

Original article

Type I latex allergy in health care workers with latex-induced contact urticaria syndrome: a follow-up study

Background: Latex allergy is an important occupational health issue among health care workers (HCWs). Secondary prevention in sensitized/allergic individuals involves avoiding exposure to NRL products.

Aims of the study: The aim of this follow-up study is to determine the long-term health consequences in HCWs with type I latex allergy with latex-related contact urticaria syndrome, of providing appropriate information and practical avoidance education.

Methods: Seventeen HCWs with latex-induced contact urticaria syndrome, as ascertained by the glove use test, were investigated. Initial and follow-up visits included: a detailed questionnaire, skin prick test (SPT) with glove eluates and with commercial latex extract, SPT with common inhalant and food extracts, serum specific immunoglobulin (IgE) to latex and some foods and the glove use test.

Results: On re-examination, 11 (64.7%) subjects showed positive SPTs to extemporaneous extract and 10 (58.8%) patients showed a positive SPT to commercial extract. Of the nine patients with detectable levels of serum latex specific IgE at first evaluation, four (44.4%) became negative and four were assigned to at least one class lower. Only one (11.1%) employee had higher radioallergosorbent test values than those at the latex allergy diagnosis. At follow-up, the 17 individuals had positive latex challenge results, although the duration of exposure causing a reaction increased.

Conclusion: Our study shows that preventive measures are sufficient to induce a reduction of sensitization. Continued avoidance is needed to prevent re-sensitization or adverse reactions on re-exposure.

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Latex allergy is an important occupational health issue among health care workers (HCWs). Up to 17% of these subjects become sensitized and most of them develop an occupational type I allergy to natural rubber latex (NRL) (1, 2).

In the last years, in addition to immunoglobulin (Ig)E-mediated latex allergy, delayed cell-mediated hypersensitivity to latex has been reported, both contact dermatitis and airborne dermatitis (3–5). However, today, its prevalence among HCW has not been yet determined.

In the 1990s, studies were published assessing the results of primary prevention. It was found that after removing powdered latex gloves from some areas of a hospital or introducing low-protein and/or powdered free gloves there was a decline or cessation in latex sensitization (6–12). Recently, Allmers et al. (13) showed that since 1997, when powdered NRL gloves were replaced by

low-protein, powder-free gloves or alternative materials in Germany, the incidence of latex sensitization declined on a nationwide scale.

Secondary prevention in sensitized/allergic individuals means avoiding any exposure to NRL products because further personal use of latex products or bystander exposure from other sources, such as co-workers, could result in maintaining or worsening their sensitization leading to potentially life threatening reactions. The aim of this follow-up study is to determine the long-term health consequences in HCWs with type I latex allergy with latex-related contact urticaria syndrome, of providing appropriate information and practical avoidance education.

Materials and methods

In 1995–99, as part of a prevalence study (2), we diagnosed 20 HCWs as having type I latex allergy using two diagnostic criteria: a positive IgE test and a positive NRL glove use test. The IgE tests included skin prick test (SPT) with commercial NRL allergen

Abbreviations: HCWs, health care workers; NRL, natural rubber latex; SPT, skin prick test; FEIA, fluorescent enzyme immunoassay; CAP, coated allergen particle; RAST, radioallergosorbent test.

(Stallergènes, Paris, France); SPT with latex glove extract (Le Petit, Grandate, Como, Italy) and latex radioallergosorbent test (RAST) [Pharmacia coated allergen particle (CAP) system, RAST fluorescent enzyme immunoassay (FEIA) (Pharmacia and Upjohn Diagnostic, Uppsala, Sweden)]. At diagnosis four subjects worked in the operating room, three in the emergency room, two in the X-ray room, one in the obstetric and gynecology unit, one in the gastroenterology unit, one in the cardiology unit, one in the otorhinolaryngology unit, one in the spirometry laboratory, one was involved in personnel transport, two worked in kitchen and food services. The three subjects who will not be enrolled for a follow up evaluation worked in the operating room.

