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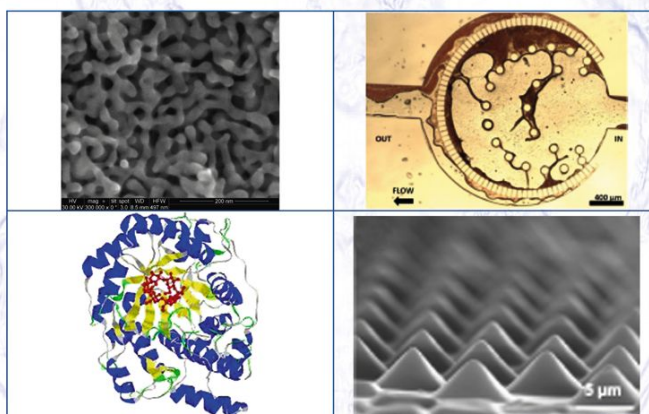
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Latex Allergy in Health Professionals: Specific Aspects of Diagnostics

Irina Reshetnikova^{1,2} · Raila Garipova³ · Eduard Baibakov²

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Abstract

The study aimed to develop preventive measures for occupational allergy to latex in health care workers and to elucidate diagnostic specifics of latex sensitization by clinical and immunological parameters. One thousand three hundred forty-six health professionals whose work involves contact with latex-containing products underwent a screening questionnaire survey. One hundred twenty health professionals had an immunoassay done involving the estimation of total and latex-specific IgE. Thirty-six health care workers had a prick skin test done with a standard kit of allergens (home dust mites, epidermal, and pollen allergens). Latex allergy in health care workers is most often characterized by the development of skin manifestations and allergic rhinitis. Latex allergy in health professionals was found to be most common in individuals with the history of allergies, confirmed by increased total IgE values, which should be taken into consideration in occupational fitness assessments on a preliminary medical examination.

Keywords Health professionals · Latex allergy · Latex-specific immunoglobulin E · Prevention · Occupational disease

1 Introduction

According to the data of researchers abroad, latex allergy (LA) occurs in 1–12% of the population, with its prevalence rate of 2.5–37.8% among health professionals (HPs) from various health care facilities [2, 7–9]. The cost of compensation payments in each case of latex allergy in the USA amounted to 220,000 dollars [11].

LA symptoms depend upon routes of exposure to foreign antigens: HPs more often have urticaria when wearing latex gloves, or conjunctivitis, rhinitis, or bronchial asthma while inhaling allergens absorbed on powdered gloves [1]. A risk of LA increases in individuals with the history of atopic reactions. For instance, based on the data of K. Turjanmaa [10] and M. H. Guillet [4], 33–67% of patients with LA are hypersensitive to pollen, food, epidermal, and other allergens.

On March 25, 2010, the 307th session of the International Labour Organization (ILO) Administrative Board approved a new list of occupational diseases which substituted for that approved on June 20, 2002 (recommendation no. 194). A new list of disorders caused by exposure to chemical factors contains “disorders caused by exposure to latex or latex-containing products” under 1.1.39 (the recommendation no. 194 of 2002 lacked this paragraph), that is, the ILO referred disorders which develop in contact with latex materials to professional ones [5].

There is no latex allergy in the official list of occupational diseases of the Russian Federation. We can only talk about the prevalence of latex sensitization among health care workers.

In addition, a prick test for the diagnosis of latex allergy is not yet available since the latex allergen has not been officially registered in the Russian Federation. Studies conducted at the Institute of Pulmonology showed that latex allergy was registered in almost 25% of Russian medical workers who regularly use latex gloves [3, 12].

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2 Materials and Methods

The first stage involved an epidemiological study of the prevalence of allergic response to latex among health professionals. One thousand three hundred forty-six HPs aged from 20 to 70 years with a work experience from 1 to 50 years

whose professional practice involves a contact with various devices made of or containing natural rubber latex proteins (gloves, catheters, condoms, enemas, syringes, drainage tubes, and so on) completed a screening questionnaire. Three hundred sixteen medical doctors (surgeons, dentists, obstetrician-gynecologists, anesthesiologists, and others), 215 paramedics, and 815 mid-level health providers participated in the screening questionnaire. 89.9% of them were females.

Persons aged 20–29 (29.0%) and 30–39 (28.3%) years prevailed. The distribution by a work experience was as follows: individuals with the work experience of up to 4 years (22.6%), 5–9 years (18.7%), and 10–14 years (18.6%). Health care workers use latex gloves or latex-containing products for 1 to 8 h a day.

The analysis of screening questionnaires showed that 490 persons (36.4%) complained of various reactions (both local and systemic ones) when handling with latex-containing devices.

