

Measurement of airborne latex allergens

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Abstract

A method for the standardized sampling and quantification of aeroallergens was developed. It proved suitable for the analysis of allergen loads in a variety of medical settings. Several studies demonstrate that the use of powdered allergenic latex gloves leads to a significant aeroallergen load which is responsible for IgE-mediated rhinitis, bronchial asthma, and conjunctivitis in health care workers. Only nonpowdered latex gloves with low or no allergen content should therefore be used. © 2002 Elsevier Science (USA). All rights reserved.

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1. Introduction

The prevailing clinical diagnosis of latex-allergic subjects is contact dermatitis. However, approximately one-fourth of those affected also suffer from conjunctivitis, rhinitis, and/or bronchial asthma. According to our examinations and medical expert opinions, 45% of a group of 262 health care workers (80% with latex-specific skin prick test responses) claiming compensation for latex-induced respiratory diseases suffered from latex-induced rhinitis, 42% from asthma, and 72% from one or both of these disorders Table 1. The pathogenetic background of the latter diagnoses is unclear so far. One frequently discussed hypothesis is that subjects present systemic reactions due to the adsorption of latex allergens on intensive skin contact with gloves. Together with other research groups we have questioned this hypothesis and investigated whether airborne latex allergens could be detected, quantified, and related to symptoms and disorders.

2. Methodology of powder and airborne allergen quantification

Only a few reports on the measurement of latex allergens in glove powder and in airborne particulates

have been published [1–4]. Respective routine methods are nonexistent. We developed the following method using two different types of area samplers: the VC 25 (Stroehlein Instruments, Kaarst, Germany) with a flow rate of 22.5 m³/h (for rooms larger than 200 m³) and Wazau (Wazau, Berlin, Germany), flow rate 2.8 m³/h (for rooms smaller than 200 m³). To collect all airborne particulates, area samplers were operated for 20 h with cellulose membrane filters (Satorius, Goettingen, Germany). Particulate matter was captured at a velocity of 1.25 m/s ($\pm 10\%$).

The filters of area samplers were removed, weighed, and cut into pieces of approximately 2 × 1 mm. Filter pieces were then extracted by vigorous stirring for 24 h in 20 ml of 0.1 M acetate buffer, pH 8, in 0.1% CHAPS at 20 °C. The supernatants were collected, filter-sterilized, and freeze-dried. The extracts were then redissolved in 400 μ L distilled water and stored at –20 °C.

The latex allergens in the collected dust sample extracts were quantified by a competitive immunoassay. Quantification was obtained by establishing a standard inhibition curve using known concentrations of allergen extracts from surgical gloves with the CAP system (Pharmacia, Uppsala, Sweden) (Fig. 1). Dust extract concentrations were adjusted to ensure inhibition in the linear range of the standard curve. A pooled serum from four latex-sensitized subjects was used as antiserum. The CAP system with latex ImmunoCAP as solid-phase antigen uses fluorescence-labeled monoclonal mouse

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Table 1
Frequency of latex glove-induced disorders in 262 health care workers (HCWs) claiming compensation for latex-induced respiratory diseases

Latex glove-induced disorder	Disorder according to	
	Physicians diagnoses (<i>n</i>) (medical expert opinion)	Questionnaire (<i>n</i>)
Rhinitis	45% (119)	64% (168)
Bronchial asthma	42% (109)	65% (171)
Rhinitis and/or bronchial asthma	72% (188)	71% (186)
Conjunctivitis	n.e. ^a	68% (177)
Urticaria	n.e.	68% (177)

^a n.e., Not examined.

anti-IgE-antibodies. Further details are described in Baur et al. [5]. The sensitivity of the assay was 0.2 ng in 14 m³ air.

This CAP inhibition assay was found to be well-functioning for the measurement of latex allergen concentrations in extracts from gloves and in a variety of other latex materials [6].

3. Latex aeroallergen quantification

One thousand pairs of powdered high-allergen latex gloves (Sempermed; protein content 1.5 mg/g rubber, latex allergen content 255 µg/g rubber) were turned inside out within an extractor hood whose exhaust van was switched off. By means of compressed air, the powder was removed and collected by an area dust sampler with a very high flow rate (Zambelli ZB2; 40 liters/min). Two hundred milligrams of powder was

obtained. The powder was extracted with 1 ml aqua dest. by shaking for 2 h and centrifugation. We obtained 2.47 µg protein from 200 mg powder. For comparison purposes, a commercially available cornstarch powder (Biosorb; Johnson & Johnson) was extracted in the same way. Neither proteins (<1 µg) nor latex allergens could be detected in this extract.

A second investigation was performed as follows: We quantified the dust load and latex allergen content in the air during the unpacking and shaking of four different glove types. This was done in the above-mentioned extractor hood with the exhaust van switched off. Two types of nonpowdered gloves with no or low allergen content produced neither measurable dust nor allergen loads in the air. The use of slightly powdered gloves with a low allergen content (27.8 µg/g rubber) was associated with the generation of dust but not of allergens; powdered high-allergen gloves had a high dust concentration as well as a measurable allergen concentration (Fig. 2).

