
A hospital-based screening program for natural rubber latex allergy

Mary E. Bollinger, DO*; Kim Mudd, RN*; Lynn A. Keible, RN*; Becky L. Hess, RN†; Rebecca Bascom, MD‡; and Robert G. Hamilton, PhD§

Background: Natural rubber latex (NRL) allergy has become an important occupational health problem for health care workers, of whom approximately 10% are reportedly sensitized. Some medical facilities have chosen to convert entirely to NRL-free gloves, but others have found this to be financially or logistically unfeasible.

Objectives: The goals of this study were 1) to devise a NRL allergy screening program that could identify sensitized (at-risk) employees for the purpose of providing them with a safe working environment; and 2) to develop a glove conversion plan that would lead to the removal of all NRL gloves from the institution.

Methods: A multidisciplinary University of Maryland Medical System NRL risk team developed a mandatory NRL screening program for all newly hired employees and any existing employees transferring into or within patient care positions. Employees were screened with a clinical questionnaire and a serology for immunoglobulin (Ig)E anti-NRL. Some employees voluntarily received an experimental NRL skin test to evaluate their skin reactivity to NRL. Each employee reporting respiratory or systemic symptoms associated with NRL exposure was evaluated by an allergist.

Results: During the 15-month study period from April 1998 to July 1999, 1,795 employees were screened for NRL allergy. Of the whole group, 8% (144 of 1,795) were NRL-specific IgE antibody-positive by CAP radioallergosorbent test (Pharmacia-Upjohn Diagnostics, Kalamazoo, MI) and/or NRL skin test, 57.3% of whom reported symptoms with powdered NRL glove exposure. The NRL IgE-positive rates of nonpatient-care employees (who did not use NRL gloves on a regular basis) and direct patient-care employees was 5.9% and 8.6%, respectively. Most NRL-sensitized employees were successfully accommodated with the use of synthetic gloves and continued to work in the positions for which they were hired.

Conclusions: The University of Maryland Medical System NRL screening program has been successful in identifying at-risk employees and ensuring them a safe working environment during a progressive conversion of the hospital to a NRL-safe environment.

Ann Allergy Asthma Immunol 2002;88:560–567.

INTRODUCTION

Immediate-type hypersensitivity reactions to natural rubber latex (NRL)-

containing products (eg, examination and surgical gloves) have become a significant occupational health problem for workers, especially in health care facilities. Studies using a variety

of diagnostic methods have identified the prevalence of NRL sensitization among the exposed health care workforce to be approximately 10%.^{1–6} NRL has become one of the leading causes of occupational asthma, particularly in health care workers.² Some health care workers have become so symptomatic that they have had to leave the profession. In managing the sensitized individual, use of pharmacotherapy to treat immediate symptoms and avoidance therapy to separate the allergen source from the sensitized individual have been an effective combination. Reinserting the NRL-sensitized worker back into the facility, however, can be more problematic. Within a health care institution, recommended strategies in the Occupational Safety and Health Agency technical bulletin⁷ can be used to reduce the overall risk of exposure to NRL products. These have included among other practices: 1) the creation of “NRL-restricted zones” for NRL-allergic workers in which non-NRL products are used and NRL allergen has been thoroughly removed from the environment; and 2) the formation of a multidisciplinary NRL task force to establish and enact policies and procedures that reduce the risk of NRL exposure to all workers in the facility. For this strategy to be successful, especially in large health care facilities, sensitized workers must be accurately identified and placed in NRL-safe environments as soon as possible after clinically evident sensitization is manifest. Depending on the situation, “NRL-safe” may include personal use of synthetic gloves, conversion to a powder-free glove environment, and/or conversion to only synthetic glove use in the work environment. In

* Division of Pediatric Pulmonology/Allergy, University of Maryland School of Medicine, Baltimore, Maryland.

† Employee Health Service, University of Maryland Medical System, Baltimore, Maryland.

‡ Division of Pulmonary, Allergy and Critical Care Medicine, Milton S. Hershey Medical Center at Pennsylvania State University, Hershey, Pennsylvania.

§ Division of Allergy and Clinical Immunology,

Johns Hopkins University School of Medicine, Baltimore, Maryland.

This research was funded by University of Maryland Medical System and Johns Hopkins University Consolidated Funds.

Received for publication February 17, 2001.

Accepted for publication in revised form December 10, 2001.

this report, we describe a NRL allergy management program that involves an institution-wide screening program for identification of NRL-sensitized employees and a plan for systematic staged NRL-glove removal. The University of Maryland Medical System (UMMS) is an ideal environment to study the performance of a large-scale diagnostic screening program for NRL allergy, as its management has taken a progressive stance on NRL avoidance and it is a complex institution in terms of size and worker-type. The 6,000 UMMS employees include direct patient-care employees such as physicians, nurses, nursing assistants, and phlebotomists and nondirect patient-care employees, such as unit secretaries, greeters, business office staff, and social workers.

