Latex allergy and its implications for the Australian Defence Force

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Abstract

- Latex allergy is a type I immediate hypersensitivity reaction to particular latex proteins in natural rubber latex. It must be differentiated from irritant dermatitis (not allergic) and allergic contact dermatitis (a type IV delayed hypersensitivity reaction).
- In the general, non-atopic population, the prevalence of latex allergy may be less than 1%, but in healthcare workers may be as high as 30%, and in some patient groups as high as 65%.
- Clinical features of latex allergy range from urticaria, rhinoconjunctivitis and asthma to anaphylaxis. A suggestive history must be complemented with appropriate investigations to confirm the diagnosis.
- A diagnosis of latex allergy would preclude entry to the Australian Defence Force (ADF) and might lead to discharge of a serving member.
- A change from powdered to powder-free latex gloves is an effective initial action in addressing the problem at an organisational level. Non-latex gloves should be available if needed.
- It is possible for the ADF to provide a latex-safe environment, but only under certain non-operational conditions.

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THE FAMED AMERICAN SURGEON William Halsted requested the Goodyear Tyre Company to make the first pair of rubber gloves in 1890.[1] The first case of an immediate type reaction to natural rubber latex (NRL; see Box 1) was described in 1927, and was provoked by a rubber dental prosthesis.[5] NRL gloves were first held responsible by Nutter in 1979, with a report of contact urticaria.[6] The introduction of universal precautions (now standard precautions) in 1987[7] coincided with a rapid increase in the number of reported reactions, and in 1991 the United States Food and Drug Administration published a bulletin outlining the risks of anaphylaxis with NRL items.[8] Multiple reports have recorded the occupational prevalence of latex hypersensitivity and allergy and a variety of instruments have been used for assessment.[9]

Latex allergy affects a significant number of the general population and it is unarguable that some members of the ADF will be affected, either knowingly or unknowingly.

Allied clinical states

In the clinical setting, failure to differentiate irritant dermatitis and allergic contact dermatitis from latex allergy can result in unnecessary anxiety, activity, delay and expense, and could have serious adverse consequences. In the United Kingdom, in a large cohort of National Health Service staff, 43% had signs or symptoms of irritant dermatitis or allergic contact dermatitis, and 10% showed latex hypersensitivity.[10]

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Irritant dermatitis

Irritant dermatitis is a non-allergic skin rash. The irritant may be any of the many different chemicals present in the natural latex rubber product — nearly 200 have been identified.[11] The most common presentation is as a dryness or cracking of the skin, with red, itchy areas when exposed to latex products (Box 2). The condition tends to be chronic, although symptoms are relieved during periods of non-exposure to latex. Incomplete hand washing/drying, the use of soaps, hand cleansers, sanitisers and glove powder may be contributory factors. Hand dermatitis disrupts the skin barrier and may predispose to the development of latex allergy.[12]

1: Terminology

"Latex" is a term that has a variety of meanings. The milk sap of the tree *Hevea brasiliensis* is natural latex. Natural rubber latex (NRL) is the material produced from natural latex by a complex industrial coagulation process involving the addition of sulfur and organic chemicals. It has the desirable characteristics of strength, elasticity, thermostability and dimensional stability. In this article, "latex" refers to NRL.

"Powder-free" or "non-powdered" means no powder or up to 2 mg of powder per glove.[2]

"Latex-safe" describes an environment in which an allergic reaction to NRL is unlikely. Such an area may not necessarily be latex-free, but NRL exposure is minimal. "Latex-free" describes an area or object having no NRL component.[3,4]

Certain paints are described as being "latex" paints. Synthetic rubber is produced from petrochemicals and is distinct from NRL. These have no clinical significance in this context.