Three groups were identified: the first included persons with skin manifestations ($n = 188$), those having signs of respiratory allergy comprised the second group ($n = 156$), and the third one consisting of persons with a combination of skin and respiratory events ($n = 146$).

The following stage involved the estimation of total and latex-specific IgE in blood serum.

Based on the screening questionnaire results, 120 HPs had an immunoassay done involving the estimation of total IgE (the conditional normal value is up to 100 IU/mL) and latex-specific IgE (the conditional normal value is up to 0.35 IU/mL) in blood serum. Fifteen medical doctors, 18 paramedics, and 87 mid-level health providers had the immunoassay done.

2.1 Statistical Analysis

Statistical analysis was carried out using some methods of parametric and non-parametric statistics: mean value (M), standard error (m), z -criterion (with normal distribution); in case of multiple comparisons of groups, Student's criterion

(t) with the Bonferroni amendment and the Kruskal-Wallis criterion (H) (paired intergroup comparisons); and Spearman's rank correlation (r). Differences in samples were considered statistically significant at $p < 0.05$.

3 Results and Discussion

Fifty-seven persons (47.5%), including 3 medical doctors, 10 paramedics, and 44 mid-level health providers, had elevated latex-specific IgE values. The persons with elevated latex-specific IgE values were subdivided into two groups, i.e., 27 persons with the latex-specific IgE levels from 0.35 to 0.5 IU/mL and the remaining ones ($n = 30$), whose latex-specific IgE levels exceeded 0.5 IU/mL (Table 1).

HPs with a mean age of 35.5 years and an average work experience of 9.5 years prevail among those with latex-specific IgE values above 0.5 IU/mL. At the same time, there was a tendency towards total IgE rise as the latex-specific IgE concentration increased (> 0.5 IU/mL).

There was a correlation between an increase of total IgE and latex-specific IgE values more than 0.5 IU/mL ($r = 0.43$, $p = 0.018$). However, latex-specific IgE levels from 0.35 to 0.5 IU/mL were detected without any increase of total IgE (Table 2). There was also a correlation between the work experience and latex-specific IgE values of 0.35–0.5 IU/mL ($r = 0.485$, $p = 0.011$).

The relationship between elevated values of total IgE and latex-specific IgE has been revealed: with latex-specific IgE (above 0.5 IU/mL) concentration increase, the total IgE ($r = 0.43$, $p = 0.018$) values increase as well. This situation is accompanied with the development of systemic reactions, such as rhinitis and conjunctivitis.

Local skin reactions were detected at latex-specific IgE values as high as 0.35–0.5 IU/mL. When latex-specific IgE increased above 0.5 IU/mL, systemic reactions such as rhinitis and conjunctivitis occurred in addition to skin reactions (Table 3).

Table 1 Distribution of latex-specific and total IgE by age and work experience

Parameter	Latex-specific IgE, IU/mL			H	p
	Up to 0.35 M_c [0.25; 0.75]	0.35–0.5 M_c [0.25; 0.75]	≥ 0.5 M_c [0.25; 0.75]		
Number of cases, N	63	27	30		
Latex-specific IgE, IU/mL	0.31 [0.26; 0.35]	0.37 [0.35; 0.49]*	1.1 [0.51; 5.95]*^	98.5	0.000
Total IgE, IU/mL	42 [5; 957]	40.8 [2; 833]	120.3 [14.2; 500.4]	9.122	0.010
Age, years	43 [20; 68]	41 [25; 56]*	35.5 [22; 57]*	7.394	0.025
Working experience, years	14 [1; 36]	17 [3; 30]	9.5 [2; 35]	5.171	0.075

H – a Kruskal–Wallis test for intergroup comparison, p – statistical significance by the Kruskal–Wallis test; * – significance of differences with subgroup 1 ($p < 0.05$ by the Dunn (post hoc) test); ^ – significance of differences between subgroups 2 and 3 ($p < 0.05$ by the Dunn test)

Table 2 Correlation between latex-specific IgE and total IgE levels

Parameter	Latex-specific IgE, IU/mL						<i>p</i>		
	До 0,35		0,35-0,5		0,5 и более		<i>r</i> _{1/2}	<i>r</i> _{2/3}	<i>r</i> _{1/3}
	<i>r</i> ₁	<i>p</i>	<i>r</i> ₂	<i>p</i>	<i>r</i> ₃	<i>p</i>			
Total IgE	0,063	0,620	0,311	0,114	0,432	0,018	0,039	0,137	0,612

r – Spearman’s rank correlation coefficient; *r*_{1/2}, *r*_{2/3}, *r*_{1/3} – a correlation coefficient in intergroup comparisons; *p* – statistical significance

Notably, a history of allergies was statistically less often in HPs with latex-specific IgE levels below 0.35 IU/mL than in those with increased latex-specific IgE values. Based on the questionnaire survey data, it included pollinosis and drug and food allergies ($\chi^2 = 7.83, p = 0.02$).

