

A Review of Natural-Rubber Latex Allergy in Health Care Workers

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This brief review of natural-rubber latex (NRL) allergy in health care workers (HCWs) includes the definition of NRL allergy and data on its epidemiology, pathogenesis, diagnostic algorithm, management, long-term outcomes, economic impact, cost-effectiveness of changing facilities to a latex-free environment, and prevention. The data presented suggest that an individual with type I or type IV hypersensitivity to NRL should be able to continue to work in the workplace with careful evaluation and reasonable accommodations. Reducing exposure to latex is a safe and more economical alternative to complete removal of the individual from the place of employment. The use of low-allergen, nonpowdered NRL gloves substantially reduces airborne exposure to latex in most health care settings.

Latex use has been documented as early as 1600 B.C. [1]. Although an initial report suggesting immediate-type hypersensitivity was published in 1927 [2], the first clear description of immediate-type hypersensitivity was not published until 1979 [3]. This case involved a woman with a history of chronic atopic dermatitis who presented with pruritus of the hands 5 min after putting on rubber gloves [3]. When tested by the skin prick method, she demonstrated an immediate wheal with a rubber glove extract, whereas 4 control subjects did not react to similar testing [3].

In the late 1980s and early 1990s, there was a dramatic increase in the recognition of latex sensitivity, coinciding with increased use of latex gloves in response to concern regarding AIDS. The directive to implement universal precautions in 1987 by the Centers for Disease Control and Prevention contributed to this increase in glove use [4]. Several theories have been postulated to explain this increase in natural-rubber latex (NRL) sensitivity; however, scientific data are not available to substantiate any of these theories [4].

The latex epidemic hit its peak in the mid-1990s. Since then, the apparent prevalence of latex allergy has been steadily de-

creasing. Two studies have shown a dramatic decrease in the prevalence of latex allergy after switching to low-allergen, powder-free latex gloves [5, 6]. A study of 7 German university hospitals noted that, since 1998, there has been a steady decrease in the prevalence of skin latex allergy, from 68 to 21 cases per 100,000 health care workers (HCWs) [5]. They observed a 2-year lag after a gradual switch from powdered NRL gloves to low-allergen, nonpowdered NRL gloves [5]. A study from the Mayo Clinic (Rochester, MN) showed that, since 1993, there was a similar decrease in the incidence of latex allergy, from 150 to 27 cases per 100,000 HCWs per year [6].

Latex gloves are associated with 3 types of adverse reactions: irritant contact dermatitis, immediate-type (type I) allergic reactions, and allergic contact dermatitis (type IV or delayed-type hypersensitivity reactions) [7]. These 3 adverse reactions are compared in table 1.

This brief review will be limited to discussion of NRL allergy involving HCWs. Please refer to articles [7–10] for information about NRL allergy in the general population.

EPIDEMIOLOGY

Among HCWs, the reported prevalence of NRL immediate-type (type I) sensitivity has varied between 2.9% and 12.1% [8], and the annual incidence of sensitization has been between 1% and 2.5% [11]. The prevalence of occupational rhinoconjunctivitis with NRL glove exposure is reported as ranging from 1.2% to 16.3%, whereas the prevalence of occupational

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asthma is reported to be as high as 6.8% [12]. Latex-allergic HCWs who carefully avoid latex exposure have been observed to gradually lose their sensitivity [13, 14].

In one study of 39 HCWs, delayed-type allergy accounted for 82% of occupational latex allergies, whereas immediate-type latex allergy accounted for 33% [15]; these results suggest that type IV hypersensitivity is more common among HCWs and that some HCWs experience both type I and type IV hypersensitivity reactions. There are fewer published studies concerning the prevalence of type IV hypersensitivity versus type I hypersensitivity to latex [7]; our review of the recent medical literature did not produce prevalence figures for type IV latex allergy among HCWs.

PATHOGENESIS

For HCWs, there are numerous potential routes of exposure to NRL allergens. Skin exposure may occur from direct contact with many NRL products, such as latex gloves. Inhalational exposure may occur when aerosolized glove powder coated with NRL allergens comes into contact with the mucous membranes of the nose, throat, and airways of the lung [8].