MATERIALS AND METHODS

Institutional Avoidance Strategy

A multidisciplinary task force was formed that included representatives from the Departments of Allergy, Occupational Medicine, Human Resources, Employee Health, Risk Management, Administration, Patient Support Services, Materials Management and Nursing. When the task force first convened in mid-1997, six workman's compensation cases of NRL allergy had been identified at the UMMS with an average of 50 lost workdays per NRL-allergic employee required to accommodate the employees in a safe working environment. At that time, the UMMS had established two areas within the hospital (the Adult Emergency Department and the Neonatal Intensive Care Unit) as NRL-restricted environments, where only synthetic gloves were used to accommodate two severely affected employees. At the time of the present screening study, the annual hospital glove stock included 65% powdered NRL gloves, less than 20% synthetic gloves, and the remainder were powder-free NRL gloves. The majority of gloves used (>90%) were examination gloves.

The task force established a four-phase, 5-year NRL glove plan. An on-

going educational program was established for all staff, highlighting basic issues related to NRL allergy and the proper use of gloves. Phase I involved providing nitrile synthetic, nonsterile examination gloves (Safeskin Corporation, Drexel Hill, PA) to NRL-sensitized employees (completed April 1998), and conversion to powder-free, low-protein NRL examination gloves including gloves in prepackaged suction kits (completed September 1999). Phase II consists of conversion to powder-free and non-NRL surgical gloves (completed August 2001). Phase III consists of converting to all synthetic examination gloves (targeted for 2002). Phase IV consists of converting to all synthetic sterile surgical gloves (targeted for 2002 to 2003).

Screening Program Design

After a thorough investigation of known NRL-allergic cases, the UMMS NRL task force recommended that early identification of sensitized at-risk employees should be a requirement for employment. The screening program was implemented by Employee Health to identify sensitized individuals and provide them with synthetic gloves and, if necessary, placement in NRL-glove-restricted areas of the hospital. In February 1998, the hospital adopted a mandatory NRL allergy screening policy for all new incoming employees and existing employees who wished to transfer into or within patient care services. The screening program was also made available to all established UMMS employees if they desired to undergo voluntary evaluation for NRL allergy.

The UMMS screening protocol was adopted in April 1998 and the current study summarizes data collected over a 15-month period (to July 1999). Employees completed a self-reported clinical history questionnaire and provided a blood sample for serologic detection of NRL-specific IgE antibody. The decision to use a blood test for NRL-specific immunoglobulin (Ig)E antibody as the primary method to identify at-risk individuals was made because no Food and Drug Administration (FDA)-licensed skin puncture test

(SPT) reagent is available in the United States. Clinical evaluation involved questions about the individual's atopic history (rhinitis, asthma, eczema, and food allergy), NRL allergy history (localized or systemic symptoms), and NRL exposure (gloves, condoms, number of surgeries, number of years in the health care field). Whole blood was separated by centrifugation and serum was frozen within 2 to 4 hours of collection and analyzed within 1 week using the CAP System (fluorescence enzyme immunoassay, Pharmacia-Upjohn Diagnostics, Kalamazoo, MI) for detection of NRL-specific IgE antibody.⁸ IgE antibody results >0.35 kIUa/L were considered positive. NRL-specific IgE antibody results between 0.3 and 0.4 kIUa/L were automatically repeated an additional two times by the laboratory to confirm the result as concerns have been reported about the precision in this region around the positive threshold level.⁹

Both the Employee Health Service and UMMS Allergy Practice staff reviewed the clinical questionnaire and NRL-specific IgE antibody results. Approximately 25% of NRL SPT-positive individuals are known to be IgE antibody-negative in the CAP System.¹⁰ Those individuals with a discordant positive NRL allergy history and negative IgE anti-NRL serology were therefore invited to participate in an experimental skin test protocol. After informed consent and a peak expiratory flow rate measurement, a series of SPTs were administered with a bifurcated needle after applying saline (negative control), histamine (positive control; 1.8 mg/mL, Allermid, San Diego, CA) and 100 μ g/mL and 1 mg/mL of nonammoniated NRL (Greer Laboratories, Lenoir, NC, investigational drug, IND 6365) in duplicate on the volar aspect of the forearm. The skin test was read at 15 minutes and a wheal >2 mm with erythema >5 mm from the saline control was considered a positive SPT. A followup peak expiratory flow rate measurement and 48-hour diary to note delayed reactions were used to record any adverse reaction that might have been associated with the SPT.