28.1% of the HPs with increased latex-specific IgE values suffered from rashes and skin and eye itching after the use of rubber gloves in housekeeping or condoms, blowing rubber balloons, or after a vaginal examination (during a gynecological examination).

All HPs were subdivided into 3 groups based on their work experience: subgroup 1 included individuals with a work experience of up to 9 years, subgroup 2 comprised those with 10–19 years, and persons with the experience of ≥ 20 years composed subgroup 3. There was a statistically significant decrease of latex-specific and total IgE levels with the age and work experience (Table 4).

The first subgroup subjects had a mean age of 30.8 ± 1.6 years and an average work experience of 5.1 ± 0.3 years. As the work experience increased (10–19, 20 years and more) there was a significant decrease in the number of systemic reactions such as rhinitis and conjunctivitis.

There was a correlation between total IgE values and the work experience of up to 9 years (Table 5).

With professional experience of up to 9 years, a correlation relationship was found between the increases in total IgE values (Table 5).

A number of authors indicate gender and age as risk factors for latex allergy. Most often, latex allergy occurs among females (up to 70–80%) at the age of 33 years. The risk of

developing respiratory syndrome in health professionals was highest during the first 3–5 years of working with latex; the average length of service was 3.6 ± 1.5 years [6].

Eighty-seven mid-level health providers (17 medical laboratory technicians and 70 nurses) had an immunoassay done. The analysis of the results showed that 10 out of 17 medical laboratory technicians (58.8%), $\chi^2 = 5.54 (p < 0.05)$, and 20 out of 70 nurses (28.5%) had increased latex-specific IgE values. It should be noted that 10 out of 20 nurses with increased latex-specific IgE levels (50%) worked in treatment rooms, $\chi^2 = 5.58 (p < 0.05)$.

Ten out of 19 paramedics (52.6%) had increased latex-specific IgE values, with 6 of them (60%) working in clinical or pathology laboratories, $\chi^2 = 7.89 (p < 0.01)$. Two out of 15 medical doctors (13.3%)—a surgeon and an obstetrician-gynecologist—had increased values.

Thirty-six individuals with elevated latex-specific IgE concentrations (22 nurses, 8 medical laboratory technicians, 6 paramedics) underwent an examination in the Kazan Research Institute of Epidemiology and Microbiology.

In addition to taking the history, an examination for allergy included skin prick testing with a standard kit of allergens (dust mites, epidermal, pollen allergens). All subjects had prick testing done with a kit of most common airborne allergens out of a pollen season. A histamine solution was used as a positive control, with a diluent being a negative one. Reaction results were evaluated in 20 min by comparing sizes of the resulting wheals with those of the control pricks. Rhinocytogram parameters were assessed in individuals with signs of rhinitis.

Table 3 The degree of influence of latex-specific IgE concentration on the prevalence rate of systemic, local manifestations, and history of allergies

Parameter	Latex-specific IgE, IU/mL			χ^2	<i>p</i>
	Up to 0.35	0.35–0.5	≥ 0.5		
Number of cases, <i>n</i>	63	27	30		
Systemic reactions, <i>n</i>	20	14	18'	2.98	0.225
Local manifestations (skin reactions), <i>n</i>	26	23"	20'''	4.25	0.119
History of severe allergic reactions	16	20 [#]	17 ^{##}	7.83	0.020

' – significance of differences between subgroups 1 and 3 (*z* test = 2.3, *p* = 0.019); " – significance of differences between subgroups 1 and 2 (*z* test = 3.6, *p* = 0.000); "' – significance of differences between subgroups 1 and 3 (*z* test = 2.1, *p* = 0.034), # – significance of differences between subgroups 1 and 2 (*z* test = 4.7, *p* = 0.000); ## – significance of differences between subgroups 1 and 3 (*z* test = 2.8, *p* = 0.005)

Table 4 Effects of work experience on latex-specific and total IgE values, systemic and local skin manifestations

