

Occupational asthma in a latex doll manufacturing plant

Nicholas A. Orfan, MD,^a Roberta Reed, PhD,^a Mark S. Dykewicz, MD,^b
Michael Ganz, MD,^c and Gerald B. Kolski, MD, PhD^d

Cooperstown, N.Y., St. Louis, Mo., Racine, Wis., and Upland, Pa.

Background: Occupational asthma caused by latex has been reported in health care workers and workers in glove manufacturing plants.

Objective: We report occupational asthma from latex in a newly identified occupational setting, a latex doll manufacturing plant.

Methods: We evaluated an index case of asthma associated with work in a latex doll manufacturing plant by performing a workplace challenge and evaluating the work environment. We then performed an occupational survey and skin testing of 22 workers in the doll manufacturing plant.

Results: The patient, a 21-year-old woman, had severe immediate bronchospasm within minutes of beginning a workplace challenge where sanding of latex parts was performed. Two of 22 workers surveyed (including the patient) reported flushing, rhinoconjunctivitis, and wheezing on exposure to sanded doll parts. These two workers were the only subjects surveyed to have a history of atopy and positive immediate-type skin test responses to a raw latex extract and to common aeroallergens.

Conclusions: Sanding or grinding of solid latex during the manufacturing process may result in a significant incidence of occupational asthma and rhinoconjunctivitis from latex sensitization. Atopic workers appear to be most susceptible to developing latex sensitivity in this setting. (*J ALLERGY CLIN IMMUNOL* 1994;94:826-30.)

Key words: Occupational asthma, airborne latex, doll manufacturing, sanding dust

Occupational asthma caused by type I hypersensitivity to airborne latex has been described in association with both the manufacture¹ and use^{2, 3} of latex gloves. In these reports latex antigen was believed to be aerosolized by association with glove powder, a phenomenon confirmed by Beezhold and Beck.⁴ We report an index case of severe immediate bronchospasm caused by latex, which was made airborne by the sanding of doll parts in a

manufacturing plant. We proceeded to survey and skin test employees at the doll factory to assess the presence of atopy, IgE sensitization to latex, and resultant work-related symptoms.

The patient was a 21-year-old woman with a history of perennial and seasonal allergic rhinitis who had been employed in a latex doll manufacturing plant for a period of 2 years without experiencing occupational allergic symptoms. Subsequently, she began to notice itchy-watery eyes, rhinorrhea, and facial flushing, which progressed to chest tightness and wheezing within minutes of entering an area where sanding of doll parts was ongoing. She was forced to leave the sanding area after approximately 15 minutes because of dyspnea. She was placed in a work area at some distance from the sanding room but continued to have intermittent respiratory symptoms as described above. She was first seen at our allergy clinic after 3 months of progressive work-related symptoms. Results of skin testing with a latex extract preparation (see below) were markedly positive. An occupational evaluation was per-

From ^aThe Mary Imogene Bassett Hospital, Division of Allergy and Immunology, Research Institute, Cooperstown;

^bSaint Louis University School of Medicine, Division of Allergy and Immunology, Department of Internal Medicine, St. Louis; ^cRacine Medical Clinic, Department of Allergy/Immunology, Racine; and ^dCrozer-Chester Medical Center, Department of Pediatrics, Upland.

Received for publication Jan 14, 1994; revised May 9, 1994; accepted for publication May 19, 1994.

Reprint requests: Nicholas A. Orfan, MD, Division of Allergy and Immunology, The Mary Imogene Bassett Hospital, One Atwell Rd., Cooperstown, NY 13326.

