
Prevalence of latex-specific IgE antibodies in hospital personnel

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Background: Rubber latex hypersensitivity is an important concern for health care workers.

Purpose: The Center for Devices and Radiological Health, in collaboration with the Consumer Product Safety Commission, conducted a multicenter study of the prevalence of latex-specific IgE antibodies among United States hospital personnel.

Materials and Methods: Nine hospitals participated in the cross-sectional study. A total of 504 hospital personnel completed questionnaires that provided an array of demographic, occupational, and clinical information, including a history, if any, of allergies and the use of latex and nonlatex gloves. More than three-quarters (76.5%) of the participants were tested for total IgE and latex specific IgE.

Results: A total of 21 (5.5%, 95% CI = 3%–7%) of the tested participants were positive for the presence of latex specific IgE antibodies, defined as a latex IgE level of ≥ 0.6 ng/mL. Latex specific IgE antibodies were more prevalent in participants who reported tachycardia, palpitations, flushing, or wheezing associated with latex gloves (Odds Ratio = 10.2, 95% CI = 3.7–28.6).

Conclusion: The study's results suggest that the prevalence of latex-specific IgE antibodies among hospital personnel is appreciable and these personnel and their health care providers should be aware of this entity.

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INTRODUCTION

Allergy to natural rubber latex, an important material in many consumer and medical products, has been recognized, especially in several high risk groups. Patients with spina bifida are one group of individuals exposed to latex as a result of glove contact from multiple surgeries, who have a high risk (39% to 64.5%) of developing latex allergy.^{1–3} Anaphylactic responses to latex have also been described in patients who have been exposed to latex

cuffs during barium enema examinations.⁴ Healthcare workers, who are occupationally exposed to latex, have been reported to have an above average prevalence of latex allergy.⁵

Rubber gloves are an important source of exposure to allergenic latex proteins for many health care workers. The adoption and widespread acceptance of the policy of universal precautions in the late 1980s created the framework for a profound increase in the use of gloves by healthcare workers, and the potential for resultant increased exposure to latex in this population. Previously, gloves had been employed only when the procedure required sterility or the patient was known to be infectious. The Centers for Disease Control (CDC) recommendations for the widespread application of universal precautions required that all patients be considered potentially infectious.⁶ Therefore, rubber glove use has been recommended far more

often than previously. A multistate, multi-institutional study published by Kaczmarek et al⁷ demonstrated that actual glove use by health care workers during routine procedures that could involve contact with patient body fluids was substantial, although not universal. The frequency of glove use ranged from a high of 92% for arterial blood gas procedures to a low of 70% for phlebotomy. Although no data exist to quantify the extent of glove use by healthcare workers prior to the initiation of universal precaution policies, it is likely that the glove use levels observed in the Kaczmarek et al. study represent a substantial increase over pre-universal precautions levels.

The purpose of this study was to examine the prevalence of natural rubber latex specific IgE antibodies among US hospital personnel. These personnel represent a group of workers whose use of latex rubber gloves has increased substantially in recent years because of the implementation of universal precautions policies.

METHODS

This multi-institutional study was a collaborative effort of the Center for Devices and Radiological Health, a unit of the Food and Drug Administration, and the Consumer Product Safety Commission. A total of nine hospitals participated in the study. These facilities are part of an extensive network that supplies data to the Consumer Product Safety Commission regarding consumer product-related injuries resulting in emergency room visits. Demographic information that characterized the participating facilities was obtained. This information included number of beds, university affiliation status, and number of patients treated

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annually in the emergency room. The primary study population consisted of healthcare workers who worked in the emergency rooms of the participating facilities. These workers included nurses, physicians, and emergency medical technicians. A limited number of laboratory and radiology personnel also participated in the study. Participation in the study was entirely voluntary and subject confidentiality was strictly maintained.

An array of demographic, occupational, and clinical information was obtained by questionnaire from study participants. A history, if any, of allergies was elicited. Participants also described their current use of both latex and nonlatex gloves.

