ORIGINAL ARTICLE

Latex allergy: a follow up study of 1040 healthcare workers

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Background: Natural rubber latex allergy can cause skin and respiratory symptoms The aim of this study was to evaluate the prevalence and incidence of latex related symptoms and sensitisation among a large group of healthcare workers in Trieste hospitals, followed for three years before and after the introduction of powder-free gloves with low latex release.

Methods: In the years 1997–99 the authors evaluated 1040 healthcare workers exposed to latex allergen for latex related symptoms and sensitisation by means of a questionnaire, a medical examination, skin prick tests, and IgE specific antibody assay. The second evaluation was carried out in the years 2000–02, subsequent to the changeover to a powder-free environment.

Results: Glove related symptoms were seen in 21.8% of the nurses (227), mostly consisting of mild dermatitis: 38 (3.6%) complaining of contact urticaria and 24 (2.3%) of asthma and/or rhinitis. These symptoms were significantly related to skin prick tests positive to latex (OR = 9.70; 95% CI 5.5 to 17) and to personal atopy (OR = 2.29; 95% CI 1.6 to 3.2). Follow up was completed in 960 subjects (92.3%): 19 new subjects (2.4%) complained of itching erythema when using gloves, but none was prick positive to latex. Symptoms significantly improved and in most cases disappeared ($p<0.0001$).

Conclusions: Simple measures such as the avoidance of unnecessary glove use, the use of non-powdered latex gloves by all workers, and use of non-latex gloves by sensitised subjects can stop the progression of latex symptoms and can avoid new cases of sensitisation.

Allergy to natural rubber latex is an important occupational health concern among healthcare workers[1–8] and the main source of workplace exposure is powdered latex gloves.[9 10] In studies of hospital personnel, latex sensitivity was found to be three to five times higher among nurses and doctors than among personnel not involved in patient care.[7 11] The prevalence of latex allergy in the healthcare setting is reported to be affected by several factors, including atopy,[12 13] frequency of glove use, previous or current hand dermatitis, and the duration of the job being done.[1 7 11 14–17] Although atopy and frequent exposure to latex are considered independent risk factors for sensitisation, Moneret-Vautrin[18] has suggested that they act in synergy and reported a cumulative risk of 36.4%.

Exposure to latex is known to cause an array of symptoms including pruritus, dermatitis, erythema, and urticaria, as well as a systemic reaction. Exposure to aerosolised cornstarch powder from latex gloves, which binds to latex antigens, can cause conjunctivitis, rhinitis, and asthma.[14] In those parts of a hospital where powdered gloves are frequently used, the concentration of airborne latex aeroallergens can be 5–10 times higher than in areas where powdered gloves are never or rarely used.[18]

This study evaluated the prevalence of latex related symptoms and sensitisation when powdered medical gloves were used and compared differences in symptoms after the hospital changed to a powder-free environment policy. The aim was to evaluate whether using non-powdered gloves would reduce symptoms and prevent new cases. We were also able to investigate possible progression of latex sensitisation and symptoms in conditions of low latex exposure.

MATERIALS AND METHODS

Study population

The study population consisted of 1040 medical, surgical, and laboratory workers in Trieste hospitals who together constituted 90% of exposed subjects in the departments considered. In the years 1997–99, all participants were given a physical examination and at all of them completed a questionnaire providing descriptive data about their past and current health status, latex exposure, and atopy evaluation. All were prick tested with common allergens and latex. Sensitised and symptomatic subjects were immediately provided with latex-free gloves to use at work. In 1999, a recommendation stated that the use of powdered medical gloves was no longer acceptable, and during the years 1999–2000, all powdered products were substituted with low protein, latex, powder free alternatives. The second survey was carried out in the years 2000–02, after the changeover to a powder-free environment. The participants were examined once again and completed the questionnaire a second time, to evaluate latex related symptoms in the more recent years. New symptomatic cases were prick tested with the same latex extract.

Questionnaire

Before skin testing, a screening questionnaire was administered to exclude workers with serious systemic reactions to the latex extract skin test.[19] The criteria for exclusion were either a severe asthma attack or a severe reaction to latex which had required medical intervention in the past year.[13] The standardised questionnaire collected demographic data (age, sex, job title, years of seniority), exposure data (task description, number of gloves used per day, hours of use, kind of gloves), and information about family and personal histories of allergic disorders (asthma, hay fever, allergies, eczema), as well as about symptoms related to glove use.[20] All subjects were interviewed by a trained doctor.