Allergic contact dermatitis

Allergic contact dermatitis (loosely termed "rubber allergy") is a type IV delayed hypersensitivity reaction. The mechanism is cell-mediated. It is not generally a response to the latex protein, but rather to chemical agents used in the NRL manufacturing process. The reaction usually occurs 6–48 hours after contact with latex gloves. Assessment is based on patch testing: small amounts of the suspected allergen are applied to the skin and the area is observed for any reaction. The cutaneous features of allergic contact dermatitis include burning pain, pruritus, oedema, erythema, maculopapular rash, vesicles and cracking of the skin (Box 3). This condition can become chronic with continued exposure, and is the predominant immunological response to latex.[13]

The nature of latex allergy

Pathophysiology

Latex allergy is a manifestation of a type I immediate hypersensitivity reaction to particular latex proteins in NRL.[9] About 200 different protein polypeptides have been identified in NRL, with more than 50 proving to be potentially antigenic.[14,15] This reaction is mediated by immunoglobulin E (IgE), and produces both localised and systemic symptoms. These often develop in minutes, depending on the route of absorption and dose of allergen.

Prevalence

Although the use of rubber gloves for surgical procedures was introduced in medicine more than 100 years ago and there were early reports of latex sensitivity, such reports remained uncommon until the 1980s. In 1987, the US Centers for Disease Control and Prevention mandated the use of personal protective equipment if personnel were likely to have contact with blood or bodily fluids.[7] These guidelines required healthcare workers to don gloves for a large part of their working day to prevent infection. Glove use increased eightfold in 1 year. Many glove manufacturers expanded production rapidly and may have distributed gloves with high levels of latex allergens. Inexperienced glove manufacturers produced poorly compounded, inadequately leached products.[9] Between 1987 and 1989, the Malaysian Rubber Development Board received more than 400 applications to form glove manufacturing companies, where previously only 25 had existed.[16] With a combination of high antigen concentration, poor hand care technique and markedly increased exposure and better diagnostic methods, the necessary factors for an increase in the prevalence of latex allergy were present.[17]

The prevalence of latex sensitisation and latex allergy varies depending on populations studied and the methods of testing used (Box 4).

As early as 1987, it was reported from Finland that "In operating units, 7.4% of the doctors and 5.6% of the nurses were allergic".[28] If symptomatic healthcare workers are assessed the prevalence is higher,[9,29,30] while in patients with spina bifida the sensitisation rate has been reported at 64.5%.[31]

Being female increases the incidence of latex sensitivity. Tomazic and co-workers found a female : male ratio of 3 : 1 in a review of 145 cases of latex-induced systemic allergic reactions. Both occupational and hormonal factors may be involved.[32] Other populations with high prevalence include blood donors[33] and latex industry workers.

Risk factors

Atopy

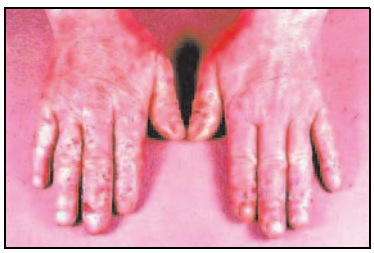
An individual with a predisposition to allergy is thought to be at greater risk of developing latex allergy.[34,35] One study has reported that 34/44 individuals with latex allergy had a history of atopic illness,[36] and another reported that nine out of nine individuals who tested positive to latex skin testing were atopic and reacted to at least one other common allergen.[24]

Cross-allergies

NRL is derived from a plant protein. Cross-reactivity with other plants has been reported, including food products.[37] An increasing list of cross-reactive foods includes bananas, avocados, kiwifruit, strawberries, watermelon, chestnuts, peaches, cherries, apricots, apples, plums, tomatoes, potatoes,

2: Irritant dermatitis caused by exposure to latex

3: Allergic contact dermatitis



This is a type IV delayed hypersensitivity

4: Prevalence of latex allergy

Australia

One study found a 9% prevalence of latex hypersensitivity among dental workers in a Sydney dental school;[18] another reported 5.2%–14.7% incidence in first responders.[19] Both studies used the same validated questionnaire. The inherent properties of this questionnaire (sensitivity 0.58; specificity 0.94; positive predictive value 0.18; negative predictive value 0.99) and, in the latter study, a low response rate, must be considered. It was reliable for identifying people at low risk but overestimated those at risk of true latex allergy.[20] In one Australian hospital, it was concluded that IgE-mediated hypersensitivity to latex was common among nurses.[21]

In Australian children and adolescents with spinal cord dysfunction, 15.4% had a history of latex allergy and 36.9% were latex-specific IgE-positive.[22]