Each study participant was asked to provide a serum specimen that would be analyzed in a previously described radioallergosorbent test (RAST)⁸ for IgE antibodies to rubber latex. All sera were pre-coded and analyzed in a blinded manner. Latex-specific antibodies, if present in serum, were bound to a solid phase latex allergosorbent prepared with latex proteins extracted from commercially available natural rubber surgical/examination gloves. Following an overnight incubation, unbound serum proteins were removed with a buffer wash and bound IgE antibodies were detected with I¹²⁵ labeled polyclonal anti-human IgE Fc. Following a second incubation and subsequent buffer wash, bound radioactivity was measured in a gamma scintillation counter. The relationship between counts per minute bound and IgE anti-latex concentration was determined in each assay using a multipoint reference serum standard curve. Specificity of IgE antibody binding to the rubber-latex solid phase was documented by competitive soluble latex allergen inhibition for each IgE antibody positive serum identified in this study. Further details and clinical documentation of the assay are presented elsewhere.⁶ Total serum IgE was also determined in these individuals using the Abbott IMx. Total IgE results were reported in ng/mL which was used to compute the "Z score" or the number of standard

deviations that the subject's total IgE fell from that of an age-adjusted nonatopic population mean.⁹

Questionnaire data and laboratory results were analyzed using the SAS-PC software. Except where indicated, p values were calculated using the chi-square test.

RESULTS

Of the nine hospitals in the survey, three had fewer than 300 licensed beds, 4 had 300 to 599 beds, and 2 had 600 or more beds. Two of the hospitals had fewer than 20,000 emergency room visits per year, 5 had 20,000 to 49,999 emergency room visits per year, and 2 had 50,000 or more emergency room visits per year. Four hospitals had university affiliations, and 5 did not. Hospitals were recruited from all of the major geographic regions of the United States. The regional representation was as follows: Northeast, 3; Midwest, 1; South 2; and West, 3.

Of 915 potential participants, 504 (55%) completed questionnaires, 384 (42%) had blood test results for total and latex-specific IgE, and 381 (42%) had both completed questionnaires and blood tests. Reason for a blood test result being unavailable included refusal of the participant to be tested and absence of the participant from work during the period when blood collection was done. Descriptive information on questionnaire respondents is presented in Table 1. Demographic information was not consistently available for those who did not complete questionnaires.

Ninety-eight percent of questionnaire respondents reported at least intermittent use of latex gloves. Fifty-two percent (264) reported experiencing at least one sign or symptom since they had begun using latex gloves; 40% of all respondents (78% of those reporting symptoms) believed they had symptoms as a result of contact with latex gloves or powder on gloves. Forty-nine percent of respondents reported one or more of a variety of skin effects (including irritation, erythema, scaling, vesicles, itching, drying, cracking or bleeding of skin). Respondents with

histories of any allergy were more likely to report symptoms (65% vs. 39%, $P < .001$). Thirty percent of respondents reporting symptoms stated that they had reduced their use of latex gloves. This question was not asked of those without symptoms.

Twenty-six percent of questionnaire respondents reported the use of nonlatex gloves. Respondents who reported any symptoms since beginning to use latex gloves were more likely to report nonlatex glove use than those reporting no symptoms (33% versus 19%, $P < .001$), as were respondents reporting any type of skin effects (31% versus 21%, $P = .007$). Three percent of questionnaire respondents (10% of current nonlatex glove users) reported symptoms occurring in association with the use of nonlatex gloves.

Of those who completed questionnaires, 381 (76%) had blood test results available. Respondents were more likely to have blood test results if they gave histories of any symptoms since beginning to use latex gloves (78% versus 71%, $P = .02$), reported skin effects of latex glove use (80% versus 71%, $P = .03$), worked 40 or more hours per week (81% versus 70%, $P = .004$), or had worked in their professions less than 10 years (81% versus 70%, $P = .003$). Likelihood of blood testing did not vary with age, race, sex, job title, or allergy history (Table 1).

