



Self-reported hand symptoms: a role in monitoring health care workers for latex sensitization?

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ABSTRACT

Background: The use of powdered natural rubber latex (NRL) gloves increased greatly in the 1980s because of concerns about transmission of blood-borne infections and the subsequent implementation of universal precautions. The most common clinical reactions to glove use are irritant and T-cell-mediated contact dermatitis. However, IgE-mediated immediate reactions to latex have become a serious concern for health care workers (HCWs). The diagnosis of latex allergy requires a comprehensive medical history and diagnostic tests. The skin prick test is the preferred diagnostic method, although it can be time-consuming.

Objective: To determine the role of hand symptoms reported on questionnaires in monitoring HCWs for latex sensitization.

Methods: Questionnaires were completed by 804 HCWs at 2 hospitals. Using a positive skin prick test (SPT) result as a criterion standard of latex sensitization, the diagnostic performance of hand symptoms was evaluated.

Results: Increasing latex glove use was strongly related to increasing reports of hand symptoms. Hand symptoms were highly associated with glove-related respiratory and systemic symptoms. A positive SPT result was seen in 5% of HCWs and increased with the number of hand symptoms: 0 (1.6%), 1 to 2 (3.4%), and 3 to 7 (19.0%). Participants reporting more than 2 hand symptoms were 11 times more likely to have positive SPT results compared with those with 2 or fewer hand symptoms.

Conclusion: Hand symptoms are closely associated with latex sensitization. Questionnaires should be useful in health monitoring for HCWs who use latex gloves.

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Introduction

Widespread use of powdered gloves made from natural rubber (referred to as “latex”) began in 1987 after health care facilities implemented universal precautions to prevent occupational transmission of infections. Common clinical reactions to latex glove use include irritant and T-cell-mediated contact dermatitis. T-cell-mediated contact dermatitis can be induced by a variety of chemicals, including thiuram, carbamate, and mercaptobenzothiazole, which are used to accelerate the cross-linking of isoprene during

glove manufacturing. IgE-mediated contact urticaria may also develop in broken skin exposed to latex proteins. In some individuals, latex allergy can be a systemic disorder and produce rhinitis, asthma, or anaphylaxis. Reports of allergy to latex proteins greatly increased in the early 1990s. Allergy to latex was recognized as an increasingly common and potentially serious health problem, particularly for health care workers (HCWs) and patients who undergo frequent surgical procedures.^{1–3} The diagnosis of latex allergy is confirmed based on a comprehensive medical history and examination, combined with diagnostic tests. The skin prick test (SPT) is considered to be the most useful test in diagnosing type 1 hypersensitivity, but no commercial latex allergy skin test reagent is available in the United States.⁴ In addition, the SPT has been reported to entail a risk of anaphylaxis in highly allergic individuals. For that reason, investigators have searched for an accurate, safe, and efficient way to screen at-risk individuals for latex allergy. We performed a post hoc study to investigate the relationship of self-reported hand symptoms and positive latex SPT results to determine the role of hand symptoms reported on questionnaires in monitoring HCWs for latex sensitization.^{5–8}

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Methods

Approval of the study was received from the institutional review boards at Children's Hospital of Wisconsin, Froedtert Memorial Lutheran Hospital, the Medical College of Wisconsin, the Food and Drug Administration, and the Human Subjects Review Board at the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health. The study took place from June 1998 to December 2002. Employees who worked with latex gloves in 2 hospitals were studied prospectively during 4.5 years. Data were collected after written informed consent was obtained. Participants and methods have been described in detail⁹ and are reviewed briefly in this article.

Study participants

All employees, especially those who regularly used gloves at both hospitals, were asked to participate in the study. A total of 805 employees (12.1%) who used medical gloves were recruited from the 2 hospitals among 6,635 total employees. This cross-sectional analysis is based on the 804 individuals with complete data collected at the initial survey. Informed consent was obtained before participation.

Skin prick testing

All participants underwent SPTs with Clone 600 nonammoniated latex in duplicate (2 latex SPTs were placed simultaneously on the same arm) (reagent provided by Greer Laboratories Inc, Lenoir, North Carolina). A latex SPT result was considered positive when the mean diameter of the wheal was at least 3 mm greater than the wheal from a saline control on both of the duplicate tests. In this study, a positive latex SPT result was considered to be the criterion standard for sensitization to latex.

Participants also underwent SPTs with a panel of seasonal and perennial allergens and food extracts using Multitest (Lincoln Diagnostics Inc, Decatur, Illinois). A positive test result was determined when the mean diameter of the wheal was at least 3 mm greater than a wheal from a saline control. Individuals with a positive SPT result to one or more of the allergens were considered to be atopic.

