

Cotton fluffs as latex allergen carriers in a glove factory

Xaver Baur, MD *Hamburg, Germany*

Background: Latex allergens released from gloves and bound to airborne cornstarch powder have been shown to cause respiratory allergy in health care workers.

Objective: Cornstarch from powdered latex gloves is a well-known carrier of airborne allergens. It should be investigated whether cotton fluffs used to lubricate household and industrial gloves also function as airborne carriers for latex allergens.

Methods: Latex gloves, cotton fluffs with or without latex glove contact, dipping water from the glove cooling tank, a dust sample from the floor, and 10 samples from area dust samplers were analyzed for their allergen content by using a CAP inhibition method. Furthermore, 84% (119/142) of the working group participated in a cross-sectional study involving a questionnaire and measurement of latex-specific IgE by means of CAP inhibition.

Results: Latex gloves, area dust samples from latex glove production sites, and the floor dust sample contained high concentrations of latex allergens. Cotton fluffs were free of allergens before being in contact with gloves but showed considerable allergen concentrations after their removal from gloves. The dipping water of the cooling tank also contained latex allergens. Of the examined employees, 12.6% had IgE-mediated sensitization, and a third of the sensitized subjects (ie, 4% of the total group) reported work-related hypersensitivity reactions.

Conclusions: Cotton fluffs bind latex allergens and behave like cornstarch as airborne allergen carriers causing conjunctivitis and allergic respiratory disorders. (*J Allergy Clin Immunol* 2003;111:177-9.)

Key words: Aeroallergens, allergy, cornstarch, cotton fluffs, gloves, latex

Various powder lubricants for latex gloves have been used in recent decades to reduce stickiness and to facilitate donning. The first one was *Lycopodium* species (moss spores). Because *Lycopodium* species was responsible for severe granuloma formation and adhesions, talcum powder was introduced. Because this powder also frequently caused granulomas, adhesions, and cytotoxic effects,^{1,2} it was replaced by cornstarch cross-linked with phosphorus oxychloride or epichlorhydrin and mixed with approximately 2% magnesium oxide. Cornstarch appears to have fewer and less intense side effects. How-

ever, during glove manufacture, allergenic latex proteins are easily released from gloves when dipped into the cornstarch slurry for powdering.³⁻⁶ Because of the aerosolization of cornstarch powder from finished latex gloves, latex allergens are constantly inhaled in environments where powdered gloves are manufactured or frequently used.⁷⁻¹¹ Chaiear et al¹² reported extremely high air concentrations of latex allergens (geometric mean, 15.4 µg/m³) in Thai glove production plants; however, no information was given on the powder type obviously functioning as an allergen carrier. Contrary to this, Pisati et al¹³ reported that no latex allergens were found in air samples of a textile factory using talc-powdered rubber skeins. Proteins could not be detected by using the Bio-Rad method in the dust or in the latex-lubricating talc powder extract of this textile factory, whereas latex allergens were found in the deposited dust and in the latex-lubricating talc powder extract, indicating that such allergen contents and their distribution are only measurable by means of sensitive immunologic methods. Similarly, we found rather low measurable latex allergen contents in talc powder removed from latex gloves and low air concentrations in our challenge test chamber when talc-lubricated latex gloves were used (measurable concentrations were lower than one tenth of those when cornstarch-powdered latex gloves were tested (Baur X, unpublished observations). As reported by Lundberg et al,¹⁴ talc irreversibly binds latex allergens, whereas the cornstarch binding of allergens is unstable.

For some latex products (eg, household gloves), cotton fluffs are used instead of cornstarch. As far as we know, it has not been investigated yet whether cotton fluffs also function as allergen carriers. The aim of this study was to measure air concentrations of latex allergens in different working areas of a factory producing synthetic, as well as latex, household and industrial gloves powdered with such fluffs. Furthermore, the prevalence of work-related symptoms and latex sensitization was investigated.

METHODS

Latex allergen measurements in workplace atmospheres and in different material samples were performed by means of the CAP inhibition assay, as previously described^{15,16}; a serum pool from 4 latex-sensitized health care workers was used as antiserum. The sensitivity of the CAP inhibition assay was 20 ng (ie, 0.2 ng in 14 m³ of air), and the interassay coefficient of variation was 16.5%.

Protein concentrations were measured according to a modified Lowry method.¹⁷ Ten samples obtained with area dust samplers in 7 work sites were collected and tested for their latex allergen content.

In addition, latex gloves, cotton fluffs with or without latex glove contact, samples of the cooling tank's dipping water, and a dust sample of the production area were analyzed.