Of 381 study participants with blood tests and completed questionnaires, 21 (6%) were positive for latex-specific IgE antibody (defined as ≥ 0.6 ng/mL). Positive RAST results ranged from 0.7 ng/mL, to 222.3 ng/mL, (median 1.8 ng/mL). Completed questionnaires were available for all participants with positive blood tests. Positive blood tests were significantly more likely in nonwhites, as compared with whites (18% versus 4%, $P < .001$), and in participants who gave histories of any of a group of symptoms suggestive of allergic response (tachycardia, palpitations, flushing, or wheezing) since beginning to use latex gloves (29% versus 4%, $P < .001$). When blood test results were recoded to "low"/"high"

Table 1. Proportional Distribution of Selected Characteristics of Questionnaire Respondents* and Proportion Tested by Characteristic†

	Respondents total = 504		Respondents Tested	
	n	%	n	%
Age, year				
<35	276	55	215	78
≥35	224	45	166	74
Sex				
Male	119	24	91	76
Female	385	76	290	75
Race				
White	446	89	336	75
Non-white	57	11	44	77
Job title				
Nurses	281	56	208	74
Physicians	86	17	64	74
Aides	36	7	25	69
Other/Unknown	101	20	84	83
Allergy history				
yes	251	50	189	75
no‡	253	50	192	76
History of symptoms since beginning latex glove use				
Any symptoms¶				
yes	262	52	209	80
no	242	48	172	71
Tachycardia				
yes	6	1	5	83
no‡	498	99	376	76
Erythema¶				
yes	131	26	113	86
no‡	373	74	268	72
Wheezing				
yes	13	3	8	62
no‡	491	97	373	76
Scaling¶				
yes	100	20	86	86
no‡	404	80	295	73
Skin irritation§,¶				
yes	249	49	199	80
no‡	255	51	182	71
Allergy-type symptom complex				
yes	33	7	24	73
no‡	471	93	357	76
Work hours¶				
<40 h/wk	238	48	166	70
≥40 h/wk	260	52	210	81
Number of years employed¶				
<10 yrs	264	52	214	81
≥10 yrs	240	48	167	70
User of latex gloves				
yes	496	98	377	76
no	(8)	2	4	50

* Percentages may not total to 100% due to the presence of unknown or missing responses. Percents are column percents.

† Percents are row percents.

‡ Includes respondents with "don't know"/"missing" responses.

§ Recode variable includes irritation, erythema, scaling, vesicles, itching, dry cracked or bleeding skin.

¶ Indicates a statistically significant difference in the likelihood of being tested among those with and without the given characteristic.

(<1.9 ng/mL/≥1.9 ng/mL), 3% of latex-specific IgE antibody results were "high". Twenty-one percent of those reporting immediate type hypersensitivity symptoms had "high" latex-specific IgE antibodies results, as compared with 1% of those without histories of these symptoms ($P = .0001$, Fisher's exact test).

The participant group with positive latex IgE specific RASTs had a mean total IgE level of 354.7 ng/mL. In contrast, participants with negative IgE specific RAST tests had a mean total IgE level of 127.9 ng/mL. This difference was statistically significant ($P < .0001$, Wilcoxon test).

DISCUSSION

The survey focused on hospital personnel because this group faces a high likelihood of exposure to latex rubber products as a result of adhering to universal precautions. As noted previously,⁷ glove use by healthcare workers has been as high as 92% for arterial blood gas procedures. A total of 98% of the respondents of the present study reported that they use latex gloves in the course of their work.

The choice to participate in blood testing appears to have had some relationship to the level of interest of the study subject, since the likelihood of having a blood test done was associated with a history of symptoms. The positive association of participation in blood testing with number of hours worked per week probably reflects the difficulty of accessing part-time workers for blood sampling.

The data presented here describe the spectrum of symptomatology experienced by a group of healthcare workers with frequent use of latex gloves. The fact that many of the respondents reported at least one symptom believed by the respondent to be related to latex glove use is of concern, in that it may affect healthcare workers' compliance with universal precautions. The vast majority of these symptoms were related to skin irritation. Furthermore, chronic skin irritation, regardless of the etiology, could actually have the effect of increasing a healthcare worker's susceptibility

to infection by compromising the integrity of the epithelium and diminishing its effectiveness as a barrier to infectious agents. Further study is warranted to address this issue and to examine the role of other factors that may be related to chronic skin irritation, such as frequent handwashing.