An increased risk of sensitization to NRL has been well documented with certain conditions and risk factors, including spina bifida, multiple surgeries, history of atopy, and some food allergies [8]. A history of atopy is a risk factor, especially a history of hand dermatitis [8, 16]. Increased risk of latex allergy has also been associated with a history of sensitization to foods, such as kiwi, banana, chestnut, avocado, apple, potato, tomato, and papaya [7, 8].

Even though it may seem intuitive that HCWs would be at a higher risk of becoming sensitized to NRL because of latex glove use, significant controversy exists regarding the exposure-response relationships between HCWs and sensitization to NRL [8]. A systematic review of 15 studies did not support the assumption that HCWs are at an increased risk of latex sensitization, compared with other occupations in the United States [11]. However, a recent Canadian cohort study of 769 apprentices who were training in the fields of animal health technology, pastry-making, and dental hygiene found that the dental hygiene students had greater NRL exposure and higher NRL sensitization rates than did the other apprentices [17]. This study strongly suggested that increasing exposure increases the risk of sensitization to latex [8].

DIAGNOSIS

The diagnostic approach for latex allergy starts with obtaining a detailed clinical history, including the history of risk factors and the temporal relationship between exposure to NRL products and the symptoms [16]. If immediate type I hypersensi-

tivity is strongly suggested by the history, a confirmatory test is performed with either an epicutaneous allergen skin test or an anti-latex IgE serologic test [16]. Allergen skin testing provides higher sensitivity and specificity (94% and 98%, respectively) than does anti-latex IgE serologic testing (77% and 91%, respectively) [16]; however, at the time of this article's submission, no latex reagent for allergen skin testing had received regulatory approval by the US Food and Drug Administration [16]. If delayed type IV hypersensitivity is suggested by the history, patch testing is done to confirm the presence of sensitization to rubber chemicals [16]. To clinically diagnose type I or type IV latex allergy, the individual's clinical history and the confirmatory *in vivo* and/or *in vitro* laboratory test results must be carefully considered [16].

There are pitfalls in the diagnosis of type I latex allergy. Because a standardized latex extract has not been approved in the United States, some allergists have elected to make their own extract using latex gloves [16]. This may result in varying amounts of allergen in each extract, as well as the inclusion of other chemicals, producing both false-positive and false-negative reactions. Other physicians choose to perform anti-latex IgE antibody serologic tests only for patients with a convincing history. However, serologic tests for latex-specific IgE have sensitivities of ~70%–80% [16]; therefore, 20%–30% of latex-allergic patients may test negative. Misdiagnoses may also result from over-reliance on the clinical history alone and failure to perform objective tests [18].

If an HCW has a clinical history highly consistent with latex allergy but all results of objective tests are negative, then challenge testing may be considered. Three different methods of *in vivo* provocation testing has been reported: (1) environmental exposure, (2) glove use test (finger or glove, with or without preceding skin puncture), and (3) inhalation challenge [16]. However, there may be discrepancies in challenge test results, and no challenge method has become broadly accepted by clinicians. If all results of tests for latex allergy are negative while the clinical history is highly suggestive of such an allergy, we would first recommend carefully reconsidering alternative diagnoses. If latex allergy is still the most probable diagnosis after other diagnoses have been considered, we would consider the individual to be allergic to latex, for maximum safety. Unfortunately, this position can be difficult to defend if litigation ensues.

MANAGEMENT

A stepwise approach to treating latex-allergic HCWs is crucial. Bernstein [19] has recommended the following approach: (1) use validated methods and confirm the diagnosis of NRL allergy, (2) justify modification of exposure, (3) determine whether there is impairment or disability due to NRL allergy,

(4) advise the employer and risk manager of their responsibility for instituting environmental interventions, and (5) if accommodation efforts are unsuccessful, advise the individual to seek workers' compensation benefits and rehabilitation. The Americans with Disabilities Act states that the employer must make reasonable accommodations for an impaired employee [19].