At diagnosis, all patients were informed of the hazards of latex allergy and given oral instruction on preventive measures and a written hand-out. In particular, the subjects were advised to strictly avoid exposure to latex in occupational settings and, whenever possible, at home. Patients were recommended to use gloves made of alternative materials such as vinyl, polyurethane and neoprene. Co-workers were advised to wear gloves made of alternative materials or, when latex gloves were necessary, that a substantial reduction in NRL exposure might be achieved by using low-protein powder-free latex gloves. Instruction comprised information on latex-containing products frequently used in daily life (such as clothes, condoms, air mattresses) and latex-free alternatives. Patients were instructed to perform all surgical and medical procedures in a latex-free environment and to inform physicians of this requirement. Risk factors, signs and symptoms of latex allergy ranging from contact urticaria to anaphylactic shock were explained, emphasizing the most hazardous forms of exposure like anaesthesia, condoms and other forms of mucosal contact. In addition, recommendations were given to avoid the five cross-reactive foods investigated in the prevalence study (kiwi, chestnut, banana, avocado and pineapple).

Latex allergy follow-up

In 2002, 17 of the original series of 20 subjects were enrolled for a follow-up evaluation, three having declined to participate in this study phase. All subjects gave written informed consent. The protocol and procedures of the study were approved by the Ethics Committee of our Hospital.

Questionnaire. All patients were carefully interviewed employing a structured questionnaire in order to assess any changes, as instructions on latex avoidance had been given at the time of the latex allergy diagnosis.

Questions concerned current occupation and job tasks and any changes therein. Other questions were about the type of gloves used by them and co-workers. The questionnaire also collected data on self-reported symptoms associated with gloves use. Patients were asked whether they had experienced reactions during medical/surgical procedures or following contacts with any type of latex product. Inquiry was also made about the ingestion of cross-reactive foods and any hypersensitive reactions against them.

Skin prick tests. Glove extracts used for skin prick testing were prepared as reported previously (2). Variability in the potency of skin tests materials was minimized by use of the same gloves (same lot) for skin testing at baseline and follow-up (Le Petit). Additional SPTs were performed with food and common inhalant allergens (Stallergènes), and a commercial extract of nonammoniated latex (Stallergènes). Food extracts included avocado, banana, pineapple, kiwi and chestnut (Stallergènes; Lofarma, Florence, Italy). Inhalant extracts included *Dermatophagoides pteronyssinus* and *D. farinae*, grass pollen, olive pollen, cypress pollen, Parietaria, *Artemisia*

vulgaris, cat dander, dog dander, *Alternaria tenuis*, and *Aspergillus*. Histamine dihydrochloride (10 mg/ml) was used as positive control, and physiological saline as negative control. A prick test was considered positive if the wheal size had a mean diameter 3 mm larger than the wheal of the negative control. Atopy was diagnosed in the presence of one or more positive prick tests to common inhalant allergens.

Glove provocation tests. The glove use test was performed with the same gloves (same lot) for skin test and for glove use test both at baseline and follow-up (Le Petit), as follows. A fingertip was cut from a latex glove, and placed on one finger for 15–30 min. If the reaction was negative, a whole glove was then worn for the same amount of time. If the reaction was negative, the whole glove was worn for 60 min. If still negative, patients were instructed to wear a glove for 2 h daily on three consecutive days (14). A vinyl glove was used as control. A glove use test was regarded as positive when contact urticaria on the finger/hand exposed to latex, or rhinitis or asthma developed.

Serum specific IgE. The laboratory evaluation included measurements of serum specific IgE to latex and some foods (Pharmacia CAP system, RAST FEIA) under standardized conditions, as recommended by the manufacturer. A positive RAST was defined as a value >0.35 kU/l.

