skin, and when the hands were sealed with gloves, the irritancy of the soap was maximized, causing hand eczema.

The present study did not show any relevance between the use of alcohol-based hand rubs and the prevalence rate of hand eczema. Based on previous studies, the use of alcohol-based hand rubs is recommended, instead of using water and soap, as it is not a cause of hand eczema.^{2–4} Nevertheless, this study demonstrated that there is a misperception that using alcohol-based hand rubs contributes to hand eczema. Instead, clinical test results indicate that washing hands with water and soap irritate the hands more than alcohol-based hand rubs, leading to hand eczema.^{2–4} Therefore, except for the case when one can see a contaminant with the naked eye,

Table 3. Frequency of positive patch test reactions to reported relevant allergens in OHE

Allergens	No. of positive reaction (%)	Antibiotics	No. of positive reaction (%)
Nickel sulfate (5%)	25 (35.7)	Ciprofloxacin (20% aq.)	8 (11.4)
Cobalt chloride (1%)	20 (28.6)	Sulfamethoxazole + trimethoprim (20% aq.)	8 (11.4)
Thiomersal (0.1%)	15 (21.4)	Gentamycin (20% aq.)	5 (7.1)
Ammoniated mercury (1%)	14 (20.0)	Ampicillin (5% pet.)	2 (2.9)
Potassium dichromate (0.5%)	9 (12.9)	Ceftazidime (20% pet.)	2 (2.9)
Formaldehyde (1%)	6 (8.6)	Cefepime (20% pet.)	2 (2.9)
Thiuram mix (1%)	4 (5.7)	Clindamycin (20% aq.)	2 (2.9)
Glutaraldehyde (0.3%)	4 (5.7)	Vancomycin (20% pet.)	2 (2.9)
CMIT+MIT (0.01%)	4 (5.7)	Amoxicillin + clavulanate (20% pet.)	1 (1.4)
1,2-Benzothiazoline-3-one, Na-Salt (0.1%)	3 (4.3)	Piperacillin + tazobactam (20% pet.)	1 (1.4)
Glyoxal trimer (1%)	3 (4.3)	Ceftriaxone (20% pet.)	1 (1.4)
Mercaptobenzothiazole (2%)	2 (2.9)	Meropenem (20% pet.)	1 (1.4)
Chloroxylonol (1%)	2 (2.9)	Benzathine penicillin G (10 000 IU/g pet.)	0 (0.0)
Benzalkonium chloride (0.1%)	2 (2.9)	Ceftazole (20% pet.)	0 (0.0)
Quaternium-15 (1%)	2 (2.9)	Cefotetan (20% pet.)	0 (0.0)
Trolamine (2.5%)	1 (1.4)	Cefotaxime (20% pet.)	0 (0.0)
Propylene glycol (5%)	1 (1.4)	Cefpiramide (20% pet.)	0 (0.0)
Chlorhexidine digluconate (0.5%)	1 (1.4)	Ceftizoxime (20% pet.)	0 (0.0)
Triclosan (2%)	1 (1.4)	Clarithromycin (20% pet.)	0 (0.0)
Mercapto mix (1%)	1 (1.4)	Teicoplanin (20% pet.)	0 (0.0)

CMIT-MIT, 5-chloro-2-methyl-4-isothiazolin-3-one + 2-methyl-4-isothiazolin-3-1 (3:1 in water).

it is advised to use alcohol-based hand rubs. This finding must be taught to those involved in this study.

In the past, OHE was thought to be mostly caused by irritation factors and that the patch test would show lower positivity compared to the control group.^{19,20} Although the role of allergic factors in OHE has not been established yet, as studies show one or more positive results in more than 60–70%, the role is gaining attention.^{8–10} In this study, the frequency of one or more positive reactions is reported to be 61.4%, demonstrating that the ACD ratio is not small. In comparison to previous studies performed on the general population of Korea, the type of frequent allergen corresponded with our result, although the overall sensitization rates to each allergen were higher in the present study.^{21,22} It is reasonable to assume that because the study was performed on individuals with hand eczema, the dysfunction of the skin barrier may have resulted in increased sensitization rates to allergens.

Rubber chemicals – thiuram mix, mercaptobenzothiazole, mercapto mix – are noteworthy occupational allergens in health-care workers. Nurses are frequently exposed to these allergens due to the wide usage of rubber-based utensils such as gloves, syringes, tracheal tubes, elastic bands and catheters.²⁰ In this study, seven individuals (10.0%) tested positive to rubber chemicals and interestingly all of them showed their daily number of use of rubber gloves as above 20, based on our questionnaire results (20–24 times, four individuals; 25–29 times, two individuals).

Sensitization rates in disinfectants such as formaldehyde (8.6%), glutaraldehyde (5.7%), glyoxal (4.3%), benzalkonium

chloride (2.9%) and chlorhexidine digluconate (1.4%) were comparatively high. Although these substances are not included in the standard series due to the low rate of exposure in the general population, it is notable that the sensitization rate to formaldehyde significantly increased in comparison with the 2.4% sensitization rate in previous studies in Korea.²¹ Response rates of substances in antimicrobial soap such as chloroxylonol (2.9%), trolamine, propylene glycol and triclosan (1.4% each) were relatively low.

In addition, as nurses are continuously exposed to medicines, it is known that the possibility of ACD to medicines, especially antibiotics, is high. Occupational ACD due to penicillin, cephalosporins, aminoglycoside (amikacin, gentamicin), meropenem and clavulanic acid has been reported.^{13, 23–26} In this study, interestingly, ciprofloxacin and sulfamethoxazole/trimethoprim each demonstrated 11.4% sensitization rates, the highest of all, followed by gentamicin (7.1%). On the other hand, penicillin and cephalosporin showed lower sensitization than expected. Until now, the antibiotic-induced occupational ACD of health-care workers has been usually reported in a case report form. Gielen and Goossens¹³ reported their retrospective results on a patch test with medicines administered on health-care workers, however, the present study may be the first to prospectively conduct a patch test on nurses with the most currently widely used antibiotics. Nevertheless, more controlled studies with large sample sizes are needed.

Allergic contact dermatitis and OHE affect each other. The higher sensitization rate to relevant allergens in OHE patients indicates that ACD would exacerbate OHE, while the skin

barrier dysfunction caused by OHE may lead to a high frequency of ACD among OHE patients. Therefore, this study supports that there is a significant role of allergic factor in OHE as well as irritant and endogenous factors.

This study has several limitations. It was based on questionnaires, only 70 individuals participated in the patch test and the study had a very high ratio of female staff members at the hospital. However, it is the first study conducted on nursing practitioners at a general hospital to determine the prevalence rates and risk factors of hand eczema in Korea. Also, through patch testing with widely used antibiotics and allergens associated with hand eczema, we were able to estimate the sensitization rates and reveal the causal allergens of hand eczema.

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