
Latex aeroallergen quantification in hospitals of Moscow, Russia

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Background: Health care workers (HCWs) who use latex gloves regularly are at a significant risk for developing allergic sensitization to natural rubber latex (NRL) proteins. The airborne route of exposure presents a hazard for sensitization and subsequent allergic symptoms.

Objective: The purpose of this study was to measure the content of the NRL proteins in the air of work areas (laboratories, treatment rooms, operating rooms, examination rooms, and dentist's treatment rooms) in eight Moscow hospitals where the employees used powdered latex gloves.

Methods: The air samples were collected by a volumetric filtration method using a static air sampler at a flow rate of 3 L/second. Airborne particles were collected onto polytetrafluoroethylene filters rated 99.9% efficient at 0.3 μm . The NRL allergens were extracted from the air filter samples in phosphate-buffered saline and quantified by an inhibition immunoassay using a five-person pool of sera containing latex-specific human immunoglobulin E.

Results: The airborne latex allergen concentrations in 11 areas (including positive control) where latex gloves were used varied from 5 to 26 ng/m^3 . Conversely, in 12 areas where latex gloves were seldom used or where powdered-free latex gloves were used allergen levels were not detectable (including two negative controls). The highest concentration of latex allergen (26 ng/m^3) was found in an examination room of a gynecology department. Low and moderate concentrations were detected in most operating rooms, and low concentrations in the laboratories and treatment rooms.

Conclusions: This study indicates that, in general, the airborne NRL concentrations in the work areas of Moscow hospitals are rather low compared with NRL concentrations reported from American hospitals and are dependent on the intensity of latex glove usage.

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INTRODUCTION

Allergy to natural rubber latex (NRL) proteins, a type I hypersensitivity, has been recognized as a significant problem in several occupational groups including health care workers (HCWs) who are exposed to latex allergens and subsequently develop various allergic manifestations ranging from localized urticaria and rhinoconjunctivitis to

asthma and occasionally systemic reactions.^{1,2} The prevalence of latex allergy estimates among HCWs estimates vary widely (3 to 25%), depending on the occupational group, the country of origin, the method of detection of type I hypersensitivity,³ and perhaps most importantly, when the study of prevalence was conducted in relation to latex allergen education and avoidance programs. HCWs, particularly those who are atopic and use rubber gloves regularly, are at increased risk of sensitization to NRL.⁴ Health care environments using powdered gloves will likely have measurable concentrations of latex allergens in the air. The latex allergen becomes

airborne during donning and removal of gloves and has been found on clothing, furniture, and in dust samples, raising the possibility of resuspension in room air.^{5–7}

Successful management of individuals with latex allergy involves documentation of latex sensitization by skin test or allergen-specific immunoassay, and consequently, allergen avoidance education. Information about the concentration of the latex allergen in the air is necessary to confirm the existence and extent of airborne latex allergen dispersion and to determine which interventions may reduce this index of indoor air allergen exposure.⁸

Airborne NRL proteins are measured by an immunochemical assay of extracted latex allergen-containing particles which are collected on filters from air sampling devices. The air sampling and aeroallergen assay methods provide objective evaluation of airborne latex allergen concentrations and the effects of various abatement efforts.

In Russia, the exact prevalence of NRL allergy is still unknown both in the general population and in HCWs, as well as the relative content of latex proteins in the air of Russian hospitals. A preliminary study of the prevalence of latex allergy among HCWs in eastern European countries including Russia demonstrated a low rate of sensitization to latex allergens.⁹ This situation may be connected with insignificant concentrations of airborne latex allergen in work areas of Russian hospitals.

The aim of this study was to measure the content of the NRL proteins in the air of work areas (laboratories, treatment rooms, operating rooms, examining rooms, and dentist's treatment

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rooms) in eight Moscow hospitals where the employees use powdered and nonpowdered latex gloves.