From the Institute of Occupational Medicine, University of Hamburg, Hamburg.

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Reprint requests: Xaver Baur, MD, Ordinariat und Zentralinstitut für Arbeitsmedizin Hamburg, Adolph-Schoenfelder-Str. 5, D-22083 Hamburg, Germany.

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TABLE I. Protein and latex aeroallergen concentrations in area dust samples*

Area	Concentration of latex allergens (ng/m ³)
Production of synthetic gloves	ND
Production area 1 of latex gloves	>60.0
Production area 2 of latex gloves	>60.0
Technical laboratory (3 samples)	22.0
	45.0
	19.0
Formulating room (with connecting door to production area of latex gloves)	1.9
Mold construction room	ND
Stock-warehouse	ND
Floor	ND

ND, Not detectable.

*The dust sample taken from the floor of latex glove production area 1 contained greater than 10,000 ng/g dust.

TABLE II. Protein and latex allergen concentrations in different samples-materials

Samples	Amount or concentration	
	Proteins	Latex allergens
Gloves after vulcanization		
Before washing	1270.2 µg/g rubber	955.5 µg/g rubber
After washing	714.5 µg/g rubber	634.5 µg/g rubber
Cotton fluffs before being in contact with latex gloves	100.4 µg/g cotton fluffs	ND
Cotton fluffs removed by a vacuum cleaner from latex gloves at different production steps		
Rough gloves after cooling and dipping into the cooling tank (2.1 g of fluffs obtained from 5 gloves)	>10,000 µg/g cotton fluffs	15,580.0 µg/g cotton fluffs
Rough gloves after additional rinsing and washing (1.8 g of fluffs obtained from 5 gloves)	>8000 µg/g cotton fluffs	11,700.0 µg/g cotton fluffs
Finished gloves (0.4 g of fluffs obtained from 8 gloves)	>5000 µg/g cotton fluffs	9244.0 µg/g cotton fluffs
Water samples from cooling tank (3 samples)		
Water after one washing process	19.5 µg/mL	0.3 µg/mL
Water after one washing process	8.4 µg/mL	0.4 µg/mL
Water after several washing processes	109.5 µg/mL	56.5 µg/mL

ND, Not detectable.

All 142 employees were informed by a company meeting and a notice about the risk of latex allergy and about this cross-sectional study; 119 (84%) of them participated (38 women and 81 men; 10 were absent, and 13 refused to take part). Mean duration of work was 9.2 years (range, 0.7-24.7 years). All 119 participants filled in a case history questionnaire and underwent latex-specific IgE antibody determination by means of CAP inhibition.

RESULTS

Latex aeroallergen measurements

No airborne latex allergens were detectable in the production area of synthetic gloves, which was well isolated from the section producing latex gloves. The highest air concentrations of latex allergens were found in the production and vulcanization areas of latex gloves, followed by the technical laboratory, where the quality of newly produced latex gloves was to be approved (Table I). A considerable lower airborne allergen load was found in the section where latex sap was formulated for production. This section is directly connected by a door to the latex glove production area. Several other rooms of the factory, which are not in the neighborhood of the latex

glove production area, did not show latex contamination. Fine dust covering the floor of the latex glove production area was collected and shown to contain an extremely high latex allergen concentration (Table I).

Latex allergen concentrations in different material samples

Lubricated rough latex gloves contained high concentrations of proteins and latex allergens, which decreased by 44% or 34% after the gloves were washed and cooled down in a cold-water tank (Table II).

The natural cotton fluffs did not contain latex allergens before their contact with latex gloves. During the production process, dry fluffs were spread on the glove surface for lubricating before vulcanization. After vulcanization, the cotton fluffs that were not tightly attached to the gloves were washed off in the cooling tank during the cooling process. In the meantime the latex allergens that were released from latex gloves were transferred to the cotton fluffs. Thus high protein and latex allergen concentrations were found in cotton fluffs from finished latex gloves collected with a vacuum cleaner.

In the cooling tank of the production area, considerable allergen concentrations were measurable after several washing processes.

IgE antibody analysis and symptoms

Fifteen (12.6%) of 119 examined employees working in areas with measurable latex aeroallergen loads had latex-specific IgE antibodies (range, 0.37-33 kU/L). Five of them complained of workplace-related symptoms (ie, conjunctivitis, $n = 4$; dermatitis, $n = 3$; rhinitis, $n = 2$; cough, $n = 2$; and/or shortness of breath, $n = 1$), whereas subjects without latex-specific IgE antibodies did not report work-related symptoms ($P < .05$).