Statistics. The Wilcoxon matched-pair test was used to compare the results of SPTs and latex-RAST at diagnosis and re-examination. Proportions were compared by the McNemar test. In all instances, a probability value <0.05 was considered to be statistically significant.

Results

Subject characteristics and questionnaire results

The study group included three males and 14 females (mean age 45.8 ± 8.8 , range 31–58), with a mean follow-up of 4.5 years. Of the 17 subjects, seven (41.2%) had changed department, two (11.8%) had changed their job title and four (23.5%) had changed both department and job title, while the remaining four (23.5%) had not changed either department or job title. At follow-up four subjects worked in central administration office, three in the ambulatory of a psychiatry unit, two in the ambulatory of a neurology unit, one in the ambulatory of an ophthalmology unit, two in the administration office of a radiology unit, one in a spirometry laboratory, one in a hospital pharmacy, one was involved in transport personnel, two worked in kitchen and food services.

All subjects stopped using latex gloves after the diagnosis of latex allergy; 13 (76.5%) used vinyl or polyurethane gloves, while four (23.5%) did not need to use any type as gloves were not required in their new job. Six (46.1%) individuals who wore vinyl gloves sometimes used cotton gloves underneath, as well as barrier creams (Table 1).

Co-workers replaced powdered latex gloves with vinyl and polyurethane if possible, when glove use was required. However, when latex gloves were essential, they

Table 1. Follow-up questionnaire summary results among 17 health care workers

Response	No. (%)
Department and job title	
Different department because of latex allergy	7 (41.2)
Different job because of latex allergy	2 (11.8)
Different department and job because of latex allergy	4 (23.5)
No change	4 (23.5)
Symptoms on glove exposure (at least one)	8 (47.1)
Localized urticaria*	
Disappeared	9 (52.9)
Improved	5 (29.4)
Did not change	3 (17.6)
Generalized urticaria*	
Disappeared	6 (35.3)
Conjunctivitis*	
Disappeared	9 (52.9)
Improved	1 (5.9)
Did not change	1 (5.9)
Rhinitis*	
Disappeared	8 (47.1)
Improved	1 (5.9)
Dyspnoea*	
Disappeared	8 (47.1)
Improved	1 (5.9)
Glove use	
Yes	13 (76.5)
No	4 (23.5)
Current glove type	
Vinyl only	8 (47.1)
Polyurethane only	1 (5.9)
Vinyl and polyurethane	4 (23.5)
Use of barrier cream	6 (35.3)
Use of cotton gloves	3 (17.6)
Co-workers alternative glove use	
Vinyl	12 (70.6)
Polyurethane	3 (17.6)
Powder-free latex gloves	7 (41.2)
At least one glove type	13 (76.5)
Ingestion of cross-reactive food	7 (41.2)
Reaction to cross-reactive food	1 (5.9)

* The symptoms on glove exposure were scored according to four options: disappeared, improved, worsened and did not change. Only the positive responses are reported in the table.

used the low-protein nonpowdered latex kind. Of the workers who still used nonlatex gloves, eight (61.5%) reported glove-induced symptoms, cutaneous in all cases and in four, ocular and respiratory too. After switching to synthetic gloves, nine (52.9%) HCWs remained asymptomatic during the follow-up period. No allergic complication occurred during any medical/surgical procedures. One subject underwent an operation in a latex-free environment without any adverse reaction. No patients experienced latex-associated anaphylactic reactions in situations not related to medical procedures. Seven (41.2%) individuals ingested cross reactive foods, but only one experienced generalized urticaria after ingesting a banana. He had had only a positive SPT with avocado at the time of the first evaluation.

Table 2. Immunoglobulin (Ig)E test responses to aeroallergens and food allergens in 17 subjects

	At diagnosis No. positive subjects (%)	At follow-up No. positive subjects (%)	P-value
Skin prick test extracts			
At least one inhalant	10 (58.8)	11 (64.7)	0.4
At least one food	11 (64.7)*	8 (47.1)†	0.8

* In one subject specific IgE antibodies were detected by radioallergosorbent test (RAST).