Questionnaire

A self-administered questionnaire included an occupational and tobacco smoking history and questions on latex glove use, symptoms associated with glove exposure, and history of asthma or allergies. Questionnaire items queried itching, redness, rash without hives, hives without rash, hives with rash, cracking, and blisters. Symptoms on the hands attributed by the participant to latex gloves were combined into a 7-part index.

Systemic symptoms related to latex gloves were also evaluated, including hives on the body, sneezing, rhinorrhea, nasal congestion, eye itching, coughing, throat irritation, voice change, shortness of breath, wheezing, asthma, anaphylactic shock, and other (to be specified). Participants were queried about allergies to specific foods, including banana, peaches, avocado, potato, chestnut, tomato, passion fruit, apple, kiwi, melon, cherry, and watermelon.

Statistical analysis

Statistical analysis was performed using SAS statistical software, version 9.0 (SAS Institute Inc, Cary, North Carolina). Participants were classified as either latex SPT positive or negative based on the test results. The SPT-positive group comprised 40 HCWs; all other participants were in the SPT-negative group ($n = 764$). Hand symptom groups were defined by the number of self-reported symptoms associated with the use of latex gloves. To improve specificity of hand symptoms, participants were grouped according to whether they reported 0, 1 to 2, or 3 to 7 hand symptoms. Group

comparisons were made between the SPT-positive and SPT-negative groups and among hand symptom groups (0, 1–2, and 3–7). Statistical significance of differences was assessed using t tests and analysis of variance (for continuous variables) and χ^2 or Mantel-Haenszel χ^2 test (for dichotomous variables).

Odds ratios and diagnostic values were estimated for single and combined hand symptoms from latex gloves using SPT positivity as the criterion standard to define latex sensitization and single or more than 2 hand symptoms from latex gloves as the clinical index test. The association between hand symptoms and SPT positivity was assessed by odds ratio estimates from 2×2 tables.¹⁰ The diagnostic values of sensitivity, specificity, positive likelihood ratio (LR),^{11,12} positive predictive value, and negative predictive value were also computed using 2×2 tables. The LR is a useful index of test performance that combines information about the sensitivity and specificity of a test and provides an indication of how much the odds of disease change based on a positive or a negative result. A positive LR of 2 to 5 indicates a fair clinical test, 5 to 10 is considered a good test, and more than 10 characterizes excellent test performance.¹³

Results

The study participants were predominantly nurses and patient care assistants (69%) and included 732 women (91%) and 696 whites (87%). Age ranged from 19 to 66 years (mean, 39 years). At the initial survey, 15% current smokers, 18% ex-smokers, and 67% nonsmokers were recorded. No significant differences were noted between latex SPT-positive and SPT-negative groups in mean age, distribution of race, sex, or smoking status. When participants were grouped by the number of hand symptoms, age, race, and sex were similar, whereas the percentage of ever-smokers was somewhat higher in groups with 1 to 2 or 3 to 7 hand symptoms compared with the group with no hand symptoms (38%, 38%, and 30%, respectively; $P = .02$).

Figure 1 shows the positive relationship between the prevalence of latex SPT positivity and number of hand symptoms reported. Latex sensitization was seen in 5% of HCWs overall, and the proportion with a positive SPT result increased with the number of hand symptoms. The prevalence of SPT positivity was 1.6%, 2.1%, 4.8%, 15%, 20%, 22%, 50%, and 67%, with 0, 1, 2, 3, and up to 7 hand symptoms, respectively ($P < .001$ by Mantel-Haenszel χ^2 test). Figure 2 displays the proportion of HCWs who reported each specific hand (Fig 2A) and systemic symptom (Fig 2B) attributed to latex gloves by latex sensitization: SPT positive vs SPT negative. The percentage reporting hand and systemic symptoms from latex gloves was significantly higher in the group with a positive SPT result to latex compared with the latex SPT-negative group. The relationships between hand symptoms and the occurrence of either systemic symptoms or other allergic disorders are shown in Figure 3. The percentage of HCWs with systemic symptoms (Fig 3A)

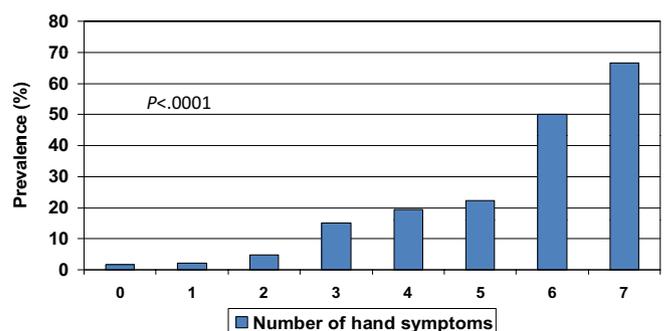


Fig. 1. Prevalence of positive skin prick test results by number of hand symptoms ($N = 804$). P value for trend derived from Cochran-Mantel-Haenszel statistics.

