Latex Allergy Symptoms among Health Care Workers:

Results from a University Health and Safety Surveillance System

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We sought to describe risk factors for latex glove allergy symptoms among health care workers by combining data from an active clinical surveillance program and a comprehensive occupational health surveillance system. A total of 4,584 employers completed a latex allergy questionnaire. Six percent ($n = 276$) of subjects reported symptoms consistent with latex allergy. Years of latex glove use was a significant risk factor for latex allergy symptoms even after controlling for the effects of atopy, gender, age, race, fruit, and other allergies. Nurses, medical or lab technicians, physician's assistants, other clinical professionals, and housekeepers had the highest prevalence of latex glove allergy symptoms. Forty subjects (0.87%) who were confirmed as having latex sensitization. Sensitizsation may have been underestimated due to use of specific IgE antibody, less sensitive than skin-prick testing, and tiered design leading to laboratory assessment on a subset of the cohort. This surveillance program identified risk factors for latex allergy symptoms. Our findings provide a basis for tailoring future prevention strategies. *Key words*: latex allergy, healthcare workers, surveillance.

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INTRODUCTION

Glove substitution using low-protein/low-powder natural rubber latex (NRL) gloves can reduce risk for latex allergy among health care workers (HCWs).[1–5] Prevention guidelines call for such glove substitution as a primary prevention method.[6] However, even after glove substitution, high rates of latex-glove-associated dermatitis among HCWs have been reported. Furthermore, HCWs have reported continuing to wear latex gloves despite experiencing latex-related dermatitis, often citing personal preference for this type of glove.[7] Thus, researchers have called for systematic post-hire evaluations by occupational health professionals to identify and protect HCWs from latex allergies.

Several studies of HCWs have documented the prevalence of latex immune sensitization, measured by the presence of antilatex IgE antibody or a positive skin-prick test, and some have investigated the prevalence in the general population.[8–10] Researchers have stressed the importance of future studies examining the relationship between NRL exposure and actual reactivity rates, as opposed to studies that exclusively examine sensitization rates.[11] Few studies have evaluated the possible contribution of age, gender, and race to latex sensitization or reactivity.[12]

The main objectives of the current analyses were to: (1) estimate the prevalence of latex allergy symptoms among HCWs in a tertiary care medical center where substitution of low-protein powder-free latex gloves occurred in 2000, and (2) quantify risk factors for such symptoms, including the duration of work as a HCW, history of latex glove exposure, history of allergic illness, occupational group, gender, age, and race.

MATERIALS AND METHODS

Health and Safety Surveillance System

The health and safety surveillance system we studied was developed in 2001, and includes all employees of the Duke University Health System in Durham, North Carolina, including a tertiary care medical center and two small community hospitals.[13] The surveillance system incorporates multiple ongoing programs and existing data sets and includes information from the human resources records, private health insurance claims, industrial hygiene, radiological hygiene, hazardous waste management, emergency preparedness, occupational health, workers' compensation claims, and employee health promotion activities. The system allows comprehensive surveillance of occupational exposure hazards, injuries, and illnesses by making maximum use of existing data sources. Analyses on an individual level were facilitated, but confidentiality and privacy were protected by removal of identifiers by an outside contractor following data linkage. The project

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was approved by the Duke University Human Subjects Institutional Review Board.

Population at Risk/Surveillance Program

The study cohort was derived from the active surveillance of current and newly hired HCWs at the tertiary medical center from October 2002 through October 2003. Only HCWs with anticipated exposure to blood and body fluids necessitating glove use were included; the employee file from human resources provided demographic information (including gender, race, and date of birth), job code, and job title.

Newly hired HCWs with anticipated exposure to blood and body fluids completed a questionnaire assessing potential latex allergy at their post-hire clinical assessment. Current HCWs completed the survey at their annual tuberculin skin testing. In addition, employees who presented for evaluation of possible glove-related symptoms were asked to complete the survey.