According to their case history, sensitized subjects did not significantly differ from nonsensitized workers with regard to smoking (27% vs 33%), the frequency of hay fever or other respiratory allergies caused by nonoccupational allergens (20% vs 17%), and duration of work in the glove factory (10.5 ± 4.7 vs 8.9 ± 4.9 years [mean $\pm$ SD]).

DISCUSSION

The data presented here demonstrate that cotton fluffs bind allergenic latex proteins and function as allergen carriers, as also shown for cornstarch. Airborne allergenic cotton fluffs can be directly released from lubricated gloves or can occur as a result of the frequent spreading of contaminated dipping water from the cooling tank because this spread dipping water evaporates in the production site and leaves behind a fine dust layer containing high concentrations of latex allergens that are easily airborne.

The allergen contamination in the workplace, as well as the high prevalence of type I sensitization to latex in our study, indicate the necessity to improve primary preventive measures (eg, to avoid the spreading of contaminated dipping water), to use closed-circuit machinery, and to install effective exhaust systems with filters.

Regarding the allergy risk of glove users, the allergen content of household gloves has to be strongly reduced and, instead of lubricating powder alternatives, should be introduced as recently recommended for medical gloves.¹⁸

REFERENCES

1. Beck WC, Beezhold DH. Starch glove powder should follow talc into limbo. *J Am Coll Surg* 1994;178:185-6.
2. Edlich RF. Medicine's deadly dust: a surgeon's wake-up call to society. Arlington (VA): Vandamere Press; 1997.
3. Beezhold D, Beck WC. Surgical glove powders bind latex antigens. *Arch Surg* 1992;127:1354-7.
4. Tomazic VJ, Shampaine EL, Lamanna A, Withrow TJ, Adkinson NF Jr, Hamilton RG. Cornstarch powder on latex products is an allergen carrier. *J Allergy Clin Immunol* 1994;93:751-8.
5. Lundberg M, Wrangsjö K, Johansson SGO. Latex allergens in glove-powdering slurries. *Allergy* 1995;50:378-80.
6. Swanson MC, Ramalingam M. Starch and natural rubber allergen interaction in the production of latex gloves: a hand-held aerosol. *J Allergy Clin Immunol* 2002;110(suppl):S15-20.
7. Heilman DK, Jones RT, Swanson MC, Yunginger JW. A prospective controlled study showing that rubber gloves are the major contributor to latex aeroallergen levels in the operating room. *J Allergy Clin Immunol* 1996;98:325-30.
8. Swanson MC, Bubak ME, Hunt LW, Yunginger JW, Warner MA, Reed CE. Quantification of occupational latex aeroallergens in a medical center. *J Allergy Clin Immunol* 1994;94:445-51.
9. Baur X, Jaeger D. Airborne antigens from latex gloves. *Lancet* 1990;335:912.
10. Tarlo SM, Sussman GL, Contala A, Swanson MC. Control of airborne latex by use of powder-free gloves. *J Allergy Clin Immunol* 1994;93:985-9.
11. Charous BL, Schuenemann PJ, Swanson MC. Passive dispersion of latex aeroallergen in a healthcare facility. *Ann Allergy Asthma Immunol* 2000;85:285-90.
12. Chaiear N, Sadhra S, Jones M, Cullinan P, Foulds IS, Burge PS. Sensitization to natural rubber latex: an epidemiological study of workers exposed during tapping and glove manufacture in Thailand. *Occup Environ Med* 2001;58:386-98.
13. Pisati G, Baruffini A, Bernabeo F, Falagiani P. Environmental and clinical study of latex allergy in a textile factory. *J Allergy Clin Immunol* 1998;101:327-9.
14. Lundberg M, Wrangsjö K, Johansson SGO. Latex allergy from glove powder and unintended risk with switch from talc to cornstarch. *Allergy* 1997;52:1222-8.
15. Baur X. Measurement of airborne latex allergens. *Methods* 2002;27:59-62.
16. Baur X, Chen Z, Allmers H, Beckmann U, Walther JW. Relevance of latex aeroallergen for healthcare workers. *Allergol Int* 1996;20:105-11.
17. ASTM D 5712-95. The standard test method for analysing proteins in natural rubber and its products. In: *Annual Book of ASTM Standards*. Vol. 14.02. Philadelphia: American Society for Testing and Materials; 1995.
18. Charous BL, Blanco C, Tarlo S, Hamilton RG, Baur X, Beezhold D, et al. Natural rubber latex allergy after 12 years: recommendations and perspectives. *J Allergy Clin Immunol* 2002;109:31-4.