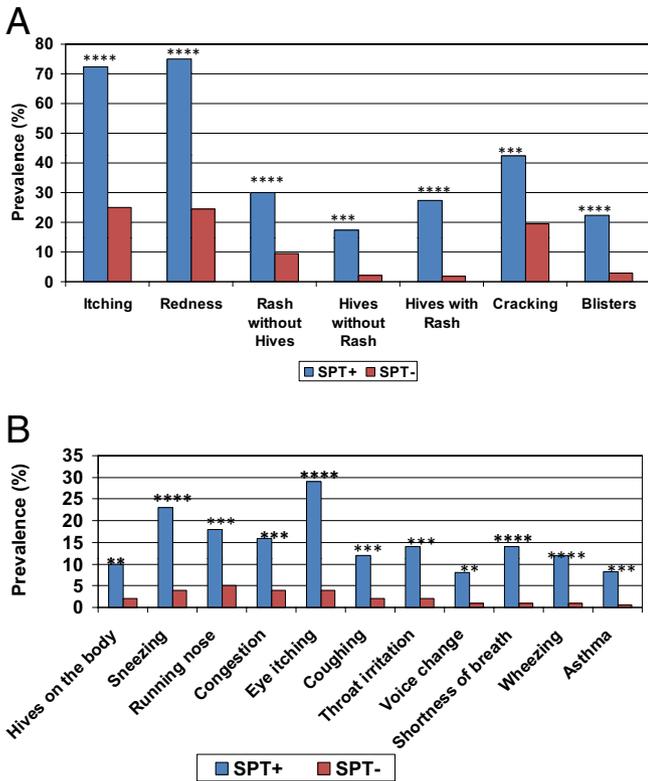


Fig. 2. A, Prevalence of hand symptoms from latex gloves by skin prick test (SPT) results (N = 804). B, Prevalence of systemic symptoms associated with latex gloves by SPT results (N = 804). ****P < .0001; ***P < .001. P values by χ^2 test for SPT-positive vs SPT-negative groups.

was highest in the group of participants who reported 3 or more hand symptoms, followed by the group with 1 to 2, and significantly lower in the group without hand symptoms. Similar patterns are seen for the prevalence of other allergic disorders (Fig 3B).

The association between latex SPT positivity and the number of hand symptoms was assessed by odds ratio estimates from 2 × 2 tables (Table 1). The results indicated that HCWs who reported hand symptoms from latex gloves had 3 to 20 times higher odds of being latex sensitized. Table 1 also lists the sensitivity, specificity, and positive LR for each specific hand symptom and for an index of any one, combining any 2 or 3 or more of the 7 hand symptoms. The sensitivity for an index of reporting at least 1 of the 7 hand symptoms was 80%. The sensitivity decreased to 65% and the specificity increased to 86% when the number of hand symptoms reached 3 or more. The symptom of hives with rash had the highest odds ratio and specificity, and positive LR indicated excellent test performance.¹³

The number of latex-associated hand symptoms is compared with indicators of glove use and allergic disorders in Table 2. The number of hand symptoms recorded by HCWs was significantly associated with indicators of latex glove exposure (use of latex examination gloves, number of glove pairs used per day, and the number of hours per day wearing gloves, Table 2), as well as reports of several allergic conditions (change glove type due to symptoms, allergy problems during use of condoms or blowing up of balloons, self-reported food allergy, positive SPT result to one or more foods and aeroallergens, and symptoms that begin after starting work and are better when away from work, Table 2). Reporting the number of hand symptoms was not related to whether the HCW used powdered or powder-free gloves (Table 2).