Canada

12.1% prevalence of latex sensitisation among latex glove users in a Canadian hospital.[23]

Hong Kong

6.8% prevalence of skin test positivity to latex extract among healthcare workers in a large teaching hospital.[24]

North America

Reported rates of latex allergy of less than 1% in general population,[25,26] but up to 30% among healthcare workers.[27]

coconuts, pawpaw and figs. This cross-reactivity has been labelled the "latex-fruit" syndrome.[38,39]

Multiple surgical procedures

Individuals who have undergone multiple operations are at high risk of sensitisation due to cumulative exposure to latex products.[31] Intraoperative anaphylaxis without prior evidence of allergy has been reported in this group.[40]

Exposure, sensitisation and provocation

Exposure, with subsequent sensitisation and later provocation, may occur by:[41]

- Direct skin contact with a range of medical or non-medical latex-containing products;
- Inhalation of airborne latex proteins;
- Exposure of mucosal or serosal surfaces to medical products such as rubber catheters or gloves.

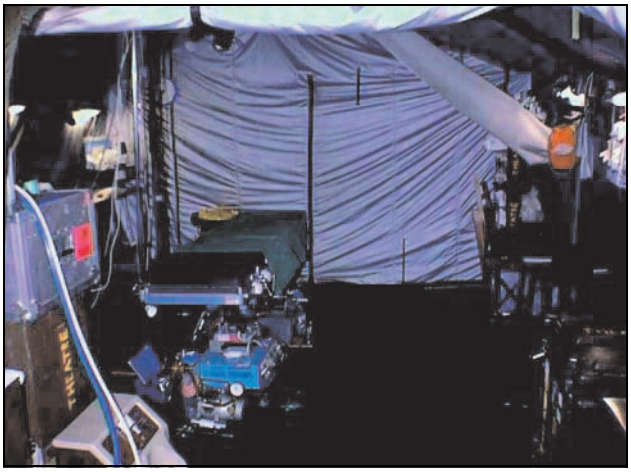
Although the amount of exposure needed to cause sensitisation or symptoms is not known, studies indicate that the higher the overall exposure in a population, the greater the likelihood that more individuals will become sensitised.[42] The use of powdered gloves with high levels of residual latex proteins is thought likely to be responsible for the increase in type I hypersensitivity to latex.[43] The proteins responsible for latex allergy adhere to the powder that is used in some gloves. Subsequently, a combination of high antigen load, sweating within the glove and absorption may lead to increased sensitisation. As the gloves are donned or removed, powder particles with adherent latex protein become airborne and may be inhaled, coming into direct contact with the mucosa of the respiratory tract.[44-46] This can be very significant in a confined space, but probably less so in the context of an army "medic" in the field. Exposure to NRL aeroallergens alone may not be sufficient to cause sensitisation.[47]

Latex may also be encountered rarely in activities as innocent as exposure to air expelled from a "whoopee cushion"[48] and to food prepared by someone wearing latex gloves.[49]

Clinical features

The manifestations of a type I hypersensitivity reaction often relate to the type of exposure. Most severe reactions to latex have resulted from latex products contacting the mucous membranes of the mouth, vagina, rectum, or urethra. Oral mucosal contact has resulted in a large number of reactions to various products used in dentistry.[50] Signs and symptoms may include rhinitis, conjunctivitis, coughing, swelling around the mouth or throat, wheezing, tachycardia, hypotension, feeling faint, loss of consciousness, and anaphylaxis with cardiopulmonary arrest.[12,50] Healthcare workers may feel well at the beginning of a work period and then deteriorate towards the end of the period.

5: Deployed surgical facility



A latex-free environment cannot be maintained in these conditions.

Skin exposure may result in itching and urticaria, and airborne material may produce ocular and respiratory symptoms.

Diagnosis

"A suggestive clinical history is necessary but not sufficient for a definitive diagnosis of IgE-dependent latex allergy" — even a thorough questionnaire will not identify all NRL-allergic patients and may falsely identify others.[51] Latex allergy may remain undiagnosed for years and the individual may be exposed to further latex with increasing sensitisation.