Latex related lower respiratory symptoms were defined as presence of attacks of cough, wheezing, and dyspnoea which appeared only at work or became significantly worse at work. Work related rhinitis was defined as the presence of sneezing and/or itchy, running nose during the work period. Contact urticaria related to latex use was defined as a self reported weal and flare reactions at the site of glove contact that

appear within 10–15 minutes of usage; generalised urticaria was defined as a self reported weal and flare reaction appearing in several skin sites. Contact dermatitis was defined as a self reported erythemato-papulous persistent eruption that appears on the skin after 2–3 days of contact with latex gloves. Personal atopy was defined as reported symptoms of allergic rhinitis and/or asthma and/or urticaria in the past not related to latex exposure, while family atopy was defined as the same symptoms present in parents or children. In the second control the change of symptoms was assessed during a medical examination.

Skin testing

Workers were skin tested with common inhalant allergens including perennial allergens (*Dermatophagoides farinae* and *pteronyssinus*, dog and cat danders, and *Alternaria* spp), pollens (Gramineae, *Parietaria* spp, Betulaceae, Colylaceae, Oleaceae). The extract of common allergens and of latex were supplied by Lofarma Allergeni (Milan, Italy). The protein concentration of this latex extract was 12.5 µg/ml.[21 22] The positive control was 1% histamine dihydrogen chloride solution and the negative control was 1% glycerinate solution. Skin prick tests were performed by trained registered nurses. Both forearms were wiped clean with alcohol. Skin test sites were clearly marked, a drop of extract was placed on the skin, and this was pricked with commercially available skin test lancets (Hollister Stier Laboratory, Ontario, Canada).

All tests were red and recorded each 15 minutes, and a weal of ⩾3 mm was considered positive. A single positive response to an inhalant allergen was considered the determining criterion for atopy (by prick test).[13] Prick test in subjects who had no reaction to positive control or who had a positive reaction to negative control were repeated after two months. No one was excluded as false positive or negative to skin prick test.

The serum of subjects with positive skin prick tests to latex, or who had latex related symptoms, was tested for specific IgE (RAST-Pharmacia) for latex extract.

Statistical procedure

Data analysis was performed with the SPSS programme for Windows, release 9.0 (SPSS Inc, Chicago, IL, USA). Continuous data were summarised as means (SD). The difference between means was tested by Student's *t* test. Categorical data were analysed by the likehood χ^2 techniques with Yates's correction as indicated by the data. Fisher's exact test was used if the expected number of observations in any cell was less than 5. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using EPI INFO (version 5.01a). The Symmetry Exact tests were used for paired data (Statxact 2000). For all statistical analyses, a 0.05 level of significance was used and all p values were two sided.

RESULTS

Results at baseline

The total number of participants in the baseline survey was 1040, representing a participation rate of 90%. A group of subjects (116) refused to undergo the sanitary control and the prick test; however, compared with all those elegible, the participants were identical for age, sex, and seniority of work (table 1).

The study population had a mean age of 36.5 (SD 8.9) years and an average work seniority of 11.0 (SD 8.3) years. There were more females (n = 749, 72%) than males. Glove related symptoms were present in 227 workers (21.8%), and were more frequent in women (24.6%) than in men (14.6%). The most common symptoms were erythema and itching (181 subjects, 17.4%) while 26 (2.5%) had contact dermatitis related to glove use. Symptoms suggestive of latex IgE allergy were urticaria in 38 subjects (3.6%), rhinitis in 21 (2%), and asthma in three cases (0.2%).

Table 1 Comparison of study participants with those elegible

	Participants	Eligible
Number (%)	1040 (90)	1155 (100)
Mean age years (SD)	36.5 (8.9	36.8 (9.1)
Work seniority years (SD)	11.0 (8.3)	11.3 (8.3)
Female, n (%)	749 (72.0)	835 (72.3)

Among the 1040 participants there were 62 (6%) who were positive to latex; 52 of them were tested for IgE specific for latex and 30 (57.7%) had specific IgE in serum.

We found a significant association with glove related symptoms and female sex, work seniority, and duration of glove use at work; the workplaces with the highest prevalence of symptoms were operating theatres (33.5%), and the laboratory/haemodialysis ward (25.4%) (see table 2). No significant differences were noticed among different work tasks and among age groups.