† In four subjects specific IgE antibodies were detected by RAST.

Skin prick tests

At diagnosis all HCWs had positive SPTs with glove extract. On re-examination, 11 (64.7%) subjects showed positive SPTs to extemporaneous extract. In these subjects, the SPT reactivity to NRL glove extract was statistically different in the first examination and the follow-up ($P < 0.05$). Of the 16 positive at diagnosis, 10 (62.5%) patients showed a negative SPT with commercial extract in the follow-up observation and a significant difference was verified for the mean wheal diameter (mean diameter in mm 7.4 vs 3.5, range (mm) $< 3-14$ vs $< 3-10.5$; $P < 0.05$). At diagnosis, 10 (58.8%) subjects showed positive SPTs to inhalant allergens. At re-examination, 11 (64.7%) subjects showed at least one positive SPT to inhalants ($P = 0.5$). At diagnosis, 11 (64.7%) subjects showed at least one positive IgE test to food extracts; at re-examination, eight (47%) subjects had at least one positive IgE test to food extracts ($P = 0.8$). Because of a previous hypersensitive reaction to food, in three subjects specific IgE were detected and measured by RAST (Table 2).

None of the participants experienced adverse reactions to the latex SPT procedure.

Glove provocation tests

At the initial assessment, the 17 individuals had a positive latex challenge. All reactions appeared within 60 min, eight subjects experiencing a reaction while they were wearing only one finger and the remaining nine subjects while they were wearing the whole glove, within the first 60 min of the test. At the follow-up examination, the duration of exposure causing a reaction increased. In fact, in six (35.3%) subjects, the reaction appeared between 30 and 60 min and in 10 (58.8%), wheals appeared between 60 and 120 min. Only one (6%) subject experienced a reaction within 30 min, while he was wearing just the finger, as had occurred during the first examination, but his IgE test showed a decrease in sensitization (the SPT positive reaction to latex extract dropped from 1 : 100 to 1 : 10, the SPT to commercial latex extract declined in mean diameter from 6 to 5.5 mm, the RAST value from 10.1 to 3.3 kU/l). None of the participants experienced a

Table 3. Immunoglobulin (Ig)E test result at first evaluation and follow-up examination

Subjects	Time interval (years)	SPT with commercial extract at diagnosis‡	SPT with commercial extract at follow-up‡	SPT with glove extract at diagnosis†	SPT with glove extract at follow-up†	IgE antilatex (kU/l) at diagnosis	IgE antilatex (kU/l) at follow-up
1	3	10.5	4.5	1 : 100	1 : 1	<0.35	<0.35
2	5	6.5	4	1 : 10	Neg*	<0.35	<0.35
3	7	4	<3*	1 : 10	Neg	2.2	<0.35
4	4	4.5	<3	1 : 100	Neg	<0.35	<0.35
5	6	10	10.5	1 : 100	1 : 1000	3.1	10.3
6	7	11.5	9.5	1 : 1000	1 : 1000	1.62	0.45
7	7	7	<3	1 : 100	1 : 1	1.87	<0.35
8	3	5.5	<3	1 : 1	Neg	<0.35	<0.35
9	3	7.5	<3	1 : 100	1 : 1	<0.35	<0.35
10	3	14	6	1 : 1000	1 : 10	85.1	3.22
11	4	7.5	5.5	1 : 100	1 : 10	0.82	0.37
12	4	6	5.5	1 : 100	1 : 10	10.1	3.3
13	5	8.5	5	1 : 1000	1 : 1	44.8	<0.35
14	4	4.5	4.5	1 : 1	1 : 1	0.6	<0.35
15	5	<3	<3	1 : 10	Neg	<0.35	<0.35
16	4	11.5	5	1 : 100	1 : 1	<0.35	<0.35
17	3	7	<3	1 : 1	Neg	<0.35	<0.35

* Negative.