Diagnostic testing may include a skinprick test (SPT) or blood test for latex-specific IgE antibody (radioallergosorbent test; RAST). SPT is quick and inexpensive. The process involves pricking the skin through a drop of diluted antigen solution. There is no internationally standardised and validated extract for this purpose, but preparations are commercially available. Positive reactions are indicated by an itchy weal and flare and are measured against positive and negative controls. SPT sensitivity ranges from 70% to 98%, with specificity generally exceeding 95%.[51-53] Although there is potential for serious systemic reactions, the Mayo Clinic reported a 5-year retrospective series between January 1992 and June 1997 with a systemic reaction rate for NRL SPT of 228 per 100 000 skin tests.[54] In a review of English-language literature from 1979 to 1994, five anaphylactic episodes in this setting were noted.[55-57]

RAST is useful if positive, but a negative result does not exclude latex allergy. Such patients should have SPT and, if the result is still inconclusive, a carefully supervised challenge test may be necessary.[58]

A number of FDA-approved allergen-specific IgE serology tests have been assessed, with diagnostic sensitivities between 73.3% and 91.6% and specificities between 67.5% and 96.7%.[59-61]

Implications for the Australian Defence Force

Latex allergy has potentially far-reaching consequences for the Australian Defence Force (ADF) as an organisation and for individual members.

ADF policy development

Although the ADF has considerable documentation on latex, there is presently no policy relating to latex hypersensitivity. In December 2000, NSW Health published Circular 2000/99 ("Policy framework and guidelines for the prevention and management of latex allergy").[3] To date, these are the only published guidelines in Australia. They follow the same principles that have been introduced in most states in the US, Canada and the United Kingdom.

In developing ADF policy, the following should be considered:

- The provision of low-protein, powder-free latex gloves;
- The provision of non-latex gloves for sensitised individuals and those who wish to choose a latex alternative;
- The reduction of latex glove use in non-clinical areas;
- The provision of education/training programs and material; and
- The periodic screening of high-risk workers for latex allergy symptoms.

Economic implications

The sensitisation of an ADF member may directly affect that member by way of loss of income or a decreased earning capacity and incur compensation costs. Latex allergy may necessitate a career modification or change,[62] or even be classified as a permanent disability.

For the ADF, costs may arise from adverse treatment outcomes, medicolegal issues with compensation pay-outs, changes in protocols for the treatment of sensitised individuals and changes required to minimise latex allergy sensitisation and reactions, together with the provision of relevant materials, equipment and facilities.[63] Manufacturers incur costs as they try to eliminate latex proteins from their products through research and development. These costs are often passed on to the consumers.[64]

Personnel management implications

Fitness for enlistment or appointment

The possibility of latex allergy should be considered at the time of enlistment or appointment, but there is no specific mention of the condition in the ADF *Recruit medical examination procedure*.[65] This document allows discretion and applies basic principles in decision making with reference to unlisted conditions. Nevertheless, a history of repeated attacks of urticaria or other skin rashes of an allergic nature, particularly when associated with hay fever, asthma or other types of allergic illnesses, is regarded as rendering an applicant permanently unfit for service.

Fitness for duty

Latex allergy excludes a member from deployment into any area remote from a major operating facility, as the requirements of a latex-safe environment cannot be met in a tactical setting (Box 5). It precludes the involvement of that person in areas and procedures associated with potential latex exposure.

The statement "The member is primarily enlisted as a warrior and secondarily for their specialist skills" is pivotal.[65] Accordingly, known sufferers are unfit for enlistment in the ADF, and, if the allergy should develop during service, medical discharge may be initiated. In the US Army, this is reflected in Army Regulation 40-501[66] (latex allergy renders the soldier worldwide nondeployable), but Reese et al also argue that "Accommodation can easily be made for the vast majority of active duty healthcare workers or those who may be at high risk for becoming allergic to NRL with no risk to the mission."