MATERIALS AND METHODS

Air Sampling

An area air sampler (Institute of Occupational Medicine, Moscow) was used to collect air samples. The air sampler was operated for 2 hours at a flow rate of 3 L/second. Airborne particles were collected onto polytetrafluoroethylene (PTFE) filters (Quan-Tec-Air, Inc, Rochester, MN) rated 99.9% efficient at 0.3- μ m particle size. The air samples were collected from 20 areas of Moscow hospitals, including two negative controls (medical and secretarial offices in which latex gloves were not used) and one positive control (six pairs of gloves were opened every 12 minutes for 1 hour).

Immunoassay for NRL Allergens

A laboratory reference standard extract of powdered latex examination gloves (Bodyguards, T.K. Glove Products Co, Ltd., Huntington Beach, CA) was prepared as a 1:5 wt/vol extract in Dulbecco phosphate-buffered saline (0.0027 M KCl, 0.0015 M KH_2PO_4 , 0.008 M Na_2HPO_4 , 0.14 M NaCl, pH 7.5 PBS). The extract was centrifuged at 15,000 *g* for 20 minutes. The supernatant was then ultrafiltered and concentrated 20 times through a YM2 (1,000 MW cut-off) Amicon Diaflo membrane (Amicon Division, W.R. Grace & Co, Danvers, MA) at 45 psi of pressure. This concentrate was then assayed for protein content by the bicinchonic acid method and assigned a protein concentration of 7 mg/mL.

Airborne particles were collected by filtration using PTFE filter membranes. The filter medium is a bilaminate of stretched Teflon (DuPont, Wilmington, DE) with a polyester-spun support backing. NRL allergens were extracted from the air filter samples in 500 μ L of 0.1 M PBS containing 0.2% bovine serum albumin, 1% Tween20 and 0.1% NaN_3 by delaminating the PTFE from the backing and placing it in a 13 $\times$ 100 mm tube with the buffer. The support backing was discarded and the tube was vigorously mixed to wet the entire sample. The sample was kept overnight at 4° C, mixed again the next day and centrifuged. The supernatant was stored at -20° C.

NRL allergens were quantified by an inhibition immunoassay using latex-specific human immunoglobulin (Ig)E. Extracts of the air filters or the reference standard glove extract compete with the immobilized reference latex allergens for specific IgE antibodies obtained from five latex-sensitized HCWs. An affinity-purified rabbit anti-IgE ^{125}I -radiolabeled antibody detects the latex allergens in a relationship inversely proportional to the bound count.

Immulon IV microtiter plates (Dynatech Inc, Chantilly, VA) were adsorbed with 1 μ g of latex glove protein. Latex glove reference standards (7 mg/mL) or air filter extracts were placed (50 μ L) in the microtiter plate wells along with human sera (50 μ L) from five individuals containing IgE antibodies to latex allergens. The results were calculated from the latex

glove extract standard curve plotted by logistic regression and expressed as protein mass per cubic meter of air. The detection limit was <5 ng/m³. The data were interpreted as: low is <10 ng/m³; moderate is 10 to 50 ng/m³; and high is >50 ng/m³.

RESULTS

The airborne latex allergen concentration in the 10 areas where latex gloves were seldom used or where powder-free latex gloves were used demonstrated latex allergen levels which were not detectable, similar to the negative controls (Tables 1 and 2). The highest concentration (26 ng/m³) was found in an examination room of a gynecology department. Low to moderate concentrations were found in most operating rooms, and low concentrations in laboratories and treatment rooms (Table 1). The concentration of airborne latex was related to the frequency and intensity of glove use. Areas with frequent latex glove use, especially using powdered NRL gloves, had the greatest concentrations of airborne latex allergen. In general, operating rooms demonstrated higher concentrations than treatment rooms or laboratories; however, this can not be attributed to surgical gloves alone because exam gloves are also used at times. The highest concentration occurred in a gynecology examination room known to have the most frequent use of latex gloves.

DISCUSSION

The air sampling method and aeroallergen assay used in this investigation provide an objective means for evaluation of airborne latex allergen concentrations. Latex allergen becomes associated with cornstarch powder, which becomes airborne when gloves are donned or removed.