In the meantime, we have introduced a standardized occupational-type challenge test. In a small cabin, patients susceptible of suffering from respiratory hypersensitivity due to latex are first tested with vinyl gloves powdered by Biosorb cornstarch (Johnson & Johnson) as placebo. The handling of one pair of powdered high-allergen latex gloves for up to 30 min follows. Finally, the subjects handle 10 pairs of these gloves for up to 30 min. Measurements of latex aeroallergens produced concentrations of about 200 ng/m³ in the first and ca. 1000 ng/m³ during the last step.

In addition, air samples were collected in 45 rooms of different hospital units, laboratories, and two physicians' offices where powdered latex gloves have been used. Latex aeroallergens were present in all 26 rooms

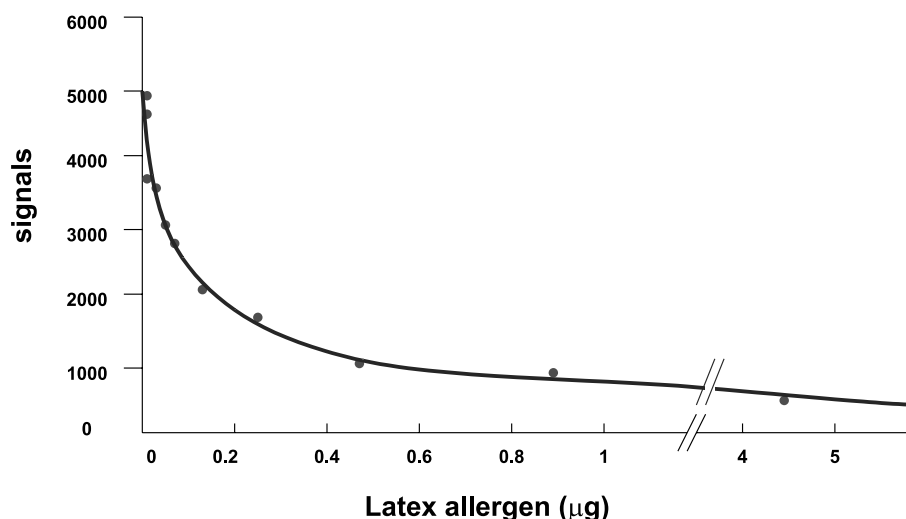


Fig. 1. CAP inhibition curve used for the quantification of latex allergens in air dust samples.

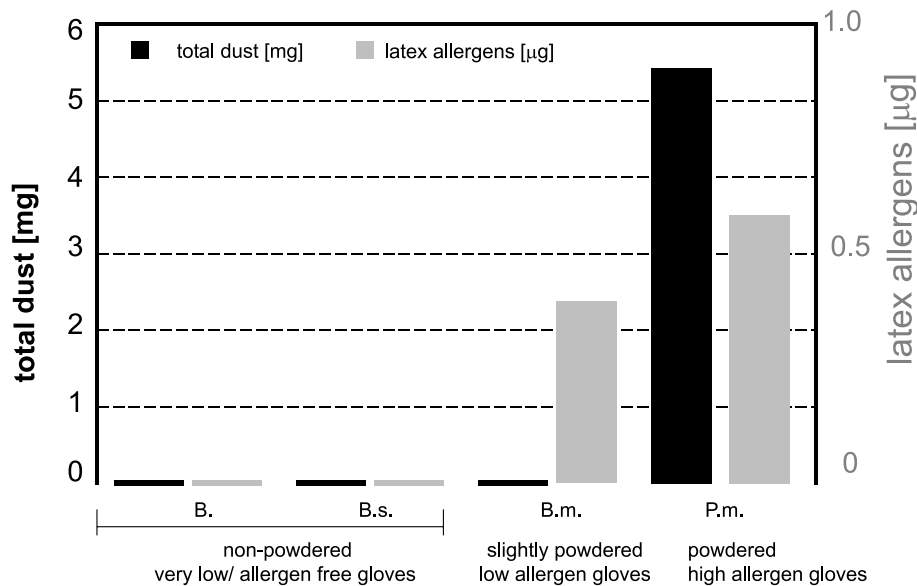


Fig. 2. Release of total dust and latex allergens by unpacking and shaking four different latex glove types (10 pairs each). For details see text. B. and B.s., nonpowdered; B.m., slightly powdered; P.m., powdered. Latex allergen content of gloves: B., nondetectable; B.s., 0.22 µg/g rubber; B.m., 27.8 µg/g rubber; P.m., 398.4 µg/g rubber.