Parameters	Work experience, years			Statistic tests
	Up to 9	10–19	≥ 20	
Number of cases, <i>n</i>	38	44	38	
Work experience, years	5.1 ± 0.3	13.7 ± 0.4*	25.8 ± 0.8*^	$F = 340.4, p = 0.000$
Age, years	30.8 ± 1.6	39.8 ± 1.3*	48.3 ± 0.9*^	$F = 41.7, p = 0.000$
Latex-specific IgE, IU/mL	0.87 ± 0.17	0.46 ± 0.04*	0.35 ± 0.02*	$F = 7.079, p = 0.001$
Total IgE, IU/mL	187.3 ± 36.6	93.2 ± 16.7*	81.9 ± 0.3*	$F = 5.56, p = 0.005$
Systemic reactions, <i>n</i>	23	21	9 [#]	$\chi^2 = 4.44, p = 0.109$
Local skin reactions, <i>n</i>	26	23	20	$\chi^2 = 0.33, p = 0.846$

F – the *F* test in one-way analysis of variance in intergroup comparison, *p* – statistical significance by the *F* test; * – significance of differences with subgroup 1 ($p < 0.05$ by the Bonferroni-adjusted *t* test); ^ – significance of differences between subgroups 2 and 3 ($p < 0.05$ by the Bonferroni-adjusted *t* test); ' – significance of differences between subgroups 1 and 3 (z test = 3.03, $p = 0.002$); # – significance of differences between subgroups 2 and 3 (z test = 2.02, $p = 0.044$)

Thirty-four HPs had a skin testing done. The results in 28 of them were negative (82.4%); four were identified to have sensitization to house and paper dust and cat and dog hair and two persons were hypersensitive to timothy grass, rye grass, brome grass, and maize pollen.

Rhinocytogram results of 22 health professionals with signs of rhinitis were studied. 54.5% of the examined had eosinophilia (more than 5%); the rest having elevated neutrophil counts. Six out of 8 clinical laboratory technicians had eosinophilia.

All of them had a clinical examination by an allergist, a dermatologist, and an ENT specialist.

Values of the main epidemiological parameters used to assess the probability of LA development were calculated. A relative risk (RR) of increased latex-specific IgE values in health professionals (HPs) with the history of allergies was 2.53 (95% CI, 1.63–3.94; $p < 0.001$), with an odds ratio (OR) being 5.51 (95% CI, 2.52–12.05; $p < 0.001$), and an etiological fraction (EF) of 60.5%, which indicates a high relationship of this pathology to occupation in medical personnel who have had the history of any allergic reactions.

The obtained values of epidemiological criteria to assess the risk of LA in HPs demonstrated a high relation between increased latex-specific IgE values and respiratory and skin

manifestations such as allergic rhinitis and rash on the back of the hand when wearing latex gloves. For example, in HPs with latex-specific IgE of more than 0.35 IU/mL, the odds ratios were 2.95 (95% CI, 1.39–6.27; $p = 0.004$) with the relative risk being 1.7 (95% CI, 1.20–2.66; $p = 0.004$) and the etiological fraction of 41.1% for the development of allergic rhinitis in contact with latex-containing products, which suggests a moderate relationship of this pathology to occupation. The odds ratio of dermatitis with increased latex-specific IgE values was 2.54 (95% CI, 1.20–5.38; $p = 0.01$) with a relative risk of 1.66 (95% CI, 1.21–2.46; $p = 0.01$) and the etiological fraction of 40.0% for the development of allergic dermatitis in contact with latex-containing products, which also suggests a moderate relationship of this pathology to occupation.

4 Conclusion

Latex allergy in health professionals is characterized by the development of skin manifestations and allergic rhinitis. It is most common among individuals aged 35.5 years who have a work experience of 9 years and the history of allergies (OR = 5.51, the EF = 60.5%, suggesting a high relationship of this pathology to occupation), confirmed with increased total IgE

Table 5 Correlation between latex-specific IgE and total IgE levels, age and work experience

Parameter	Work experience, years						<i>p</i>		
	0–9 (subgroup 1)		10–19 (subgroup 2)		≥ 20 (subgroup 3)		r_1/r_2	r_2/r_3	r_1/r_3
	r_1	<i>p</i>	r_2	<i>p</i>	r_3	<i>p</i>			
Latex-specific IgE	0.078	0.639	0.196	0.201	0.026	0.874	0.318	0.183	
Total IgE	<u>0.368</u>	<u>0.024</u>	0.096	0.535	0.057	0.730			

Underlined entries are significant values

r – Spearman's rank correlation coefficient; $r_1/r_2, r_2/r_3, r_1/r_3$ – correlation coefficients in intergroup comparisons; *p* – statistical significance

values, that should be taken into consideration in occupational fitness assessments on a preliminary medical examination. It is necessary to approve a prick test for diagnostics of latex allergy officially and to include latex allergies in the list of occupational diseases. The use of vinyl gloves reduced skin manifestations in 41.2% of health professionals who had elevated latex-specific Ig E values.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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