This study examined 20 air samples from working areas of eight Moscow hospitals for their content of latex allergen. Concentrations of latex allergen ranged from nondetectable to 26 ng/m³, suggesting that there are low

Table 1. Airborne Concentrations of Latex Allergen in 23 Work Areas of 8 Moscow Hospitals

Work areas (number of areas)	Infrequent latex glove use or powder-free use	Frequent latex glove use or powdered use
Laboratories (5)	ND; ND; ND	6 ng/m ³ ; 5 ng/m ³
Operating (4)	ND	6 ng/m ³ ; 11 ng/m ³ ; 15 ng/m ³
Examination (2)	ND	26 ng/m ³
Treatment (7)	ND; ND; ND; ND	7 ng/m ³ ; 5 ng/m ³ ; 7 ng/m ³
Dental (2)	ND	5 ng/m ³
Negative Control (2)	ND; ND	
Positive Control (1)		10 ng/m ³

ND—Not Detected; <5 ng/m³.

levels of NRL allergen in the work areas of Moscow hospitals. The amount of latex allergen captured was dependent on the number of gloves used. It should be noted that the gloves used for the positive control aerosolized very low concentrations of NRL in comparison with the concentrations generated in the American study using a similar protocol but different gloves.¹⁰ This study confirms previous findings that the use of powder-free¹¹ gloves or gloves containing low concentrations of latex allergen¹² is associated with significant reduction in latex aeroallergen concentrations. The concentrations of latex allergen during working hours in 10 medical areas where latex gloves were relatively frequently used ranged from 5 to 26 ng/m³. Measurements in 10 other areas where latex gloves were seldom used or powder-free allergen gloves were used demonstrated concentrations below the limit of detection.

The data obtained in this study indirectly support observations about the low prevalence of latex allergy among HCWs in Russia, particularly in Moscow hospitals. A preliminary study of sensitization to latex among HCWs from the same Moscow hospitals studied in this report also demonstrated a low rate of sensitization to latex. Prevalence of sensitization was evaluated by clinical history of latex sensitivity, skin testing with latex allergen, and measuring of latex-specific IgE in sera samples. The IgE-mediated latex allergy in HCWs was associated pre-existing atopy.¹³

A contrasting situation regarding sensitization to latex allergen takes place in some American hospitals. Using the Pharmacia CAP system (Pharmacia Biotech, Uppsala, Sweden) and whole-blood histamine release tests, we noted that the prevalence of latex allergy in HCWs of an American hospital was at least 5 times higher than in a Russian hospital.^{14,15}

At the same time, latex allergen concentrations in the working areas of an American health care center where la-

tex gloves were frequently used ranged from 13 to 121 ng/m³, whereas in areas where latex gloves were never or seldom used or where powder-free latex or vinyl gloves were used, concentrations ranged from 0.3 to 1.8 ng/m³.¹⁶ Nevertheless, the demand and use of latex gloves may affect the airborne NRL concentrations in Russian hospitals, as well as the prevalence of sensitization to latex among their HCWs in the near future, considering the HIV/AIDS epidemic looming over the former Soviet Union's population.¹⁷

The estimation of airborne latex allergen in the work areas of medical institutions is a necessary step in the evaluation of prevalence of latex sensitization among HCWs. Evaluation of airborne latex allergen concentrations provides essential information, possibly illustrating the need for interventions designed to reduce sensitization and improve symptoms in HCWs who are allergic to NRL.

CONCLUSION

This study indicates that, in general, the airborne NRL concentrations in Moscow were rather low compared with NRL concentrations reported from American hospitals. The NRL concentrations were dependent on the intensity of latex glove use and the frequency of powdered NRL glove use. The results suggest that the lower prevalence of latex sensitization in Russia among HCWs as compared with the prevalence of latex sensitization among American HCWs could be related to two factors. Moscow hospitals have lower airborne concentrations of NRL than American hospitals and they also use NRL gloves less frequently.

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