Copyright © 1994 by Mosby-Year Book, Inc.
0091-6749/94 \$3.00 + 0 1/1/57699

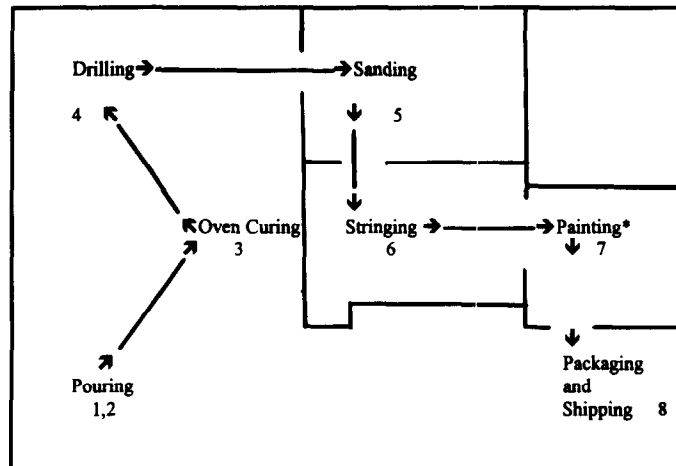


FIG. 1. Floor plan of doll factory. Sequence of doll manufacture is indicated by arrows beginning at lower left. Numbers in figure correspond to numbered steps of manufacturing process listed in the text. Asterisk indicates water-based paint containing no natural latex proteins.

formed including delineation of the latex doll manufacturing process, occupational challenge to reproduce symptoms, air sampling in the factory, and survey and skin testing of factory employees.

The doll manufacturing process was assessed by a site visit with direct observation of operations and review of written materials provided by the factory. Doll parts were composed of latex and china clay in a water base, stabilized by ammonia and aliphatic amines. The manufacturing process included: (1) pouring liquid latex composition into molds and air curing, (2) removing and trimming molded parts, (3) oven curing, (4) drilling holes in parts, (5) sanding parts, (6) stringing parts together, (7) painting bodies, and (8) packaging and shipping dolls. Activities took place in separate work areas (Fig. 1).

METHODS

Preparation of latex extracts for skin testing

Latex extract was prepared from raw ammoniated latex (Ansell, Inc., Dothan, Ala.), which was neutralized with 1N HCl to a pH of 7.4, with subsequent removal of solids. The liquid preparation was centrifuged at 1500 rpm for 30 minutes and sterile-filtered (0.2 μ m syringe filter). Protein concentration was 400 μ g/ml as determined by the Lowry method with bovine serum albumin as standard. This latex extract for skin testing had previously demonstrated 100% sensitivity in 13 patients seen in our clinic with a clinical history of type I allergy to latex and was demonstrated in more than 10 control subjects to be a nonirritant.

Doll sanding dust was collected from the containment chamber of a continuously running air filter

suction system with suction ports at each sanding station, which were designed to clear the sanding room of airborne sanding dust (Fig. 1). Doll sanding dust extract was prepared by dissolving 3 gm of dust in 125 ml of saline solution and stirring overnight at room temperature. The preparation was centrifuged at 1500 rpm for 30 minutes then filtered through a Sterivex-GS 0.22 μ m filter (Millipore Corp., Bedford, Mass.). Protein concentration was 470 μ g/ml by bicinchoninic acid assay with bovine serum albumin as standard. This doll dust extract for skin testing elicited no response in four control subjects and significant wheal and flare responses in two nurses and one patient with spina bifida who had previously diagnosed type I allergy to latex.

Air sampling

Area air sampling in the stringing and sanding rooms (Fig. 1) was performed for total particulates (National Institute for Occupational Safety and Health method 0500) with personal sampling pumps (Mine Safety Appliances, Pittsburgh, Pa.) calibrated to a flow of 2 L/min. Samples were collected on 25 mm diameter, 0.45 μ m vinyl metrical filters and reported in milligrams per cubic meter. Sampling collection was done for 4 hours during the workday, and results were reported as average concentrations. Personal sampling pumps were placed at a height of approximately 5 feet in proximity to worker stations. Air sampling was performed on the day of the workplace challenge.

Workplace challenge of patient

Workplace challenge was performed by placing the patient in the stringing room (Fig. 1) where symptoms had been occurring. The patient was asked not to touch doll parts during the challenge to ensure that cutaneous absorption of latex protein was not a factor. Vital signs,

TABLE 1. Occupational challenge in stringing room

		Pulmonary function			
	Clinical	FEV ₁		FVC	
		L	% Predicted	L	% Predicted
Baseline	Asymptomatic	3.32	100	3.40	85
20-minute exposure	Wheezing, itchy eyes, runny nose, flushed	1.17	35	2.11	51
After removal and treatment with 2.5 mg nebulized albuteral*	Residual red eyes, asymptomatic	2.69	82	3.32	81

FEV₁, Forced expiratory volume in 1 second; FVC, forced vital capacity.

*Also given 60 mg of terfenadine and 40 mg of prednisone orally.

symptoms, and spirometry were monitored; and the patient was removed from the work area with the onset of respiratory compromise.