Sensitized-Employee Management

Staff with a self-reported positive history and serology or a positive history but a negative serology and positive SPT were classified as NRL-allergic and advised to use synthetic gloves (nitrile, Safeskin) at all times in their work. Employees with a negative history and positive serology were considered sensitized but asymptomatic health care workers³ and were also advised to use synthetic gloves to avoid further sensitization as evidenced by increased SPT or CAP radioallergosorbent test to NRL and/or the development of NRL-associated symptoms. Any employee with NRL glove-associated symptoms isolated to the skin and confined to the area of glove contact, whether they were NRL-specific IgE-positive or not, were advised to use a synthetic glove (eg, nitrile). Reported skin symptoms could include contact urticaria, eczema, or contact dermatitis. Individuals with a self-reported negative history and negative serology and/or SPT were classified as not NRL-allergic. Employees with a self-reported history of respiratory or systemic symptoms after NRL exposure, irrespective of their serologic status, were referred for medical evaluation. The allergist evaluated whether accommodations other than the use of synthetic gloves (eg, NRL-restricted environments) were needed. All employees with symptoms and/or positive serology were given information packets about NRL allergy and instructed to return to Employee Health if any further NRL-related allergic symptoms developed. Any employees with respiratory symptoms associated with NRL exposure were prescribed self-injectable epinephrine and advised to obtain an emergency bracelet. Affected employees were also advised about avoidance of nonmedical NRL-containing products such as NRL condoms and toy balloons, and encouraged to notify their health care providers about their NRL allergy. Educational information and programs about NRL allergy have occurred on a regular basis, including grand rounds presentations, small group

sessions with nursing staff, and regular articles in the hospital newsletter.

Statistical Analyses

All statistical analyses were performed using SPSS-PC/Windows (release 5, SPSS, Chicago, IL). Bivariate data were evaluated by χ^2 analysis using the Mantel-Haenszel test for linear association. Significant differences in the levels of quantitative data were evaluated by analysis of variance using the Student's *t* test. A value of $P < 0.05$ was considered significant.

RESULTS

Over a 15-month period, 1,795 new or transferred UMMS employees were evaluated in this study. The algorithm used in the management of sensitized UMMS employees based on results of their clinical questionnaire and NRL serology and/or skin test results is presented in Figure 1. Of the employees screened, 8% were positive for NRL-specific IgE antibody by serology and/or skin testing. Of the NRL-specific IgE positive group, only 57.3% ($n = 82$) reported symptoms with known NRL-glove exposure. This group had 47 individuals reporting NRL-associated symptoms confined to the skin; 35 reported additional symptoms, including 6 with only eye symptoms, 2 with only upper respiratory symptoms, 17 with eye and upper respiratory symptoms, 8 with lung symptoms and eye and/or upper respiratory symptoms, 1 with lung symptoms, and 1 with anaphylaxis. History data were unavailable for one seropositive subject. Of the NRL-specific IgE negative group, 349 (21.2%) self-reported NRL-associated symptoms, with 285 (81.7% of the group) reporting symptoms isolated to the skin and 64 (18.3% of the group) reporting additional eye, upper respiratory, and/or lung symptoms with NRL exposure. History data were unavailable for two seronegative subjects.

The demographics of the employee group are presented in Table 1. The different denominators in Table 1 reflect missing data points. The age ranged from 18 to 66 years (mean =

33 years). Approximately 72% of the study group were women. More than 73% of the employees evaluated were involved in direct patient care where gloves were routinely used. Of the entire study group, 33.6% had an atopic history and 24.1% provided a history of symptoms after exposure to dipped NRL products (primarily powdered NRL gloves). Serologic evaluation of the entire employee group identified 7.6% who were NRL-specific IgE positive (>0.35 kIUa/L). An additional 8 seronegative subjects were identified by a positive NRL skin test. As presented in Figure 2, an atopic history was more common in the NRL-sensitized group than the serologically negative group ($P < 0.05$). There was a significantly greater percentage of individuals with a history of asthma, allergic rhinitis, and food allergy, specifically banana/avocado/kiwi allergy in the NRL-sensitized group ($P < 0.05$). Reported symptoms with banana/avocado/kiwi ranged from isolated mouth symptoms to systemic symptoms. These food-associated symptoms have not yet been confirmed with food-specific IgE testing. Studies are in progress to confirm this self-reported food allergy. No statistical differences were detected in the age or sex distribution of the NRL-sensitized versus -nonsensitized groups. Reported symptoms after NRL exposure were more common in the sensitized group (57.3% vs 21.2%: NRL IgE positive vs negative groups, $P < 0.00001$). Employees in the NRL-sensitized group were more frequently involved in direct patient care where gloves were routinely required (80% vs 20%). When classified according to their previously assigned duties involving patients, 5.9% of those indicating nonpatient-care positions (eg, clerical, support staff, and business) were IgE antibody-positive (by serology and/or SPT), whereas 8.6% of those previously assigned to direct patient care (eg, physicians, nurses, and lab personnel) were identified as being sensitized to NRL (Table 2).