The odds ratios of possible risk factors and glove related symptoms are reported in table 3. We found a significant association with being female (OR = 1.89; 95% CI 1.3 to 2.7), with a positive history of atopic disease (OR = 2.29; 95% CI 1.6 to 3.2), with family atopy (OR = 1.85; 95% CI 1.3 to 2.7), with skin prick test positivity to common inhalant allergens (OR = 1.3, 95% CI 1.0 to 1.8), and with skin prick tests positive to latex (OR = 9.7; 95% CI 5.5 to 17). The Mantel-Haenzel ORs for association of symptoms and latex SPT status adjusted for atopic status as defined by prick test

Table 2 Characteristics of participants with symptoms related to latex glove use at baseline

Characteristic (n)	Latex symptoms, n (%)	p Value for difference in %
All (n = 1040)	227 (21.8)	0.000
Sex		
Female	184 (24.6)	0.07
Male	42 (14.6)	
Age group (years)		
⩽25	19 (16.2)	0.07
26–30	41 (21.5)	0.07
31–35	58 (29.6)	
36–40	43 (21.7)	
41–45	26 (17.4)	
>45	41 (21.6)	
Work seniority (years)		
<2	24 (10.1)	0.03
2–5	32 (25.8)	
6–10	39 (29.8)	
11–15	54 (29.3)	
16–20	40 (19.3)	
>20	38 (22.4)	
Workplace		
Medicine	102 (17.2)	0.03
Surgery	38 (22.8)	
Operating theatre	72 (33.5)	
Lab/haemodialysis	16 (25.4)	
Job title		
Nurses	153 (23.5)	0.15
Nursing auxiliaries	22 (21.0)	0.15
Lab workers	22 (21.5)	
General assistants	19 (19.3)	
Latex glove use		
Less than daily usage	11 (8.6)	0.001
At least daily	31 (20.5)	
<4 hours/day	115 (21.0)	
>4 hours/day	71 (31.0)	

Table 3 Odds ratios of possible risk factors and glove related symptoms (227 subjects)

Factor	n (%)	OR (95% CI)
Demographic variables		
Female sex	749 (72.0)	1.89 (1.3–2.7)
History of atopic diseases		
Family atopy	209 (20.1)	1.85 (1.3–2.7)
Personal atopy	215 (20.7)	2.29 (1.6–3.2)
Atopy by prick	405 (38.9)	1.30 (1.0–1.8)
SPT + to latex	62 (6.0)	9.70 (5.5–17.0)

SPT, skin prick test; OR, odds ratios (95% confidence limit).

(table 4) confirm the strong association between latex sensitisation and glove related symptoms, higher for rhinitis (OR = 64; 95% CI 17 to 250) and contact urticaria (OR = 46; 95% CI 17 to 128), and lower for itching/erythema (OR = 4.5; 95% CI 2.5 to 8.0).

Follow up

Follow up was performed in 960 subjects (92.3%) and table 5 shows their characteristics together with those lost to follow up. The subjects lost had a lower work seniority ($p = 0.004$) and reported more allergic symptoms and family atopy compared to those who completed the follow up. No differences were seen in the two groups as regards glove related symptoms. No one had changed their job for allergic symptoms but they had gone to work in other hospitals.

Table 4 Odds ratios of possible risk factors and skin prick test (+) to latex

Factor	n	OR (95% CI)	ORADJ (95% CI)
History of atopic diseases			
Family atopy	209 (20.1)	2.7 (1.6–4.6)	1.8 (1.1–3.2)
Personal atopy	214 (20.6)	6.2 (3.6–10.0)	3.0 (1.7–5.5)
Glove related symptoms	227 (20.1)	9.7 (5.4–18.0)	9.9 (5.6–17)
Itching/erythema	181 (17.4)	4.4 (2.5–7.8)	4.5 (2.5–8.0)
Contact dermatitis	26 (2.5)	8.1 (3.0–21)	9.9 (3.0–27)
Contact urticaria	38 (3.6)	47 (20–113)	46 (17–128)
Rhinitis	21 (2.0)	83 (26–286)	64 (17–250)
Asthma	3 (0.3)	α	α

SPT, skin prick test; OR, odds ratios (95% confidence interval); ORADJ, Mantel-Haenzel odds ratio for association of symptoms and latex SPT status adjusted for atopic status defined by prick test.