That most of the respondents reporting latex-related symptoms were negative for latex allergy on RAST testing was not surprising, since a report of nonspecific skin irritation is insufficient to indicate a true IgE antibody-mediated allergic response. On the other hand, positive blood tests were significantly more likely in those respondents reporting symptoms consistent with allergic reactions (wheezing, flushing, tachycardia, and wheals). This association is biologically plausible.

Presently, skin prick testing is considered to be more sensitive than serological (RAST) testing in the diagnosis of allergy.¹⁰ However, the clinical sensitivity of recent in vitro assays has been demonstrated to be appreciable. The assays used in the current study have been shown to identify approximately 90% of latex sensitive children with spina bifida¹¹ and up to 78% of latex allergic adult healthcare workers.⁸ In the context of our study, the serological evaluation offers important advantages. The RAST minimizes the risk of adverse reactions for the research participant; the only risk is from venipuncture. In contrast, anaphylactic reactions to latex skin prick tests have been described.¹² The greater safety and confidentiality of the serological test facilitates participant recruitment and improves the overall response rate, enhancing the validity of an epidemiologic study. It also promotes facility recruitment for a multicenter study. Others have found a prevalence of anti-latex IgE of 6.5% among blood donors in southeastern Michigan¹³ and 7.7% among United Kingdom blood donors¹⁴ using an analogous, but not identical assay for detecting IgE antibodies. Although blood donors may not be fully representative of the general population, these results suggest

Table 2. Proportional Distribution of Selected Characteristics of Survey Participants Tested for Latex Allergy* and Proportion with Positive Result by Characteristic†

	Tested group N = 381		Positive Blood Test	
	n	%	n	%
Age, yr				
<35	215	56	11	5
≥35	166	44	10	6
Sex				
Male	91	24	7	8
Female	290	76	14	5
Race				
White/Hispanic	336	88	13	4
Non-white	44	12	8	18
Job title				
Nurses	208	55	11	5
Physicians	64	17	3	5
Aides	25	6	0	0
Other/unknown	84	22	7	8
Allergy history				
yes	189	50	14	7
no	192	50	7	4
History of symptoms since beginning latex glove use				
Any symptom				
yes	209	55	14	7
no‡	172	45	7	4
Tachycardia				
yes	5	1	2	40
no‡	376	99	19	5
Wheezing				
yes	8	2	3	38
no‡	373	98	18	5
Skin irritation§				
yes	199	52	12	6
no‡	182	48	9	5
Allergy-type symptom complex ¶,				
yes	24	6	7	29
no	357	94	14	4
Work hours (wk)				
<40	166	44	10	6
≥40	210	56	11	5
Number of years employed				
<10 yr	214	56	10	5
≥10 yr	167	44	11	7

* Percentages may not total to 100% due to the presence of unknown or missing responses. Percents are column percents.

† Percents are row percents.

‡ Includes respondents with "don't know"/"missing" responses.

§ Includes irritation, erythema, scaling, vesicles, itching, dry, cracked or bleeding skin.

¶ One or more of: tachycardia, wheezing, flushing, wheals.

|| Indicates a statistically significant difference in the likelihood of having a positive test result among those with and without the characteristic.

that the prevalence of such antibodies in the general population may be greater than previously suspected. The general population may be exposed to

latex rubber from a variety of sources, including barrier contraceptives and the latex gloves of healthcare providers, such as dental personnel.

Other studies of healthcare workers have also demonstrated an appreciable prevalence of latex sensitization. A study that employed latex skin prick tests of 101 physicians disclosed a prevalence of 11.0% for latex sensitization.¹⁵ A study of 197 operating room nurses indicated a prevalence of 10.7%, based on latex skin prick test positivity.¹⁶ Yassin et al reported¹⁷ a prevalence of latex allergy of 17% among 224 hospital employees. The inclusion of dental personnel, a lower participation rate, and the use of more sensitive prick skin testing instead of RAST, may have contributed to the higher prevalence of latex allergy observed.