Discussion

Occupational latex allergies can range from troublesome skin disorders to life-threatening systemic illnesses. The prevalence of latex allergies among HCWs can be markedly reduced when facilities adopt specific exposure control practices.^{3,9} However, worker health monitoring is still encouraged because some individuals may become sensitized, even after adoption of such practices. Questionnaires have been recommended as tools for screening occupational groups for skin disorders.⁸ There is accumulating evidence that skin exposure can trigger respiratory and systemic allergies for both low- and high-molecular-weight occupational sensitizers.¹⁴ As part of a study in HCWs, we sought to determine whether hand symptoms recorded on a questionnaire might be a useful component of health monitoring for latex sensitization. The results showed that self-reported hand symptoms from latex gloves were significantly correlated with positive latex SPT results. As the number of hand symptoms increased, participants demonstrated a significantly higher percentage of positive SPT results. This finding was reinforced by the parallel finding that HCWs who reported increasing numbers of hand symptoms also had significantly higher exposures to latex glove use and a higher percentage of systemic symptoms and other allergic conditions.

The highly significant associations observed in this study between latex skin test results and the glove-associated hand symptom index (such as rash with hives) provide validation of the use of questionnaire-based health monitoring in workplaces with exposure to latex gloves. Sensitivity of the index was only 65%, indicating the need to maintain a relatively high index of suspicion, but negative predictive values were higher than 95%. The diagnostic values for hand symptom of hives and rash are very similar to values reported for the available serologic assays at the cutoff

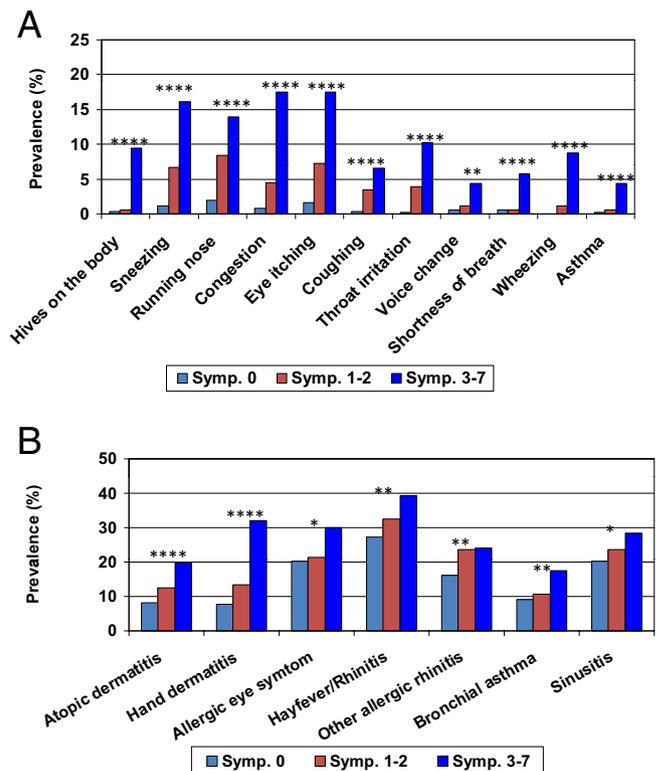


Fig. 3. A, Prevalence of systemic symptoms associated with latex gloves by number of hand symptoms (N = 804). B, Prevalence of allergic disorders by number of hand symptoms (N = 804). ****P < .0001; **P < .01; *P < .05. P values for trend derived from Cochran-Mantel-Haenszel statistics. Symp. indicates number of hand symptoms from latex gloves: 0, 1 to 2, or 3 to 7.

Table 1
Odds ratios and diagnostic values for latex sensitization by specific hand symptoms from latex gloves and combinations of 3 or more symptoms

Hand symptom	Prevalence, %	Odds ratio (95% CI)	Sensitivity, %	Specificity, %	PPV, %	NPV, %	Positive LR
Itching	27.5	7.9 (3.8–16.0)	72.5	74.9	13.1	98.1	2.9
Redness	26.9	9.3 (4.5–19.4)	75.0	75.7	13.9	98.3	3.1
Rash	10.6	4.1 (2.0–8.3)	30.0	90.4	14.1	96.1	3.1
Hives	2.7	10.6 (4.0–27.7)	17.5	98.0	31.8	95.8	8.9
Hives and rash	3.1	20.3 (8.5–48.6)	27.5	98.2	44.0	96.3	15.0
Cracking	20.8	3.0 (1.6–5.8)	42.5	80.4	10.2	96.4	2.2
Blister	4.0	9.4 (4.0–22.0)	22.5	97.0	28.1	96.0	7.5
≥1 symptoms	39.2	6.8 (3.1–15.0)	80.0	63.0	10.2	98.4	2.2
≥2 symptoms	27.5	9.0 (4.3–18.8)	75.0	75.0	13.6	98.3	3.0
≥3 Symptoms	17.0	10.9 (5.5–21.6)	65.0	85.5	19.0	97.9	4.5

Abbreviations: CI, confidence interval; LR, likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

Workers who reported hand symptoms from latex gloves had from 3 to 20 times higher odds of being latex sensitized. The symptom of hives with rash had highest odds ratio and specificity, and the value of LR+ indicated an excellent test result.