Questionnaire and Clinical Evaluation of Latex Allergy

The latex allergy questionnaire inquired about the number of years of latex glove use, current and 12-month history of latex-related symptoms, history of physician-diagnosed latex allergy, and prior latex allergy skin and blood testing. Also assessed were history of hayfever, eczema, asthma, fruit allergies (including avocado, banana, chestnut, kiwi, and tomato), pollen and/or dander allergies, skin, and serology testing for allergies, surgery with general anesthesia, spina bifida, and smoking. Clinic visits were conducted for all new employees who reported potentially latex-related symptoms at any frequency and for current workers who reported ongoing skin or upper-respiratory symptoms occurring more frequently than once a month or having potentially latex-related lower-respiratory symptoms at any frequency. These different thresholds for clinical assessment were designed to minimize time away from work for current employees who only reported mild latex-related symptoms. Those who underwent clinical assessment and were found to have latex allergy symptoms as defined below also had blood drawn for measurement of serum antilatex allergen IgE antibody by the quantitative Turbo-MP Modified RAST (radioallergosorbent test) immunoassay.[14,15]

Latex Allergy Symptoms

Latex allergy symptoms were defined as either self-report of physician-diagnosed latex allergy *or* skin or respiratory symptoms associated with latex exposure coupled with at least one additional latex-related symptom: urticaria after latex exposure, rash within one hour of latex exposure, rash extending beyond the area of latex glove contact, or respiratory symptoms due to latex exposure confirmed by clinical assessment. For subjects meeting triage criteria for a clinic visit and reporting latex allergy symptoms as previously defined, latex sensitization was determined by a positive quantitative antilatex IgE antibody (class > 0).

Data Analysis

Questionnaire and clinical data were linked to the surveillance system then de-identified. Descriptive analyses were used to characterize demographics of the study population including age, gender, race, smoking history, current occupation, years of work in health care, duration of latex glove use, history of atopic illness, surgical history, and employment status (whether a new or current employee). Stratified analyses were used to explore trends in the prevalence of latex allergy symptoms by the population demographic parameters described.

Unconditional logistic regression was used to further explore the effects of years of latex glove use and duration of work as a HCW as risk factors for latex allergy symptoms while controlling for age, gender, race, history of atopy, history of allergies to medication, fruit, pollen, and employment status. In this model, all parameters were entered as categorical variables using reference cell coding for internal contrasts.

The model building strategy involved first performing univariate logistic regression for each parameter identified as candidates for inclusion in the preceding stratified analyses. Main effects multivariate logistic regression models were next constructed using parameters found to be statistically significant in the univariate analyses. A moderate level of statistical significance ($p < 0.25$) for initial inclusion of parameters into the multivariate logistic model was chosen. With all variables in the model, the model was refined to arrive at the set of biologically plausible covariates that would best predict the risk of latex allergy symptoms. The primary tool for assessing the contribution of any given covariate was the change in the model –2 log likelihood function with and without the variable and changes in the β coefficients for the remaining covariates. The final models include all parameters with a Wald type III chi-square of 0.1 or less. SAS Proc Logistic logistic regression procedures and associated regression diagnostics were used (SAS Institute Inc., The SAS System [CD-ROM]. Version 8.0, Cary (NC): SAS Institute Inc.; 2000).

RESULTS

Sample Characteristics

Demographic characteristics of HCWs are shown in Table 1. A total of 4,584 workers (60% of the eligible

TABLE 1 Population Demographics of Health Care Worker Cohort and Prevalence of Latex Allergy Symptoms by Demographic and Other Risk Factors

Variable and Number of Employees with Data	Number Employees (%)	Number of Latex Allergy Symptom Cases and Prevalence (%) Total Cases = 276
Age (n = 4584)		
< 25	272 (5.9)	6 (2.2)
25–34	1429 (31.2)	68 (4.8)
35–44	1237 (27.0)	98 (7.9)
45–54	1137 (24.8)	81 (7.1)
55–64	464 (10.1)	21 (4.5)
65+	45 (1.0)	2 (4.4)
Gender (n = 4584)		
Male	3328 (72.6)	31 (2.5)
Female	1256 (27.4)	245 (7.4)
Race/ethnicity (n = 4584)		
White	2859 (62.4)	170 (6.0)
Black	1425 (31.1)	87 (6.1)
Other	300 (6.5)	19 (6.3)
Years as health care worker (n = 3336)		
<3	678 (20.3)	19 (2.8)
3–9	961 (28.8)	60 (6.2)
10–20	804 (24.1)	79 (9.8)
20+	893 (26.8)	83 (9.3)
Years of latex glove use (n = 4162)		
None	788 (18.9)	18 (2.3)
<5	983 (23.6)	55 (5.6)
5–14	1365 (32.8)	95 (7.0)
15+	1026 (24.7)	88 (8.6)
Personal risk factors		
History of medication allergies (n = 4502)		
Yes	1301 (28.9)	135 (10.4)
No	3201 (71.1)	136 (4.3)
History of fruit allergies (n = 4462)		
Yes	425 (9.5)	67 (15.8)
No	4037 (90.5)	206 (5.1)
History of pollen and other allergies (n = 4488)		
Yes	1492 (33.2)	154 (10.3)
No	2996 (66.8)	120 (4.0)
History of general anesthesia (n = 4497)		
Yes	2471 (55.0)	187 (7.6)
No	2026 (45.0)	82 (4.1)
Ever smoked (n = 4508)		
Yes	1510 (33.5)	89 (5.9)
No	2998 (66.5)	182 (6.1)
Born with spina bifida (n = 4496)		
Yes	24 (0.5)	3 (12.5)
No	4472 (99.5)	271 (6.1)
Physician diagnosis hayfever, asthma, or eczema (n = 4364)		
Yes	1084 (24.8)	139 (12.1)
No	3280 (75.2)	125 (3.8)
Employment status (n = 4584)		
Current employees	3633 (79.2)	224 (6.2)
New employees	951 (20.8)	52 (5.5)
Occupational group (n = 4584)		
Administration/manager	80 (1.8)	1 (1.3)
All other clinical and professional	246 (5.4)	22 (8.9)
Faculty	264 (5.8)	10 (3.8)
Food services/nutrition	13 (0.3)	0 (0.0)