Table 3 presents the frequency of positive levels and quantitative levels

Table 1. Demographics of the Employees

Characteristic	Number of employees	% of total
Age	18–66 yrs (mean = 32.9 yrs)	NA
Gender	Female n = 1,299/1,795	72.4%
Occupation	Direct patient care n = 1,304/1,780	73.3%
Atopic history	Positive n = 602/1,790	33.6%
NRL-associated symptoms	Positive n = 431/1,792	24.1%

of NRL-specific IgE antibody among the NRL allergy history-positive and history-negative subjects. As noted in Table 3, 4.4% of the 1,355 employees that denied symptoms with NRL exposure had positive NRL-specific IgE serology, whereas 17.9% of those with a positive history had positive serology. As shown on Figure 3, of the 1,355 subjects without a history of NRL-associated symptoms, 60 (4.4%) had positive serology (mean 2.14 ± 0.43 kIUa/L depicted as bar to right of data points). Of the 429 subjects reporting symptoms with NRL exposure, 76 (17.7%) had positive serology (mean 4.97 ± 1.82 kIUa/L depicted as bar to right of data points). The mean anti-NRL-specific IgE levels for the two groups was not statistically different (2.14 ± 0.43 kIUa/L [history-negative] and 4.97 ± 1.82 kIUa/L [history-positive]).

Table 4 depicts the results of NRL skin testing on the 72 employees who participated in the skin test protocol to further evaluate their NRL sensitization status. Eight subjects who were serologically negative had a positive SPT with the Greer NRL reagent at $100 \mu\text{g/mL}$. Using the skin test as a reference method, the diagnostic sensitivity of the CAP System for NRL-specific IgE antibody detection was 70.4% in this study, which is similar to the reported 76.3% sensitivity in a multicenter study.¹⁰ Alternatively, six subjects had a positive NRL-specific IgE by the CAP System with a negative SPT test at 1 mg/mL . The computed diagnostic specificity for the CAP System is 86.7% using the SPT as the reference method.¹⁰ The NRL-

specific IgE antibody levels for these six skin test negative subjects ranged from 0.66 to 49.2 kIUa/L, with a mean of 9.36. These subjects failed to respond to SPT to NRL up to a concentration of 1 mg/mL . All but one of these employees reported being involved in jobs where gloves are used regularly, and all reported NRL-associated symptoms. All 6 reported skin symptoms, whereas 2 experienced ocular allergic symptoms, and 1 had upper respiratory symptoms. Skin symptoms by history in this group were not

delayed-type hypersensitivity reactions; however, confirmatory patch testing was not performed. Upon the allergist evaluation, employees 1 and 2 were found by history to have allergic rhinitis alone; employee 3 had allergic rhinitis, asthma, and food allergy; employee 4 had allergic rhinitis, eczema, and food allergy; employee 5 had allergic rhinitis, asthma, and eczema; and employee 6 had no identifiable atopic history.

In the study, >80% of the employees evaluated were new hires to the institution with an average of 7.5 years in health care at other facilities where NRL gloves were used routinely or worked in areas where NRL gloves were used. There was no statistical difference in the number of years spent in health care between the NRL serologically positive versus negative groups (7.79 vs 7.49 years, respectively). Sensitized employees were accommodated with personal synthetic glove use in the positions for which they were hired. In addition to previous conversion of the Neonatal Intensive Care