† Positivity is defined as the lowest dilution of glove eluate that produced a positive wheal.

‡ Mean wheal diameter.

SPT, skin prick test.

systemic reaction during the glove provocation procedure or suffered from active hand dermatitis.

Serum specific IgE

Eight (47%) of 17 subjects who had not shown serum latex-specific IgE at first examination, were still negative in 2002.

Of the nine patients with detectable levels of serum latex specific IgE at first evaluation, four (44.4%) became negative and four (44.4%) were assigned to at least one class lower. Only one (11.1%) employee had higher RAST values than those at the latex allergy diagnosis. In the positive subjects there was no significant difference in mean values of latex specific IgE between the first examination and the re-examination (mean value 8.8 vs 1.01 kU/l, range (kU/l) <0.35–85.1 vs <0.35–10.3; $P = 0.054$). At follow-up serum specific IgE to cross reactive food were assayed in three patients and yielded positive results. Table 3 shows the changes in latex-specific IgE antibodies in the blood and changes in SPT with NRL and glove extracts.

Discussion

In this study we investigated the dynamic character of latex allergy among HCWs with contact urticaria syndrome proved by a challenge test. Other studies had already published data on the effects of secondary prevention among sensitized/allergic workers (15–20), but the definition of allergy in our study differs from

that in the others. In fact, we consider subjects with a positive glove use test as allergic, and subjects with evidence of specific IgE antibodies against latex allergen as sensitized (21).

In other studies the term 'allergy' indicates the presence of symptoms related to latex exposure in subjects with specific IgE antibodies against latex allergen (15, 19). This is an important difference, as according to the findings in previous studies, we judged that prophylaxis is sufficient to determine a reduction of specific IgE against latex, but not to eliminate the risk of adverse reactions on re-exposure. In fact, all the individuals in our study showed a positive glove use test at follow-up, although the time of reaction onset was longer than at the first examination (except in one case).

In our opinion, it is useful to perform a glove use test as a method for quantifying clinical latex sensitivity in studies of latex allergy natural history and intervention measures.

Analysis of our data showed that a reduction of skin sensitization was present in 88.2% of the tested subjects, whereas 14 of 15 (93.3%) showed at least a 10-fold decrease of SPT reactions with glove eluate and a decrease of the mean SPT diameter with commercial extract, while one of 15 (6.7%) showed only a decrease in SPT mean diameter with commercial extract. Hamilton et al. (18) showed a decrease of skin sensitivity, evaluated by the lowest concentration of latex allergen used in SPT that produced a positive wheal and erythema, in 30% of sensitized subjects. In this study SPTs were performed with commercial extract, while we performed SPTs both with glove extract and commercial extract to evaluate a

larger spectrum of allergens involved in the aetiology of latex allergy (22) although in fact there is good concordance between the results of SPT with eluate and with commercial extract (92.3% of subjects showed a decrease of specific IgE evaluated by both tests). In our study, 88.9% of HCWs with initially positive latex-RAST experienced a decrease in latex-specific IgE at follow-up; these data are in agreement with those of Hamilton's study (18) and lower than those reported by Allmers et al. (17), despite a longer follow-up period. Four of the subjects with a decrease of serum specific IgE showed levels below the limits of detection.

However, while Hamilton et al. (18) and Allmers et al. (17) focused their attention on sensitized workers, in this study we evaluated HCWs with latex-induced contact urticaria syndrome, as proved by the glove use test performed both at the beginning and at the end of study.