Occupational survey and skin testing of factory workers

An occupational survey of latex doll factory workers was performed on site. Subjects were instructed to fill out a written questionnaire, which inquired about prior atopic disease (asthma, allergic rhinitis, food allergy, eczema), occupational history including duration of employment at the factory, specific job assignment, and work-related symptoms (e.g., skin, eyes, nose, and chest symptoms). Workers were also asked about symptoms related to rubber exposure outside the workplace, such as contact with rubber gloves or balloons. Skin prick tests were performed with raw latex extract, grass mix, ragweed, house dust mite mix, saline control, and histamine and were read at 20 minutes. The survey was reviewed with each worker for oral clarification of written response.

RESULTS

Skin test results of patient

The patient had a 105 × 45 mm wheal with surrounding flare in response to prick testing with raw latex extract. She had a 60 × 40 mm wheal with surrounding flare in response to prick testing with doll dust extract.

Air sampling

Air sampling for total dust demonstrated average ambient dust concentrations of 1.83 mg/m³ in the sanding room and 0.78 mg/m³ in the stringing room.

Workplace challenge of patient

Workplace challenge performed on the patient in the stringing room (Fig. 1) resulted in rhinorrhea, sneezing, and watery eyes at 10 minutes,

followed by wheezing and shortness of breath at 15 minutes. There was a 65% reduction in forced expiratory volume and a 40% reduction in forced vital capacity from baseline, with good recovery after removal from the area and treatment with 2.5 mg nebulized albuterol (Table 1). Peak flow monitoring performed on a control day in the allergy clinic, when there was no exposure to latex, was 480 L/sec, which was comparable to baseline peak flow on the day of the workplace challenge. The patient was treated with 40 mg of prednisone immediately after the challenge procedure to blunt a potential late-phase reaction. The patient reported no late-phase respiratory symptoms.

Occupational survey and skin testing of factory workers

An occupational survey at the doll factory was conducted with 22 of 25 workers (17 men and 5 women, ranging in age from 21 to 52 years). The average duration of employment was 7 years (range, 4 months to 19 years). Thirteen of the subjects worked in areas where they were not exposed to sanded doll parts (e.g., pouring and shipping rooms). None of the 13 had a history of atopy. None of those workers complained of symptoms when handling unsanded doll parts. All 13 had negative prick skin test responses to raw latex extract. Two of 13 had a positive skin test response to one of the common inhalant allergens tested.

Nine of the subjects worked with sanded doll parts in or near the sanding room (e.g., sanding, stringing, painting). Two of the nine, including the patient, had a history of atopy manifesting as seasonal allergic rhinitis. These two reported symptoms of flushing, nose and eye symptoms, and wheezing when exposed to sanded doll parts

TABLE II. Subjects experiencing symptoms when working with sanded doll parts

Worker	Age (yr)	Sex	Job	Duration of employment	History of atopy	Symptoms from dust or sanded parts	Skin tests				Disposition
							Rw	G	D	L	
1*	24	F	Stringing	3 yr	Yes	Asthma, flushing, nose and eyes	4+	4+	4+	4+	Moved to office job; now lost to follow-up.
2	28	M	Sanding	3 yr	Yes	Asthma, flushing, nose and eyes	3+	4+	4+	4+	Had recently moved to shipping depart- ment because of symptoms; now free of symptoms.
3	25	M	Painting	3 yr	No	Itchy hands	—	—	—	—	Continues to work as painter without rash, conjunctivitis, or respiratory symptoms.

Rw, Ragweed; G, grass mix; D, house dust mite mix; L, raw latex extract.

*Patient.

and pruritus when touching rubber products outside the workplace. Both of these workers had significant wheal and flare reactions to latex and to all three common aeroallergens as determined by skin prick testing (Table II). The seven workers without a history of atopy had negative prick skin test responses to latex and to the common aeroallergens. One of these seven reported symptoms limited to itchy hands without swelling or rash.