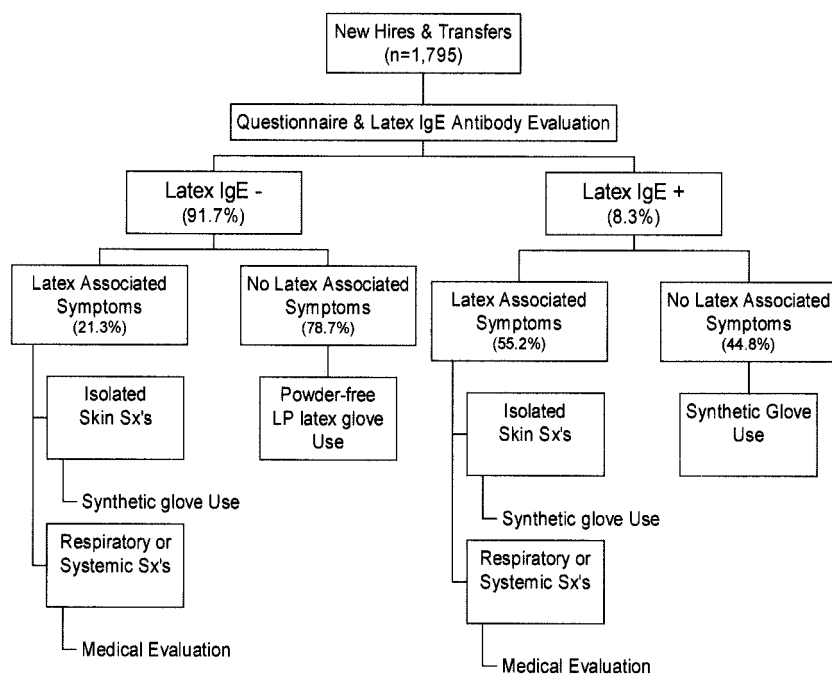


Figure 1. Algorithm of the study plan for management of new and transferred UMMS employees evaluated in the NRL allergy screening program during April 1998 and July 1999. Percentages are presented for the total study subject population in each subgroup.

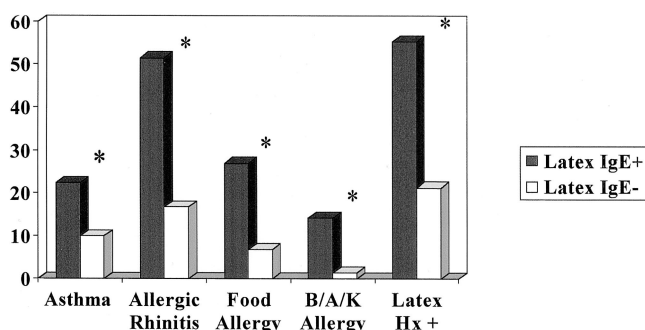


Figure 2. Percentage of sensitized (NRL-specific IgE antibody positive [closed bars]) versus nonsensitized (NRL-specific IgE antibody negative [open bars]) employees who manifested with asthma, allergic rhinitis, food allergy, banana/avocado/kiwi (B/A/K), and a positive NRL allergy history. *, significance with $P < 0.05$.

Unit and Adult Emergency Department, the bone marrow transplant unit was converted to NRL-restricted (synthetic gloves and NRL-free medical products only) to accommodate a severely affected NRL-allergic employee. Further, after the study period, one severely affected employee was placed in a nonoperating room position until the operating room conversion to powder-free gloves could occur.

DISCUSSION

Every health care facility must make informed decisions related to the protection of their employees and high-risk patients from NRL allergen exposure. Various degrees of intervention have been used by institutions to promote avoidance of NRL allergen exposure.¹¹ The nonintervention strategy involves a self-conducted program and forces the sensitized individual to rely on his or her own means to avoid NRL exposure. Because health care workers do not work in isolation, the personal avoidance strategy places them at continued risk for exposure to aerosolized NRL allergen from coworkers in a facility that uses powdered NRL gloves.¹¹⁻¹³ This nonintervention strategy almost guarantees continued or increased sensitization and the potential of life-threatening reactions in NRL-allergic workers. The opposite of personal avoidance is a comprehensive institution-wide intervention program that involves complete replacement of NRL-containing products with syn-

thetic alternatives. Complete NRL removal ensures NRL-allergic employees a reduction in the risk for symptoms and further sensitization. This approach is costly, and even in the best institutions, there can be resistance from staff who can not find suitable synthetic alternatives for each NRL-containing device they use. Most institutions compromise by adopting a partial intervention strategy intermediate between these two extremes. Regardless of the degree of intervention adopted, an essential component of any institutional intervention program for NRL allergy is early detection.

In this study, we report on our 15-month experience with a system-wide program for identifying NRL-sensitized workers. The UMMS staff consists of 6,000 employees, not including faculty, students, and other state employees. We estimated based on published NRL sensitization rates^{1,2,4,5} in health care workers that from 5 to 18%, or 300 to 1,080, of the employees in our facility could be sensitized to NRL. Because of the size of our insti-

tution, the only practical proactive program was to evaluate all new and transferring employees and open the testing to all existing employees. The cost of the questionnaire and the NRL-specific IgE antibody measurement with its associated medical evaluation was estimated at \$60,000 per year. We justified this expense by comparing it with the projected costs of three scenarios for NRL-sensitized/diseased employees if no changes were made in the hospital environment: accommodation provided, accommodation not provided/alternative employment located, and accommodation not provided/employee unable to return to any employment. Accommodation provided was the least costly case estimate in which an employee could return to work in their full capacity at UMMS with the same level of accommodation provided. This estimate of \$10,000 per employee was based on our average of 50 lost workdays to accomplish the accommodation plus associated medical costs for the already identified employees. Assuming that 2.5 to 6% (150 to 360) of our employees could be NRL-sensitized and -diseased, the best-case projections for associated worker's compensation costs were \$1,500,000 to \$3,600,000, plus associated medical costs. If employees could not return to any employment (worst-case scenario), the estimated costs were \$1,163,740 per employee, plus medical costs based on estimates to cover an average nurse salary for remaining years. It was estimated that conversion to low-protein powder-free examination gloves for non-NRL allergic employees and nitrile synthetic gloves for NRL-sensitized employees could cost an additional \$100,000/