Hence, we can conclude that secondary prevention, as performed in our study, resulted in a decrease in sensitisation in 16 of 17 subjects (evaluated by a decrease of at least one IgE test), and all except one showed a decrease in skin reactivity. The one subject who showed an increased level in sensitization had increased skin sensitivity and an increased level of specific IgE, despite having used nonlatex gloves, changing her job and her co-workers not having used powdered latex gloves. Considering the self-reported glove symptoms, we can establish that all HCWs reported reduction of at least one symptom, although in the case of contact urticaria only nine of 17 (52.9%) subjects reported its disappearance, notwithstanding preventive measures. Perhaps, the urticaria was referable to glove occlusion or to exposure to other substances before wearing gloves (three of eight subjects among those who did not report disappearance of urticaria, described as redness and itching, had had positive patch tests to standard series and rubber series, data not shown). Despite the prophylaxis and the long

follow-up time, the persistence of a clinically allergic status in all subjects could be related to several reasons:

- Difficulty in establishing a latex-free environment because the latex content of many materials is hidden and unknown.
- Sensitization to certain inhalant allergens could maintain the sensitization to latex because of cross-reactivity (23–25).
- The ingestion of cross-reactive foods, and persistency or appearance of specific IgE to these could maintain latex sensitization (26).
- As suggested by some authors (27), reservoirs of latex could be present in tissue from preceding operations, causing slow release and antigen stimulation by latex. In fact, at first examination 13 of 17 (76.5%) subjects reported having undergone at least one operation.
- The problem of latex avoidance is complicated by the occasional finding of extractable latex allergen in synthetic gloves (28). Further refinements in glove manufacturing methods might succeed in reducing cross-contamination of non-NRL gloves with NRL allergens in production facilities where both types of gloves are produced.

Our study shows that preventive measures performed first in the work environment are sufficient to induce a reduction in sensitization. Continued avoidance is needed, despite the changes in IgE antibody levels observed, to prevent re-sensitisation or adverse reactions on re-exposure.

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References

1. GARABRANT DH, SCHWEITZER S. Epidemiology of latex sensitisation and allergies in health care workers. *J Allergy Clin Immunol* 2002;**110**:S82–95.
2. NETTIS E, ASSENNATO G, FERRANNINI A, TURSI A. Type I allergy to natural rubber latex and type IV allergy to rubber chemicals in health care workers with glove related skin symptoms. *Clin Exp Allergy* 2002;**32**:441–447.
3. GUTGESELL C, ARNOLD R, BARTELS S, FUCHS T. Contact dermatitis to latex is rare. *Allergy* 2000;**55**:892–893.
4. NETTIS E, DAMBRA P, SOCCIO L, FERRANNINI A, TURSI A. Latex hypersensitivity: relationship with positive prick test and patch test responses among hairdressers. *Allergy* 2003;**58**:57–61.
5. PANASOFF J. Airborne contact dermatitis to latex. *Allergy* 1998;**53**:1228.
6. SUSSMAN GL, LISS GM, DEAL K, BROWN S, CIVIDINO M, SIU S et al. Incidence of latex sensitisation among latex glove users. *J Allergy Clin Immunol* 1998;**101**:171–178.
7. TURJANMAA K, REINIKKA-RAILO T, REUNALA T, PALOUSA T. Continued decrease in natural rubber latex (NRL) allergen levels of medical gloves in nationwide market surveys in Finland and co-occurring decrease in NRL allergy in a large University hospital (abstract). *J Allergy Clin Immunol* 2000;**104**:S373.
8. LEVY DA, ALLOUACHE S, CHABANE MH, LEYNADIER F, BURNEY P. Powder-free protein-poor natural rubber latex gloves and latex sensitisation (abstract). *JAMA* 1999;**281**:988.
9. LISS GM, SUSSMAN GL, DEAL K, BROWN S, CIVIDINO M, SIU S et al. Latex allergy: epidemiological study of 1351 hospital workers. *Occup Environ Med* 1997;**54**:335–342.
10. SUSSMAN GL, LISS GM, WASSERMAN S. Update on the Hamilton, Ontario latex sensitisation study (letter). *J Allergy Clin Immunol* 1998;**102**:333.