An LR+ of 2 to 5 indicates a fair clinical test; 5 to 10 is considered a good test; and > 10 characterizes an excellent test result.¹³

values that provide 98% specificity for determining latex sensitization.¹⁵ This finding suggests that screening with this symptom may be as effective as serologic tests, although the sensitivity of both approaches was only approximately 30%.

Several previous studies have compared self-reported skin symptoms with skin test results or physician diagnoses.^{5,16,17} Single items on questionnaires have generally shown only moderate sensitivity and specificity, but performance has been quite variable, related at least in part to the prevalence and severity of the skin conditions and also when used in different countries.⁸ In a clinical study of hairdressers referred for skin problems, self-reported localized hives was closely related to serologic or skin prick evidence of latex sensitization.⁴ Among 454 persons attending a dental association conference, the reporting of localized urticaria with or without systemic symptoms was 94% specific for latex sensitization by SPT, although the symptom had a sensitivity of only 58%.¹⁶ In the current study, high LRs for latex sensitization were seen with report of hives (LR = 8.9) and hives with rash (LR = 15.0). Similar findings have also been reported from other studies of screening for latex sensitization among HCWs in Brazil¹⁷ and Taiwan.¹⁸ Buss and colleagues¹⁷ reported that questionnaire-based hand symptoms demonstrated 100% sensitivity and provided an excellent screening test for latex sensitization in a group of HCWs; they concluded that routine questionnaire screening among HCWs should help in the early identification of latex sensitization and facilitate preventive strategies.

Taken with these previous observations, our results confirm that self-reported hand symptoms attributed to latex gloves are closely associated with latex sensitization. In our study, at least one hand symptom was reported among 80% of latex-sensitized HCWs, and the absence of hand symptoms appears to exclude latex sensitization with fair reliability. Conversely, the reporting of hives with or without other symptoms appears to be highly specific for latex sensitization,

although the sensitivity of that single symptom is low. We found an index comprising the number of self-reported hand symptoms to be significantly associated with job exposure to latex gloves. As the index of hand symptoms increased, the HCWs demonstrated an increasing proportion of positive latex SPT results (Fig 1). The report of hives or any 3 hand symptoms, in association with latex glove use, should trigger a clinical evaluation to exclude latex allergy.

A weakness of this study is that the data were collected more than 10 years ago. The current diagnostic products for IgE-mediated latex allergy were not commercially available during the study. In addition, the rate of clinically significant IgE-mediated latex allergy has decreased during the past decade.

Although control measures adopted in the past decade continue to reduce the risk of latex allergy among HCWs,⁹ clinicians must still retain an index of suspicion. The use of latex gloves has actually increased worldwide and continues to increase, albeit with more powder-free and lower allergen latex gloves. This study supports the use of hand symptoms as a screening tool in health monitoring for HCWs who use gloves to facilitate the recognition of HCWs at risk of latex allergy. Hand symptoms are significantly correlated with sensitization, although a small number of workers may demonstrate latex sensitization in the absence of hand symptoms.

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Table 2
Comparisons of indicators of glove use and allergic disorders with the number of self-reported hand symptoms from latex gloves

Indicator	No. of hand symptoms			P value for trend ^a
	0 (n = 489)	1–2 (n = 178)	3–7 (n = 137)	
Use of powdered latex examination gloves, %	36.4	51.7	51.1	<.001
Use of nonpowdered latex examination gloves, %	34.0	51.7	48.9	<.001
>20 gloves used at work per day, %	36.8	44.9	63.5	<.001
> 2 hours wearing gloves at work per day, %	42.0	50.9	57.8	<.001
Any food allergy, %	3.5	9.6	11.0	<.001
SPT positivity to food panel allergens, %	8.6	13.1	14.0	.04
SPT positivity to environmental allergens, %	16.4	19.1	35.8	<.001
Irritative symptoms due to use of condoms, %	2.3	6.2	10.2	<.001
Symptoms with blowing up balloons, %	5.7	7.9	14.6	.001
Allergy problems began after starting work, %	16.4	19.1	35.8	<.001
Symptoms seem better when away from work, n/N (%)	67/227 (24.2)	57/110 (51.8)	68/94 (72.3)	<.001
Changed type of gloves due to glove-related symptoms, %	6.0	19.8	45.2	<.001

^aP values are derived from Cochran-Mantel-Haenszel statistics.

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