Table 2. NRL Sensitization Among the Nonpatient versus Direct Patient-Care Employees

	NRL-specific IgE antibody negative	NRL-specific IgE antibody positive*	Totals
Nonpatient—care employees	448	28 (5.9%)	476
Direct patient—care employees	1192	112 (8.6%)	1304
Totals	1640	140	1780†

* Positive IgE anti-NRL serology and/or a positive NRL SPT when done.

† Missing occupational data for 15 employees.

Table 3. Comparison of Anti-NRL IgE Levels to History of Symptoms with NRL Exposure

	NRL History Negative	NRL History Positive
IgE anti-NRL negative	1,295	349
IgE anti-NRL positive	60 (4.4% of history negative)	76 (17.9% of history positive)
IgE anti-NRL mean kIUa/L $\pm$ SEM (for positives only)	2.14 $\pm$ 0.43 (n = 60)	4.97 $\pm$ 1.82 (n = 76)
Total	1,355	425

Missing NRL history data for 2 NRL-negative and 1 NRL-positive subjects. Twelve subjects had skin test without confirmatory radioallergosorbent tests.

year. All of these costs might immediately be offset by substantial savings from reduced lost work wages by early identification of at-risk employees and appropriate accommodation with synthetic gloves and, if necessary, placing them in NRL-restricted environments. In fact, by centralizing purchasing, UMMS has realized savings of \$80,000/year for glove costs alone.

Of the 1,795 new or transferred UMMS employees evaluated over the 15-month study period, 8% were identified as positive for NRL-specific IgE antibody by either serology or skin test. Interestingly, only 57.3% of these sensitized employees reported symptoms after exposure to NRL gloves. This is similar to the findings of Liss et al,⁶ who found that at least 40% of the health care workers that were skin test-positive to NRL were asymptomatic. As reported earlier by Brown et al,³ health care workers sensitized to NRL may not manifest clinical symptoms, either because they are not sufficiently sensitized or they are not exposed to sufficient levels of allergen. In our study, many of these individuals, for personal reasons, preferred powder-free NRL or synthetic gloves over powdered NRL gloves. To be conservative, we advised any employee with diagnostic or clinical evidence of NRL sensitization to avoid exposure to NRL gloves by using synthetic gloves. Even subjects with possible contact dermatitis were advised to use synthetic gloves, as studies by Brown et al,³ Turjanmaa,¹⁴ and Charous et al¹⁵ have shown that skin breakdown from contact dermatitis can increase the likelihood of also developing IgE-mediated sensitivity to NRL.

Surprisingly, the data in this study suggest that the length of time spent in health care may not be a good indicator of the extent of exposure to NRL. In our study, 5.9% of employees involved in nonpatient care (clerical, support staff, and business) and 8.6% of employees involved in direct patient care (physicians, nurses, technicians, and aides) were identified as NRL-sensitive. Some nonpatient-care employees may have worked with powdered NRL gloves in direct patient contact in previous places of employment or had exposure by working around co-workers wearing powdered NRL gloves, as

is the case with unit secretaries, for example. Alternatively, some of the employees participating in so-called direct patient-care positions are in fact managers who rarely use gloves even though they spend some time with patients.

The screening program reported in this study must be viewed within the context of several potential limitations and advantages. First, we used a self-reported questionnaire that may have resulted in underreporting of symptoms. Interestingly, asymptomatic employees who were identified as NRL-sensitized only by a positive NRL-specific IgE serology frequently identified NRL allergy risk factors (atopy, food allergies, type IV hypersensitivity to NRL gloves) and/or symptoms associated with NRL glove use in retrospect when questioned during medical evaluation with the allergist. Second, some employees may not have filled out the questionnaire completely in their hurry to complete their preemployment paperwork. Third, some employees may have held back on symptom information because of