(continued on next page)

TABLE 1 (*continued*)

Variable and Number of Employees with Data	Number Employees (%)	Number of Latex Allergy Symptom Cases and Prevalence (%) Total Cases = 276
Occupational group (n = 4584)		
House staff	285 (6.2)	4 (1.4)
Housekeeping/laundry	294 (6.4)	17 (5.8)
Medical and lab tech	727 (15.9)	57 (7.8)
Nursing inpatient	1033 (22.5)	91 (8.8)
Nursing inpatient administration/manager	50 (1.1)	5 (10.0)
Nursing, administration and ambulatory care	275 (6.0)	24 (8.7)
Office support	544 (11.9)	13 (2.4)
Physician's assistant/associate	51 (1.1)	5 (9.8)
Research and scholarship	36 (0.8)	2 (5.6)
Scientific, research tech	162 (3.5)	3 (1.9)
Nursing aides	201 (4.4)	15 (7.5)
Services: general	151 (3.3)	4 (2.7)
Skilled crafts	91 (2.0)	1 (1.1)
Students and student services	4 (0.1)	0 (0.0)
Unclassified	77 (1.7)	2 (2.6)

population) were surveyed for latex allergy. A wide range of occupational groups were represented, with inpatient nurses being the predominant group. Current glove use was reported by 82.9% of HCWs. On average, employees had worn latex gloves for 10.2 years. History of allergic conditions diagnosed by a physician was reported as 16.6% for hayfever, 11.4 % for asthma, and 7.3% for eczema. Fruit allergies were reported by 9.5% of the sample. A total of 153 (3.3%) HCWs reported a history of latex allergy diagnosed by a physician.

Latex Allergy Symptoms

Many more workers reported general latex-related symptoms via the survey than actually met the stricter criteria for latex allergy symptoms (626 vs. 276). Skin rash or hives was the most frequent latex-associated symptom, with 11.2% reporting a history of skin rash and 5% reporting ongoing problems. Upper-respiratory symptoms associated with latex exposure were common (ranging from 5.4% reporting a history of coryza to 3.8% reporting a history of sneezing spells). Lower-respiratory latex-associated symptoms were less common, with 1.5% reporting frequent cough, 1.5% wheezing, and 1.4% shortness of breath. Fifteen workers reported a history of anaphylaxis associated with latex exposure. Current latex-associated symptoms were less frequent than past symptoms.

Latex-related urticaria was reported by 2.4% of employees while 4.8% reported having had rash developing within an hour of latex exposure; 3% had rash extending beyond the area of direct skin contact with latex and 1.9% reported lower-respiratory symptoms associated with latex exposure. Positive antilatex IgE antibody levels were found in 40 employees (0.87%).

Among the cohort, 6.0% (n = 276) reported symptoms consistent with latex allergy (Table 1). The mean age of these HCWs was 41.3 year, and most were white females. Among HCWs reporting latex allergy symptoms, mean duration of work in health care was 15.3 years and average time wearing latex gloves was 11.1 years. Nurses, working either on an inpatient unit or in a managerial role, physician's assistants, other clinical professionals, medical and lab technicians, and nursing care assistants had the highest prevalence of symptoms consistent with latex allergy.