Table 5 Characteristics of population analysed at baseline, follow up, and those lost to follow up

	Baseline	Follow up	Lost
Number (%)	1040 (100)	960 (90.2)	80 (9.8)
Mean age years (SD)	36.5 (8.9)	36.6 (8.9)	35.2 (9.7)
Work seniority years (SD)	11.0 (8.3)	11.3 (8.2)	8.76 (8.6)*
Female, n (%)	749 (72.0)	692 (72.0)	56 (70.0)
Family atopy, n (%)	209 (20.0)	187 (19.5)	22 (27.5)
Personal atopy, n (%)	204 (19.6)	190 (19.8)	24 (30.0)*
Atopy by prick, n (%)	406 (40.0)	370 (38.5)	36 (45.0)
Prick latex+, n (%)	62 (6.0)	55 (5.7)	7 (8.8)
Glove related symptoms, n (%)			
All symptoms	227 (22)	211 (22)	16 (20)
Itching/erythema	181 (17.4)	169 (18)	12 (15)
Contact dermatitis	26 (2.5)	24 (2.5)	2 (2.5)
Contact urticaria	38 (3.6)	34 (3.5)	4 (5.0)
Rhinitis	21 (2.0)	20 (2.1)	1 (1.2)
Asthma	3 (0.2)	3 (0.4)	0

*$p<0.05$.

The results at follow up are reported in table 6. At baseline there were 19 subjects (2.4%) who complained for the first time of glove related symptoms: all of them had itching/erythema when using gloves and none was prick test positive to latex. There was a significant reduction in mild symptoms (such as itching/erythema) in 39 subjects (23%) and in the majority of cases (51.4%) these symptoms had disappeared after the introduction of powder-free latex gloves. Three previously symptomatic cases reported worse glove related symptoms, but at testing, none of them was sensitised to latex.

Hand eczema was significantly reduced at follow up and disappeared in seven cases (29.1%). Urticaria disappeared in 44.2% of the subjects but was still present on contact with latex gloves in 23.5% of the subjects. Subjects with rhinitis had to use non-latex gloves but continued to work in the same place. In four of these cases, symptoms resolved; in 10, they improved; and in six cases they were unchanged (30%). There was a reduction in symptoms among asthmatic subjects, but in these cases too, symptoms reappeared on occasional contact with latex gloves.

DISCUSSION

This large follow up investigation of healthcare workers in Italy allowed us to evaluate latex related symptoms and sensitisation using powdered latex gloves, and then the progression of symptoms after non-powdered latex gloves were introduced for all healthcare workers and non-latex gloves for those subjects sensitised to latex.

Natural rubber latex allergy was a major occupational health concern among healthcare workers until recent years.[7 9 21 23–26] Symptoms related to latex glove use were noticed in 21.8% of the population studied—a level similar to other studies.[2 27] Hamann[28] reported a 26.7% presence of symptoms in a survey of dental professionals while in 1997, Leung[29] found that 30.9% of Hong Kong nurses reported glove related symptoms. The lower percentage in our study could be related (1) to the low mean age and work seniority of our study group, due to the opportunity given to Italian healthcare workers to retire after 15 or 20 years' work in public hospitals; (2) to the ''healthy worker effect'', because sensitised people are at higher risk of leaving the workplace.

Substantiating what was previously reported by Turjanma[17] and Leung,[29] the majority of symptoms are mild, while a few are general symptoms related to latex IgE mediated sensitisation (urticaria, asthma, and rhinitis). Latex symptoms are significantly related to a positive history of common allergic symptoms and to family atopy, and less related to atopy as defined by prick test. A high predictive value is obtained through analysis of skin sensitisation to latex, followed by a positive history of allergic symptoms. The increased use of latex gloves increases sensitisation and related symptoms. In line with the findings of other studies,[11] workers in operating theatres, laboratories, and centres for haemodialysis are at higher risk.

Follow up showed a significant reduction in latex related symptoms among the group considered, which cannot be explained by differences in work practice variables, such as number of hours of latex glove use or a change in task description. The introduction of non-powdered latex gloves enables workers to avoid the air contamination[30] and the lower latex release of these gloves prevents new cases of sensitisation. The reduction in exposure to latex allergens resulting from the change in gloves led to fewer symptoms such as itching/erythema, but also to a decrease in IgE mediated symptoms, particularly skin reactions, in line with the findings of other studies.[30 31] There was also a significant decrease in hand eczema at follow up, just as Edelstam has reported in a similar eight month study. There was a

Table 6 Follow up results (n = 960)

Symptoms	Baseline (%)	Follow up, n (%)				p Value*
		Same	Worse	Better	Disappeared	
Number	710 (73.9)	691 (97.3)	19 (2.7)	–	–	0.0001
Itching/erythema	169 (17.6)	40 (23.6)	3 (1.7)	39 (23.0)	87 (51.4)	0.0001
Contact eczema	24 (2.5)	7 (29.1)	–	10 (41.6)	7 (29.1)	0.0001
Urticaria	34 (3.5)	8 (23.5)	–	11 (32)	15 (44.2)	0.0001
Rhinitis	20 (2.1)	6 (30)	–	10 (50)	4 (20)	0.0001
Asthma	3 (0.3)	1 (33.3)	–	2 (66.6)	–	0.235

*Symmetry exact test.

statistically significant reduction in rhinoconjunctivitis—although only a few subjects reported resolution of symptoms, most reported an improvement. The reduction in asthma was not statistically significant, probably indicating a lack of statistical power in the analysis because of the low number of asthmatics in the study.