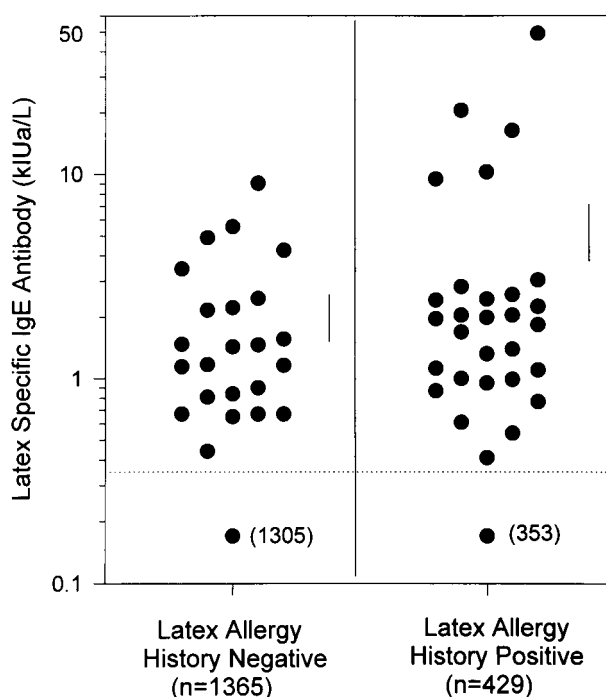


Figure 3. NRL-specific IgE antibody (kIUa/L) versus NRL allergy history. These mean levels for the two groups were not statistically different. The dotted line depicts the detection limit of the assay.

Table 4. Comparison of NRL SPT and NRL-Specific IgE Antibody Serology in Study Subjects

	NRL SPT negative	NRL SPT positive	Totals
NRL-specific IgE antibody negative	39	8 (29.6%)	47
NRL-specific IgE antibody positive	6 (13.3%)*	19	25
Totals	45	27	72

* All 6 serology positive, skin test-negative subjects reported allergic symptoms associated with NRL exposure during their first visit.

concerns about how it would affect their employment status. This became a diminishing concern, as new employees were able to see previously identified NRL-allergic employees safely accommodated in their chosen professions. Fourth, serology was used as the primary diagnostic test for identifying NRL sensitization. Finally, even the best commercial assays for NRL-specific IgE antibody misclassify up to 25% of NRL-sensitized (SPT-positive) individuals as serologically negative.⁸ An unanticipated advantage of the screening program was its benefit in educating the medical staff about NRL allergy, as many new employees were required to discuss the issue at their employment interview. This has kept NRL allergy a current topic among hospital employee discussions.

Because of limited personnel and resources, an experimental NRL skin testing protocol was offered to the most at-risk group, namely, employees with NRL-associated symptoms but negative serology. Once a NRL extract becomes FDA-approved and commercially available, skin testing will be offered to NRL-specific IgE sero-positive but asymptomatic employees as well to help elucidate the false-positive rate of the NRL IgE radioallergosorbent test. In another study, we found the specificity of the CAP system to be 96.7% (94.1% to 99.3% = 95% CL) in comparison to SPT with the experimental Greer NRL reagent. Ideally, evaluation of such individuals using a NRL provocation challenge such as those described by Kurtz et al¹⁶ could further differentiate this group.

UMMS made the decision to convert to all synthetic gloves within 5 years, realizing that as long as NRL

gloves are used in the institution, there is potential to sensitize and cause symptoms in employees and patients. A phased approach was chosen to allow time for systematic glove evaluation and selection, education of staff about appropriate glove use and NRL allergy, and to allow time for industry to improve synthetic glove quality and availability. Some synthetic gloves have been found to provide inadequate barrier protection when compared with NRL gloves.¹⁷ For this reason, the nitrile glove was chosen as the synthetic alternative as it has been found to be a comparable barrier to NRL gloves.^{18,19} Before selection and complete conversion to all synthetic surgical gloves, current studies on barrier properties of gloves will be reviewed and taken into consideration to provide the safest glove available.

CONCLUSION

The NRL screening program adopted at the UMMS has been successful because it provides invaluable information for identifying NRL-sensitized employees who are then accommodated based on symptoms and serology, as the institution makes a 5-year transition to synthetic gloves. This program has enabled the tertiary health care facility to accommodate NRL-sensitized individuals safely so they perform as productive members in their chosen profession. Added benefits of this program are the continued education for all medical staff and reduced exposure, which expectedly will lead to a decrease in sensitization and NRL allergy symptoms. This approach is cost-effective when one takes into account the potential savings in workman's compensation costs, and a pro-

active alternative for health care institutions that need to address the issue of NRL allergy among their employees. This study also demonstrates the need for an FDA-approved NRL skin test reagent, given the less than optimal sensitivity of the NRL serologic testing.