Multivariate Analyses

Table 2 shows multivariate risk estimates for latex allergy symptoms by demographic, occupational, and atopic characteristics for all HCWs undergoing surveillance. Females were significantly more likely than males, and African Americans were significantly more likely than caucasians to meet criteria for latex allergy symptoms while adjusting for all other risk factors. Employment status (new or current worker), and smoking were not significantly associated with latex allergy symptoms and were not included in the final model. Age, while significant in the model, did not demonstrate a consistent pattern over age categories. Number of years of latex glove use was highly correlated with number of years employed as a HCW (R-Sq = 0.54), thus the more direct measure of latex exposure was included in the multivariate model. Having a physician diagnosis of hayfever, asthma, or eczema was significantly associated with latex allergy symptoms. History of allergies to fruit, medication, and environmental aeroallergens was also significantly associated with latex allergy symptoms among this cohort of HCWs. Occupation in our data served as a surrogate

for use of latex gloves. A simple χ^2 test of association between occupational group and years of latex use was highly significant ($p < 0.001$); therefore, occupation was not included in the final model as our primary interest was the effects of latex exposures rather than the occupations in which exposures occurred.

DISCUSSION AND CONCLUSIONS

The 6% prevalence of symptoms consistent with latex allergy found in this cohort of HCWs is slightly lower than Zeiss et al., who reported 8% prevalence for a 12-month period.[16] Criteria for latex allergy symptoms were stricter than those used in the Zeiss et al. study, probably accounting for the lower prevalence estimate. Another recent investigation found a prevalence of latex-related symptoms of 8.1% among 901 HCWs in a multicenter study of latex sensitization and allergy in Russia and eastern Europe.[17] Although this tiered study design differed from that of the Zeiss et al. investigation by not measuring antilatex IgE levels on all participants, we found a similar prevalence of confirmed latex sensitization (0.87% in our population and 0.6% in 1959 Veterans Affairs HCWs evaluated by Zeiss et al).

In general, the prevalence of latex allergy symptoms in our cohort falls within the range reported by several reviews of latex allergy among HCWs.[12,18–20] A recent analysis of the evidence of NRL allergy among HCWs using powdered latex gloves found that the prevalence of clinical allergy to latex confirmed by IgE-mediated diagnostic testing ranged between 4.01% and 4.63%.[8] The lower prevalence of confirmed sensitization in this population may be explained by several factors: low exposure from wide use of low-protein powder-free latex gloves in the workplace, the method of assessment in that IgE measures are less sensitive than skin-prick testing, and the tiered study design. These methods allowed current workers with low-frequency latex-associated symptoms (rash or upper-respiratory symptoms occurring no more than once a month) to forego clinic evaluation and potential IgE measurement.

We found latex allergy symptoms to increase significantly with longer duration of use. Much controversy exists regarding the potential exposure-response association for latex allergy. A systematic review of the epidemiology of latex sensitization and allergy among HCWs found clear associations between measures of latex exposure and outcomes.[8] However, researchers analyzing National Heath Interview Survey (NHIS) data found no significant association between working as a HCW or in other occupations likely to involve wearing latex gloves and the presence of positive levels of antilatex IgE antibody.[9] In 2003, McCall et al. observed no statistically significant evidence of an increased prevalence of potential NRL-related conditions among HCWs compared to non-medical occupations.[11] They also found no trend over time of increasing potential NRL-related conditions since introduction of universal precautions and increased glove use. Both study's negative results, using existing NHIS data, may have been influenced by the inability of surrogate measures to accurately classify workers with regard to exposure and outcome.

TABLE 2 Multivariate Logistic Regression Models for Latex Allergy Symptoms

Model Parameter	Latex Allergy Symptoms Odds Ratio (95% CI)
# Cases and (non-cases) in model	239 (3838)
Age group	
<25	1.0
25–34	1.7 (0.7–4.1)
35–44	2.7 (1.1–6.6)
45–54	2.2 (0.9–5.4)
55–64	1.4 (0.5–3.8)
65+	1.3 (0.1–12.4)
Female gender (Male = Reference)	2.4 (1.6–3.6)
Race	
Caucasian	1.0
African American	1.4 (1.0–1.9)
Other	1.2 (0.7–2.0)
Years of latex glove use	
None	1.0
<5	2.4 (1.4–4.3)
5–14	2.6 (1.5–4.6)
15+	2.9 (1.6–5.1)
History of medication allergies (No = Reference)	1.7 (1.3–2.2)
History of fruit allergies (No = Reference)	2.1 (1.5–3.0)
History of pollen and other allergies (No = Reference)	1.3 (1.0–1.8)
Diagnosis of hayfever, asthma, or eczema (No = Reference)	2.4 (1.7–3.3)

Note: The final model includes all parameters (class or individual) with a Wald Type III Chi-Square of 0.10 or less.