In a non-defence, civilian setting, most latex-sensitive healthcare workers can stay in their healthcare profession if exposure is avoided by eliminating powdered latex gloves and supplying latex-free materials.[67,68]

Occupational health and safety

Personnel involved in areas associated with latex exposure should be advised of recommendations in line with those from the National Institute for Occupational Safety and Health.[69] To provide a latex-safe workplace, either low-protein, powder-free NRL products or non-latex products should be considered. Army commanders are constantly reminded of the requirements of the *Occupational Health and Safety (Commonwealth Employment) Act 1991* (Cwlth).

Identification of affected personnel

Personnel identified as having latex allergy should wear a warning device (eg, "Medicalert" bracelet) at all times. They should be appropriately advised on implications for their employment. Those initiating emergency care should look for such warning devices.

Hand washing

Appropriate hand-washing facilities should be available in patient and casualty care areas, and handcare, washing and drying techniques should be taught and practised by all personnel involved in patient and casualty care.

Elective surgery

No operations should be performed on personnel with latex allergy other than in a facility with an established latex-safe protocol. Appendix E of NSW Health Department Circular 2000/99[3] addresses the management of people with latex allergy within the hospital environment and specifically in the operating suite.

Material management implications

Glove use and type

In accordance with the concept and practice of standard precautions, protective gloves should be used as appropriate. Powder-free latex gloves should be provided as the standard for both sterile and non-sterile procedures associated with patient or casualty care when contact with infectious material is expected. In other circumstances, non-latex gloves (eg, Vinyl) should be encouraged; this includes during oral, vaginal or rectal examinations.

For reducing aeroallergen levels, the use of powder-free gloves is more effective than the use of a laminar-flow glove-changing station.[70] In one study comparing hospitals in different European countries, the use of powder-free latex gloves was associated with a lower prevalence of latex allergy.[68] A change from powdered to low-protein, powder-free NRL gloves within one institution was associated with a fall in hypersensitivity reactions from 15% to zero;[71] a similar action in another caused a fall in NRL aeroallergen levels,[68,72] and an ensuing decrease in latex-specific IgE antibody in sensitised staff members,[68] allowing them to continue working. In a third study, it was concluded that "Reduction of exposure to latex should be considered a reasonably safe alternative that is associated with fewer socioeconomic consequences than removal from exposure".[74] After surveying a dental faculty in 1995, and again in 2000, the results suggested that such a change had had a preventive effect on NRL allergy.[75]

Available alternative gloves

Accepting the possibility of an occasional encounter with latex allergy in either treating personnel or those being treated, a small number of acrylonitrile butadiene polymer (Nitrile) gloves ought to be available at each facility.

Glove substitution

As gloves are the single major source of latex exposure in the healthcare setting, a more radical proposal is that exposure control would be better achieved by removing latex gloves completely. Possible alternatives may be made of polyvinylchloride (Vinyl), an acrylonitrile butadiene polymer (Nitrile), polychloroprene (Neoprene) or a range of other materials. The physical properties and biological (bacterial and viral) permeability of these gloves are dependent on the characteristics of the base material. In a recent evaluation of synthetic gloves all the evaluated gloves offered adequate barrier protection (but their level of comfort varied considerably),[75] but it must be emphasised that, while intact gloves may be impermeable to transmissible viruses such as hepatitis B or C and human immunodeficiency virus, perforated gloves are not.[76] Most perforations are not apparent to medical personnel.[77]

It is to be noted that it was an objective of the NSW Department of Health to "eliminate the use of latex in NSW public health care facilities as far as possible by 2003".

Conclusion

Latex allergy is a defined clinical entity with an increasing prevalence in Western society. There are cogent arguments for the introduction of strategies to manage its effect on the individual, organisations and the community. The ADF is a large organisation with a declared commitment to occupational safety and health. While healthcare providers, recognising the medicolegal, occupational, financial and personal ramifications involving latex allergy, may choose to limit their workplace exposure by going latex-free,[63,66,78] the ADF has, by its mandate, such an indefinable, uncontrollable workplace that this is impossible. A latex-safe environment may be envisaged where practical, but even this will be challenging to achieve.

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Competing interests

Neither author has any financial relationship that might bias the content of this article. One of the authors is personally latex allergic. This results in an acute interest in the topic and may influence that author's perception of policy decisions, particularly with regard to suitability for ongoing service within the Australian Defence Force.

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