ACKNOWLEDGMENTS

The authors acknowledge the technical and clerical support of the Johns Hopkins DACI Reference Laboratory staff, the assistance of Dee Engle-Oliva and Jim Primrose in the Employee Health Service, Jamie Stevenson in the Allergy Division, Debbie Miller and Robin Barthlow for their assistance with workman's compensation data, and Vicky Bates and Jonathan Driscoll for assistance with glove usage data. The authors also acknowledge the other members of the Latex Risk Committee, including Fe Nieves-Khouw, Chuck Schevitz, Dorothy Myers, Carole Welsh, Alison Horsman, Mary Nelson, and Dave Roberts.

REFERENCES

1. Kaczmarek RG, Silverman BG, Gross TP, et al. Prevalence of latex-specific IgE antibodies in hospital personnel. *Ann Allergy Asthma Immunol* 1996; 76:51-56.
2. Vandenplas O, Delwiche JP, Evrard G, et al. Prevalence of occupational asthma due to latex among hospital personnel. *Am J Respir Crit Care Med* 1995;151:54-60.
3. Brown RH, Schauble JF, Hamilton RG. Prevalence of latex allergy among anesthesiologists. Identification of sensitized but asymptomatic individuals. *Anesthesiology* 1998;89:292-299.
4. Kibby T, Akl M. Prevalence of latex sensitization in a hospital employee population. *Ann Allergy Asthma Immunol* 1997;78:41-44.
5. Grzbowski M, Ownby DR, Peyser PA, et al. The prevalence of anti-latex IgE antibodies among registered nurses. *J Allergy Clin Immunol* 1996;98: 535-544.
6. Liss GM, Sussman GL, Deal K, et al. Latex allergy: epidemiological study of 1351 hospital workers. *Occup Environ Med* 1997;54:335-342.
7. Occupational Safety and Health Agency. Potential for Allergy to Nat-

-
- ural Rubber Latex Gloves and Other Natural Rubber Products. In: Preventing Allergic Reactions to Latex in the Workplace. Rockville, MD; 1997. Publication no DHHS (NIOSH) 97-135.
8. Hamilton RG, Biagini RE, Krieg EF, and Multi-Center Latex Task Force. Diagnostic performance of FDA-cleared serological assays for natural rubber latex specific IgE antibody. *J Allergy Clin Immunol* 1999;103:925-930.
9. Biagini R, Krieg E, Hamilton RG. Receiver operating characteristic (ROC) and reproducibility analyses of FDA cleared latex specific IgE assays. *J Allergy Clin Immunol* 2000;105:S82.
10. Hamilton RG, NF Adkinson Jr, and Multi-Center Latex Task Force. Diagnosis of natural rubber latex allergy: multi-center latex skin testing efficacy study. *J Allergy Clin Immunol* 1998;102:482-490.
11. Hamilton RG, Brown RH. Impact of personal avoidance practice on health care workers sensitized to natural rubber latex. *J Allergy Clin Immunol* 2000;105:839-841.
12. Yunginger JW, Jones RT, Fransway AF, et al. Extractable latex allergens and proteins in disposable medical glove and other rubber products. *J Allergy Clin Immunol* 1994;93:836-842.
13. Tarlo SM, Sussman G, Contala A, Swanson MC. Control of airborne latex by use of powder-free latex gloves. *J Allergy Clin Immunol* 1994;93:985-989.
14. Turjanmaa K. Contact urticaria from latex gloves. In: Mellstrom GA, Wahlberg JE, Maibach HI, editors. *Protective Gloves for Occupational Use*. Boca Raton, FL: CRC Press, 1994: 241-254.
15. Charous BL, Hamilton RG, Yunginger JW. Occupational latex exposure: characteristics of contact and systemic reactions in 47 workers. *J Allergy Clin Immunol* 1994;94:12-18.
16. Kurtz KM, Hamilton RG, Adkinson NF Jr. Role and application of provocation in the diagnosis of occupational latex allergy. *Ann Allergy Asthma Immunol* 1999;83:634-639.
17. Korniewicz DM, Laughon BE, Cyr WH, et al. Leakage of virus through used vinyl and latex examination gloves. *J Clin Microbiol* 1990;28:787-788.
18. Rego A, Roley L. In-use barrier integrity of gloves: latex and nitrile superior to vinyl. *Am J Infect Control* 1999;27:405-410.
19. Fisher MD, Reddy VR, Williams FM, et al. Biomechanical performance of powder-free examination gloves. *J Emerg Med* 1999;17:1011-1018.
- Requests for reprints should be addressed to:*
Mary Beth Bollinger, DO
Division of Pediatric Allergy/Immunology
University of Maryland School of Medicine,
MSTF 319
10 S. Pine Street
Baltimore, MD 21201
E-mail: mbolling@peds.umaryland.edu
-