DISCUSSION

Most IgE-mediated allergic reactions to latex described in the occupational setting have been attributed to direct contact of skin or mucous membranes with latex products.^{5, 6} Occupational asthma caused by inspired particles of airborne latex has been described much less frequently and, specifically, in the setting of the use or manufacture of rubber gloves.¹⁻³ In these reports latex protein was believed to be made airborne by adherence to glove powder.⁴ Our report describes occupational asthma caused by the inhalation of latex proteins made airborne by the sanding of objects. Recently, one of the authors evaluated another patient complaining of work-related wheezing and rhinorrhea whose job involved grinding latex molding on industrial machinery. This patient had a positive skin prick test response to raw latex extract. Grinding or sanding of latex objects occurs in diverse occupational settings unrelated to health care and may induce

IgE-mediated occupational asthma in a broad range of susceptible workers.

Prior reports of allergic occupational asthma caused by airborne latex allergens from latex gloves do not describe the severe and immediate bronchospasm, which was reported by our doll factory worker and confirmed by occupational challenge in the work setting. These prior reports used peak flow monitoring over a period of days to demonstrate airway obstruction related to work exposure as patients continued to perform in the work environment. Although speculative, it may be that the difference in severity of allergen-induced asthma between the prior studies and this report is related to a difference in concentration of airborne latex particles in the work area. In one of these prior studies, air sampling for total dust showed average work area concentrations from 0.4 mg/m³ to 5.5 mg/m³, but this was known to be primarily glove powder (cornstarch), which is not a significant allergen.⁷ The authors concluded that the airborne cornstarch was carrying some adsorbed latex protein transferred from the latex gloves.

Air sampling for total dust in our study revealed an average concentration of 1.83 mg/m³ in the sanding room and 0.78 mg/m³ in the stringing room. Total dust concentrations include both respirable particles, which could be expected to cause asthma, and larger nonrespirable particles, which could induce rhinitis and conjunctivitis. Most of this dust was probably composed of

airborne latex particles, hence the gradient in ambient concentration from sanding room to stringing room. In an occupational setting where sanding or grinding of latex objects occurs, asthma caused by latex allergy may be acute and life-threatening.

Our study seems to confirm previous observations that atopic subjects are prone to latex hypersensitivity⁸ because the two doll factory workers with occupational latex allergy were the only workers with a history of atopy and multiple positive skin test responses to common aeroallergens. The prevalence of type I latex allergy among workers in this latex doll factory was 9% (2 of 22). The prevalence of type I latex allergy among 54 hospital-based surgeons was recently reported as 7.4%.⁹ Although the number of workers in our study is relatively small, the risk of occupational sensitization to latex appears to be at least as high as that for health care workers with long-term latex glove exposure.

REFERENCES

1. Tarlo SM, Wong L, Roos J, et al. Occupational asthma caused by latex in a surgical glove manufacturing plant. *J ALLERGY CLIN IMMUNOL* 1990;85:626-31.
2. Marcos C, Lazaro M, Fraj J, et al. Occupational asthma due to latex surgical gloves. *Ann Allergy* 1991;67:319-23.
3. Baur X, Jaeger D. Airborne antigens from latex gloves. *Lancet* 1990;335:912.
4. Beezhold D, Beck WC. Surgical glove powders bind latex antigens. *Arch Surg* 1992;127:1354-7.
5. Slater JE. Allergic reactions to natural rubber. *Ann Allergy* 1992;68:203-11.
6. Hamann C. Natural rubber latex protein sensitivity in review. *Am J Contact Dermatitis* 1993;4:4-21.
7. Jaeger D, Kleinhaus D, Czuppon AB, et al. Latex-specific proteins causing immediate-type cutaneous, nasal, bronchial and systemic reactions. *J ALLERGY CLIN IMMUNOL* 1992;89:759-68.
8. Sussman GL, Tarlo SM, Dolovich J. The spectrum of IgE mediated responses to latex. *JAMA* 1991;265:2844-7.
9. Turjanmaa K. Incidence of immediate allergy to latex gloves in hospital personnel. *Contact Dermatitis* 1987;17:270-5.

1-800-55-MOSBY

This number links you to the full text of literally every article ever published in Mosby journals. **MOSBY Document Express[™]**, a rapid response information retrieval service, provides quick turnaround, 24-hour availability, and speedy delivery methods. For inquiries and pricing information, call our toll-free, 24-hour order line: 1-800-55-MOSBY; outside the U.S.: 415-259-5046; fax: 415-259-4019; E-mail: mosbyexp@class.org.

MOSBY Document Express[™] is offered in cooperation with Dynamic Information Corp.