Since many of the previous prevalence studies of latex sensitization were performed outside the United States,^{5,11,16} an important strength of the present study is its multicenter, national scope. Additionally, the RAST provides serologic confirmation for the presence of IgE antibodies and, thus, sensitization to latex.

The results of our study may be limited by the possibility of ascertainment bias. Participation in the study was voluntary and may have been further reduced by workplace scheduling difficulties. Nonsymptomatic healthcare workers could have been less motivated to participate than their symptomatic counterparts. Conversely, although strict patient confidentiality was maintained, some symptomatic healthcare workers may have been reluctant to participate because of concerns regarding possible job loss. The direction and precise magnitude of the ascertainment bias, if any, cannot be determined.

Given the cross-sectional nature of this study, it is impossible to determine whether there was a temporal progression from dermatitis to systemic symptoms, although such a progression has recently been suggested by several observers.¹⁸

A greater prevalence of latex allergy was observed among nonwhite, as opposed to white, hospital personnel in the study. The number of nonwhite study participants was relatively small

so these findings may not be confirmed with a larger sample size and should be interpreted with caution.

It is important to recognize that the level of leachable allergen from latex rubber gloves varies widely. In a cross sectional study, chlorinated, nonpowder gloves were found to have less than 1 ng of leachable allergen/glove, and non-powder, poorly washed gloves had leachable allergen levels in excess of 1000 ng/glove.¹⁹ A prospective study by Jones et al also disclosed considerable variability in extractable allergen levels among latex gloves.²⁰ The variability in leachable allergen levels may affect the prevalence of latex sensitization in a given healthcare facility, but this could not be addressed in the present study.

The data from this study suggest that US hospital personnel have a prevalence of latex-specific IgE antibodies that is appreciable. These personnel and their healthcare providers should be aware of the potential for the development of latex allergy. The cornstarch donning powder that becomes airborne when gloves are removed is particularly problematic because it has latex allergen adsorbed to its surface. Nonlatex gloves and powderless, pre-washed latex gloves may be used by latex allergic healthcare workers or a nonlatex (synthetic) glove may be worn under a latex rubber glove. Prophylactic treatment with antihistamines and corticosteroids may be indicated prior to medical procedures that involve latex exposure for hypersensitive individuals; however, such prophylaxis is not generally effective.²¹

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CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN NONSMOKERS

The authors evaluated prevalence of self-reported chronic obstructive pulmonary disease in 12,980 participants in the National Health and Nutrition Examination Survey of 1971 to 1975 (NHANES I), NHANES II (1976 to 1980), or the Hispanic Health and Nutrition Examination of 1982 to 1984. Data were analyzed for participants 18 to 74 years of age who indicated they had smoked fewer than 100 cigarettes during their entire lives. Those who indicated they had been told by a doctor that they had chronic bronchitis or emphysema were classified as having chronic obstructive pulmonary disease.

Overall 3.7% of these nonsmoking men and 5.6% of the nonsmoking women reported physician-diagnosed chronic obstructive pulmonary disease. Prevalence increased with age (for men, from 2.9% at <50 years of age to 5.2% at >70 years; for women, from 4.4% at <50 years to 7.2% at >70 years) and with decreasing family income (for men, from 2.7% for \$25,000+ to 5.6% at <\$7,000 per year; for women, from 3.8% at \$25,000+ to 6.9% at <\$7,000). Prevalence was higher in whites than nonwhites (for men 3.9% compared with 3.2%, for women 5.8% versus 4.4%), but these differences by race were not significant. There were no significant associations between prevalence of chronic obstructive pulmonary disease and type of home heating equipment, presence of home air conditioning, type of fuel used for cooking, area (urban versus rural) or population size of city or town.

There were no data about exposure to environmental tobacco smoke, which might account for the higher prevalence of chronic obstructive pulmonary disease in nonsmoking women. Other data indicate nonsmoking women are more likely than nonsmoking men to have a smoking spouse. Furthermore, there is an inverse relationship between household income and household smoking prevalence.

There is need for further research to explain causes of chronic obstructive pulmonary disease in nonsmokers.

—RMS

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