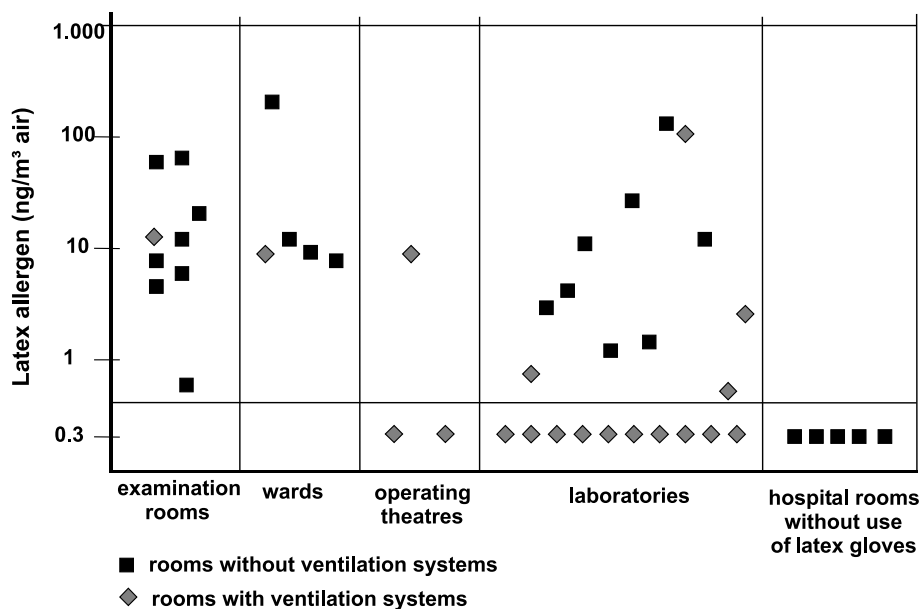


Fig. 3. Measurements of latex aeroallergens in different hospital rooms and physicians' offices.

without ventilation systems and in 7 of the 19 rooms with ventilation systems and fresh air supply. The concentration of latex aeroallergens ranged from less than 0.4–240 ng/m³ (Fig. 3). It was interesting that a relationship between total dust and latex aeroallergen concentration was not detectable. Moreover, we found that aeroallergen levels in the rooms were not closely associated with the total amount of used gloves. Rooms with well-functioning ventilation systems and fresh air supply were found to have no or a much lower concentration of

latex aeroallergens although mostly more gloves were used every day.

We intervened in five rooms with significant levels of latex aeroallergens. Powdered latex gloves were replaced by nonpowdered or synthetic ones. After 1 day, only a borderline concentration or no latex allergen was measurable. The follow-up of seven latex-sensitized subjects for 1 year revealed the persistent absence of work-related symptoms and a slight decrease in latex-specific IgE [3].

4. Estimation of a threshold limit value for airborne latex allergens

Of 145 health care workers (HCWs) participating in a cross-sectional study, 22 (15%) showed latex-specific IgE antibodies and skin test responses to latex proteins. Workplace-related, self-reported symptoms included 17 cases of conjunctivitis, 19 cases of rhinitis, and 5 cases of dyspnea. It is remarkable that all respiratory and conjunctival symptoms were exclusively reported in rooms with a concentration of at least 0.6 ng/m^3 latex aeroallergens. Furthermore, all 22 people with latex-specific IgE antibodies worked in rooms contaminated with these allergens. All but 3 of 22 subjects with latex-specific IgE antibodies but none of the nonsensitized subjects revealed respiratory symptoms associated with the use of powdered latex gloves [5]. Various confounders made it impossible to get an objective statistical analysis of the influence of used individual gloves. We assume that the number of glove applications alone does not reflect the real degree of exposure to latex in individuals. However, the finding that latex-specific IgE antibodies were present only in staff working in rooms where latex aeroallergens could be detected suggests that continuous inhalative latex allergen exposure may play an important role in the induction of immediate-type sensitization. On the basis of these results, we calculated a statistical aeroallergen threshold level of 0.5 ng/m^3 whose excess is associated with an increased prevalence of sensitization and symptoms.

5. Other research findings

Several other authors also demonstrated that the occurrence of latex aeroallergens as measured in hospital rooms of physicians' or dentists' offices depends on the use of powdered high-allergen latex gloves [1,4,7]. Using personal samplers in breathing zones Swanson et al. [1] detected $8\text{--}974 \text{ ng/m}^3$ latex allergens in areas where powdered gloves were frequently worn. On the other hand, it could be shown that the use of nonpowdered gloves with a low allergen content resulted in a

decrease in allergen levels by more than 90% [7] or even in the absence of detectable allergen levels [4].

6. Discussion

Latex-induced asthma has become one of the main causes of occupational asthma. It is No. 1 in South Africa [8] and No. 2 in Germany [9] in the register of occupational asthma. This indicates the urgent need to replace powdered high-allergen latex gloves with nonpowdered ones with low or no allergen content [10]. This aim can be achieved by campaigns, the corresponding adoption of institutional policies, and regulations. The success of such measures was recently demonstrated in Germany where a reduction of approximately 50% of recognized occupational latex-induced respiratory and skin diseases was achieved [11].

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