Our results indicate that simple measures such as the avoidance of unnecessary glove use, the use of non-powdered latex gloves by all workers, and the use of non-latex gloves by sensitised subjects can stop the worsening of latex symptoms and can prevent new cases of sensitisation. The powder-free policy produced the best results in terms of alleviating mild local symptoms (such as itching/erythema and hand eczema) and stopping new sensitisations. For people already sensitised to latex, it is essential to avoid direct contact, but they can work at the same task as long as other workers use non-powdered latex gloves. The effect of the new gloves was less evident in subjects with IgE mediated symptoms such as asthma and rhinitis, who must avoid all contact with latex. In fact, once sensitisation has occurred, it is difficult to prevent appearance of symptoms, especially in the case of systemic reactions. The role of prevention must be to avoid onset of sensitisation by providing low latex release powder-free gloves, and to identify those subjects at greater risk (such as asthmatics) who must avoid latex contact altogether and use non-latex gloves.

There are various important aspects to this study. It is one of the few to systematically enrol an unselected group of healthcare workers and follow them over a three year period, in contrast to previous studies which enrolled selected, volunteer subjects.[1 3 5 32–35] The large sample size enabled us to determine the relative roles played by the various potential risk factors and identify those subjects most at risk so as to introduce preventive measures. In fact, it is vital to screen exposed subjects for latex sensitisation so as to limit their latex exposure as much as possible, and then lower the allergen content of latex products, substitute latex with non-latex products whenever possible, reduce exposure to the airborne allergen, and avoid unnecessary glove use.

There are also some limitations of the study: subjects who may have developed latex sensitivity may have left the workforce before the study, leading to an underestimation of the prevalence of latex sensitivity. Selection bias was also possible if non-participants differed somehow from participants, or if those who thought that they were symptomatic or sensitised to latex were more likely to participate, which could result in an overestimation of risk estimates. Although we were unable to interview non-participants, table 1 suggests that the groups were essentially identical in several key characteristics. In the follow up group, those lost were younger and reported more allergic symptoms than the others. Therefore our results could in fact underestimate latex symptoms.

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Answers to questions on *The health hazards of volcanoes and geothermal areas* by A L Hansell *et al*, on pages 149–156

(1) Terminology and geology
- (a) False: jökulhlaups are meltwater floods from a volcanic eruption under a glacier
- (b) True
- (c) False: volcanic ash is defined as particles <2 mm diameter
- (d) False: the opposite is true

(2) Volcanogenic hazards
- (a) True: it is usually possible to outrun a lava flow, but with some exceptions, e.g. the eruption of Nyriagongo, Congo, 2002
- (b) False: the answer is approximately 80 000 to 100 000
- (c) True
- (d) False: the line of volcanoes that runs down the western side of the Americas from Alaska to Chile affects the neighbouring countries to the west of Belize, Honduras, and Columbia—i.e. Guatemala, El Salvador, and Ecuador

(3) Pyroclastic density currents
- (a) False: the ratio may be 10:1 or higher
- (b) True
- (c) False: the lowest speeds are around 80 km/h
- (d) False: evacuation is the only recommended way to avoid fatalities and injuries. Sheltering should only be used in an emergency

(4) Volcanic ash
- (a) True: however, relatively few such studies have been conducted and may have been subject to various methodological problems
- (b) True
- (c) False: results cannot be readily applied to ash from eruptions at other volcanoes unless the ash has similar characteristics—in terms of concentration and size of particles, mineralogical composition, and surface properties
- (d) False: the silica content of Mount St Helens ash from 1980 was judged to be unlikely to cause health problems because of the low duration of exposure. Ash from Montserrat eruptions could cause health exposures if exposure is persistent—either from ongoing eruptions or from continued resuspension of previously erupted ash

(5) Occupational and other hazards in relation to volcanoes
- (a) True
- (b) False: the death was related to an accumulation of H_2S
- (c) True: volcanologists and other geologists may undergo repeated exposures to irritant gases emitted in volcanic and geothermal areas. This potentially increased risk may also be true of some workers in volcano tourism industries
- (d) False: there have been no reported air crashes