Several researchers have argued that there is enough evidence that NRL allergy increases with occupational exposure and that NRL-associated asthma is almost solely due to exposure to powdered latex gloves.[21] Further, there is evidence that an intervention targeting reduced latex allergen exposure dose by substituting low protein powder-free NRL gloves throughout a national hospital system was associated with lowering the incidence of suspected occupational asthma among HCWs.[22] Furthermore, a review of primary preventive efforts concludes that substituting low-protein powder-free latex gloves reduces airborne exposure and prevents sensitization and NRL asthma in HCWs.[3]

Consistent with other studies, our findings show a significant association between latex allergy symptoms and history of atopic illness and other allergies. Proteins in many fruits cross-link with latex proteins and fruit allergy has been postulated to be a co-phenome-

non rather than a true risk factor for developing latex allergy.[23,24] Although the prevalence of latex allergy is elevated among atopic individuals, the actual relationship between a history of atopy and latex allergy has not been definitively described in a prospective investigation. Our model may have overadjusted by considering atopy and fruit allergy as possible independent risk factors for latex allergy symptoms, thus potentially underestimating the true effects of age, gender, race, and occupational exposure factors.

Several earlier investigations have assessed race and age as potential risk factors for latex-related symptoms. In agreement with our findings, Zeiss et al. found that nonwhite race, atopy, and occupational exposure were significantly associated with latex-glove-associated symptoms and sensitization among a study of 1959 HCWs.[17] Also, in 2002, Grzybowski et al. evaluated a general population presenting to a hospital emergency department and found that nonwhite race was associated with increased risk of positive IgE to latex.[25] In the general population, adults have shown a declining prevalence of latex allergy with age but few studies have simultaneously considered the potential effects of race, occupation, atopy, and other allergies.[23]

Like all studies assessing prevalence of and risk factors for latex-related symptoms, we were limited by the lack of standardized criteria for a definitive determination of latex allergy symptoms. Having no standard questionnaire, no gold standard for clinical diagnosis, and no broadly accepted challenge test limits comparability between studies.[20] In addition, self-report of symptoms, years using latex gloves, and years working in health care may be unreliable. However, we had no information that would indicate a likely differential distribution (and subsequent possible bias) of these self-reported items by age, race, gender, or occupation.

Our study did not allow us to draw any clear associations between changing exposure levels due to glove substitution and latex allergy symptoms among current employees within our cohort. Because this was not a primary goal of our surveillance project we did not collect information on date of latex allergy symptom onset that could be correlated with exposure to specific types of gloves used in the workplace.

One strength of this study is that we were able to evaluate the risk for latex-related symptoms among a large number of defined occupational groups having exposure to blood and body fluids at a large tertiary medical center. Many researchers have evaluated risk for latex allergy or sensitization among a few selected occupations including lab workers, nurses, physicians, and dentists.[26–28] Additional strengths of this study include the large size of the population-based sample allowing for multivariate assessment of the potential risk of age, gender, race, years of latex glove use, and occupation for latex allergy symptoms. We conservatively estimated that 60% of the available population of HCWs participated in this surveillance activity. We have no reason to believe that those who participated were biased based on demographic or other potential risk factors. By integrating data derived from clinical occupational health assessments, surveys, and existing administrative data we maximized information available to evaluate risk factors for latex allergy symptoms.

The results of our study will serve as an aid for enhancing ongoing prevention efforts. Guidelines for latex allergy prevention are already in place in the Duke University Health System where glove substitution with low-protein powder-free latex gloves has been widely accomplished and other measures were consistent with those summarized by Ranta and Ownby.[20] Employees are encouraged to assess their own risk based on duration of latex glove use and medical history. Health care workers are supported to make educated decisions about when and what kind of gloves to use. Choosing synthetic (non-latex) gloves is encouraged for HCWs anticipating short periods of contact with blood and body fluids. Our results will guide more targeted periodic latex allergy surveillance for workers in high risk jobs including medical or lab technicians, physician's assistants, nursing care assistants, housekeepers, and nurses. This work is an example of promising future research combining clinical occupational health surveillance with a comprehensive occupational health surveillance system.

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