11. TARLO SM, EASTY A, EUBANKS K, PARSONS CR, MIN F, JUVET S et al. Outcomes of a natural rubber latex control program in an Ontario teaching hospital. *J Allergy Clin Immunol* 2001; **108**:628–633.
12. LISS GM, TARLO SM. Natural rubber latex-related occupational asthma: association with interventions and glove changes over time. *Am J Ind Med* 2001; **40**:347–353.
13. ALLMERS H, SCHMENGLER J, SKUDLIK C. Primary prevention of natural rubber latex allergy in the Germany health care system through education and intervention. *J Allergy Clin Immunol* 2002; **110**:318–320.
14. HEESE A, VAN HINTZENSTERN J, PETERS KP, KOCH HU, HORNSTEIN OP. Allergic and irritant reactions to rubber gloves in medical health care services. Spectrum, diagnostic approach and therapy. *J Am Acad Dermatol* 1991; **25**:831–839.
15. TAYLOR JS, PRADITSUWAN P. Latex allergy. Review of 44 cases including outcome and frequent association with allergic hand eczema. *Arch Dermatol* 1996; **132**:265–271.
16. WRANGSJO K. IgE-mediated latex allergy and contact allergy to rubber in clinical occupational dermatology, Thesis. Stockholm, Sweden: National Institute of occupational Health, 1993.
17. ALLMERS H, BREHLER R, CHEN Z, RAULF-HEIMSOTH M, FELS H, BAUR X. Reduction of latex aeroallergens and latex specific IgE antibodies in sensitised workers after removal of powdered natural rubber latex gloves in a hospital. *J Allergy Clin Immunol* 1998; **102**:841–846.
18. HAMILTON RG, BROWN RH. Impact of personal avoidance practices on health care workers sensitised to natural rubber latex. *J Allergy Clin Immunol* 2000; **105**:839–841.
19. TURJANMAA K, KANTO M, KAUTIANEN H, REUNALA T, PALOSUO T. Long-term outcome of 160 adult patients with natural rubber latex allergy. *J Allergy Clin Immunol* 2002; **110**:S70–S74.
20. VANDENPLAS O, JAMART J, DELWICHE JP, EVRARD G, LARBANOIS A. Occupational asthma caused by natural rubber latex: outcome according to cessation or reduction of exposure. *J Allergy Clin Immunol* 2002; **109**:125–130.
21. TURJANMAA K. Diagnosis of latex allergy. *Allergy* 2001; **56**:810–812.
22. BAUR X, CHEN Z, RAULF-HEIMSOTH M, DEGENS P. Protein and allergen content of various natural latex articles. *Allergy* 1997; **52**:661–664.
23. NETTIS E, MICALE G, FANELLI M, SERIO G, COLANARDI MC, FERRANNINI A et al. Atopy and risk factors for latex sensitization in a selected population. *Allergy Asthma Proc* 2003; **24**:185–191.
24. WAGNER S, BREITENEDER H, SIMON-NOBBE B, CRAMERI R, FOCKE M, KURUP VP et al. Hev b 9, an enolase and a new cross-reactive allergen from Hevea latex and molds. *Eur J Biochem* 2000; **267**:7006–7014.
25. FUCHS T, SPITZAUER S, VENTE C, HAVLER J, KAPIOTIS S, RUMPOLD H et al. Natural latex, grass pollen, and weed pollen share IgE epitopes. *J Allergy Clin Immunol* 1997; **100**:356–364.
26. KURUP VP, FINK JN. The spectrum of immunologic sensitisation in latex allergy. *Allergy* 2001; **56**:2–12.
27. MAZON A, NIETO A, LINANA JJ, MONTORO J, ESTORNELL F, GARCIA-IBARRA F. Latex sensitisation in children with spina bifida: follow-up comparative study after two years. *Ann Allergy Asthma Immunol* 2000; **84**:207–210.
28. JONES R, LOBLAND T, SCHEPPMANN D, YOUNGINGER J. Latex aeroallergen contents of rubber gloves packaged in sterile medical kits and trays. *J Allergy Clin Immunol* 1998; **102**:994–996.