Studies have shown that economically feasible interventions to reduce NRL exposure can successfully allow latex-allergic individuals to continue working [6, 19, 20]. Several years after institution of low-allergen or nonlatex gloves in the work environment, Turjanmaa et al. [20] reexamined 160 Finnish HCWs with documented NRL allergy. None of the HCWs changed their work activities, and the prevalence of hand eczema decreased from 54% to 38%, which was statistically significant [20]. Hunt et al. [6] concurred in their follow-up of Mayo Clinic workers after the institution of use of gloves with low or undetectable NRL allergen at the work site. These steps reduced the concentration of allergen in the work site, allowed most HCWs to remain on the job, and decreased the number of new cases of occupational latex allergy [6]. Furthermore, in a recent Belgian study of occupational asthma, 36 HCWs with reduced exposure to NRL had an improvement in asthma severity scores similar to that of workers who had been completely removed from latex exposure [21]. The complete cessation of exposure was associated with a greater rate of asthma-related disability and loss of income; therefore, reduction of exposure to latex is a safe and more economical alternative to complete removal from the workplace [21].

Allmers et al. [13] noted a decrease in anti-latex IgE antibody levels in HCWs who had avoided powdered latex gloves for 12 months. Hamilton et al. [14] concurred with these results, although they observed that >15 months of avoidance was necessary to reduce latex sensitization, as measured by anti-latex IgE antibody levels or latex allergen skin test results. Even though latex sensitization may be reduced by avoidance measures for these HCWs, there is a risk of resensitization with reexposure to NRL [14].

GLOVES AS PREVENTATIVE BARRIERS

There are clinical advantages to using latex gloves. Compared with vinyl gloves, latex gloves have been noted to have lower rates of perforation and better strength, elasticity, tactile sensitivity, comfort, fit, barrier properties, and durability [22, 23]. Vinyl gloves have a much higher viral leakage rate than do latex gloves, including a higher rate of failure to protect against herpes simplex virus type I [24, 25]. Latex gloves are biodegradable and do not produce hazardous and toxic emissions when incinerated, as do synthetic gloves [23]. Even though synthetic gloves may be free of protein, there are reports of contact urticaria (type I) with the vinyl and nitriles [23, 26, 27] and

contact dermatitis (type IV) with the residual chemicals found in these gloves [23, 28]. Unfortunately, neither type of glove can protect against needlestick or penetrating sharp injuries [22].

Glove manufacturers have taken steps to improve NRL glove quality and to lower the NRL gloves' sensitization potential. Malaysia has developed a program in which gloves are certified to provide an effective barrier and a minimum risk of developing latex allergy [23]. Improvements in glove manufacturing include the use of low-protein latices, "precure" and "postcure" leaching (washing) protocols, and chemical or enzymatic deproteinization [23]. Powder-free gloves are lubricated with a polymer coating, and tackiness is reduced by the process of chlorination [23].

COST-EFFECTIVENESS

Disability costs associated with NRL allergy can be large. Tyler [18] reports that the average cost of lost work time due to disability from latex allergy was \$38,077 per case in 1996 in a Michigan health care organization; during the same year, the average cost of nonlost time associated with latex allergy was \$219 per case. "Lost work time" in this study was defined as missing ≥ 8 days of work, and "nonlost time" referred only to medical expenses paid. A protocol involving the diagnosis and management of NRL allergy was implemented in Michigan, which resulted in the reduction of the average cost of lost time to \$4298; the average cost of nonlost time was slightly increased, to \$692, which was due to the cost of tests confirming the diagnosis [18]. In Minnesota, a study of all workers' compensation indemnity claims in 10 years for NRL allergy revealed an average cost per claim of \$7580, with 69.2% of claims being for less than \$1000 [29]. However, not all HCWs experiencing a latex allergic reaction file a workers' compensation claim [29].

Is it cost-effective for a health care facility to switch to latex-free gloves? Phillips et al. [30] did a cost analysis in Georgia in 1999 of 3 types of medical care settings: a tertiary care hospital, a community hospital, and a large internal medicine clinic. According to their estimates, the annual cost of switching to latex-free gloves was \$515,789, \$117,468, and \$48 per facility, respectively [30]. Estimates for wage replacement benefits for permanent total disability were estimated at the maximum weekly wage of \$300 for 400 weeks; similarly, permanent partial disability was estimated at the maximum weekly wage of \$192.50 for 350 weeks [30]. If >1% of workers become fully disabled, or if >2% become partially disabled, these authors conclude that it would be cost-effective for a tertiary-care facility to switch to latex-free gloves [30]. Horwitz et al. note that these cost estimates assume that a claimant would seek the maximum amount for permanent partial and permanent total disabilities; however, in Minnesota, this was not observed

Table 1. Characteristics of irritant contact dermatitis and type I and type IV hypersensitivity reactions associated with natural rubber latex gloves.

Variable	Irritant contact dermatitis	Type I hypersensitivity reaction	Type IV hypersensitivity reaction
Etiology	Occlusion, maceration	IgE-mediated	T-cell mediated
Requires previous sensitization	No	Yes	Yes
Onset of reaction	Gradual	Acute: usually within 30 min	Subacute/delayed: usually 24–48 h after exposure but can be from 8 h to 5 days
Characteristics	Dryness, scaling, cracking, and erythema of the hands	Urticaria, angioedema, pruritis, allergic rhinitis, asthma, and anaphylaxis	Erythema, scaling, and vesiculation
Triggers and exacerbants	Frequent hand washing, contact with harsh chemicals, and cold winter weather	Proteins within the natural rubber latex	Chemicals such as accelerators and antioxidants
Location of reaction	Localized	Localized or generalized	Localized

because none of the claimants were permanently disabled [29]. Furthermore, Horwitz et al. [29] noted that the costs associated with latex reactions were minimal, the number of lost workdays was low, and the severity of reactions was minimal. However, Bonauto et al. [31] noted that the study by Horwitz et al. [29] contained numerous limitations, including an underestimation of the number of latex-allergic HCWs that resulted from underreporting, inaccuracies in identifying the number of latex allergic workers, and the potential for overestimation of the number of HCWs. In an alternative to switching to completely latex-free gloves, the Mayo Clinic reported a cost saving of \$200,000 per year with a switch to low-allergen, powder-free latex gloves [6]; similarly, a Canadian teaching hospital in Ontario reported no increase in cost with this approach as a result of consolidated glove purchases [32].

GUIDELINES FOR MANAGEMENT AND PREVENTION

For HCWs whose medical history and diagnostic tests results produce a high suspicion of latex allergy, preventative measures have focused on creating a “latex-safe environment.” (We prefer the term “latex-safe” to the term “latex-free,” because it may be impossible to make a health care environment latex free.) As part of an overall effort to reduce latex allergy, latex gloves should only be used when indicated [33, 34]. Accepted guidelines include the following recommendations: (1) NRL gloves should be used only when prudent under universal precaution standards (i.e., NRL gloves should not be used in low-risk situations, such as those involving food handlers, housekeeping, and transport personnel); (2) low-allergen, nonpowdered NRL gloves should be used (this will reduce sensitization to latex, reduce the occurrence of reactions for sensitized individuals, and reduce NRL aeroallergen levels), and (3) nonpowdered sterile NRL gloves are preferred in situations that require sterile

gloves, but low-protein, powdered, sterile NRL gloves may be used in conjunction with ongoing assessment of allergic reactions [33, 34]. Powder-free gloves lack the lubrication provided by powder, but the manufacturing steps mentioned previously make them an acceptable option in the operating room [23]. Nonlatex gloves should be used by HCWs sensitized to NRL [13, 14].

In a “latex-free” environment, all products containing any NRL must be removed. In a “latex-safe” environment, NRL may be present, such as the low-allergen, nonpowdered NRL gloves mentioned above. In a latex-safe environment, all NRL objects that could come into contact with mucosa and non-intact skin should be removed or covered [7]. Products made of dry, molded, or extruded rubber, such as wheelchair tires, tool handles, rubber seals, vial stoppers, and syringe plungers, do not need to be removed, because they contain much less allergen than do items that were manufactured with the “dipping” method. “Dipped” items include gloves, condoms, and balloons that are formed by dipping forms into liquid latex [7, 23, 35]. HCWs with NRL sensitivity are not at an increased risk when incidentally exposed to dry, molded, or extruded rubber products in the health care environment; however, if direct contact with such objects is routine, direct exposure should be minimized by covering the object or exposed body part [7]. Because NRL gloves remain the primary source of latex allergen exposure in the health care environment, the latex glove use guidelines mentioned above should be followed by all HCWs [33, 34].

CONCLUSIONS

With careful evaluation and reasonable accommodations, an HCW with a type I hypersensitivity to NRL should be able to continue in the workplace. Reduction of exposure to latex is a safe and more economical alternative to complete removal from

the place of employment. Low-allergen, nonpowdered NRL gloves should be used whenever possible.

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