

Latex allergy

Occupational
aspects of
management

A national guideline



Royal College
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Setting higher medical standards

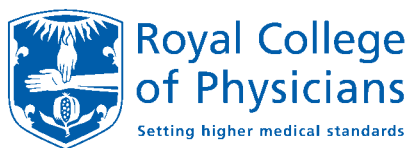
NHS
Plus

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2008



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Executive summary

About a quarter of the world's demand for elastic products is supplied by natural rubber derived from the *Hevea brasiliensis* tree. Natural rubber latex (NRL) from this tree is used in the production of numerous rubber products found at home and at work including gloves, balloons, adhesive tape and bandages, condoms and catheters, rubber bands, dental dams, tourniquets and resuscitation equipment.

Allergy to certain latex proteins emerged as an occupational disease in the 1980s and continues to be an important occupational health problem as natural rubber products are used increasingly worldwide, particularly in healthcare. Symptoms of the immediate type of allergy produced range from rash, itchy or runny eyes or nose, sneezing, and coughing to chest tightness, shortness of breath and anaphylactic shock. The symptoms experienced depend in part on the route of exposure, which can be by direct contact with skin or mucosa, or by inhalation.

Although there is a large body of research on latex allergy, few studies have examined occupational health interventions. This systematic review summarises current evidence and is intended to assist occupational health professionals, managers and other interested parties in providing advice on occupational health interventions to address the problem of latex allergy from both individual and institutional perspectives. The review is concerned particularly with issues relating to gloves, as these represent by far the main occupational use of latex. Latex allergy of the immediate type is distinguished in this review from contact dermatitis caused by delayed hypersensitivity (type IV allergy) to chemicals that are added to latex during processing. The main focus of this review is on type I or immediate-type allergy to latex proteins, which has a reported prevalence of up to 17% in certain occupational groups.

Key findings and recommendations

- The use of powder-free, low protein latex gloves as an alternative to powdered latex gloves significantly reduces the incidence of latex allergy and latex-induced asthma, as well as the prevalence of latex-related symptoms. Powdered latex gloves should therefore not be used in the workplace.
- At a national and local level, a policy that encourages switching from powdered latex gloves to powder-free low protein latex gloves is a proven effective method of reducing the incidence of latex allergy.
- Employees with latex allergy, latex sensitivity or latex-induced asthma should use non-latex gloves.
- In employees who are latex allergic/sensitised, taking latex avoidance measures results in cessation or diminution of symptoms. Markers of sensitisation decrease regardless of whether co-workers continue to use powder-free low protein latex gloves or latex-free gloves.
- In employees with latex-induced asthma or rhinitis, the use of powder-free low protein gloves by their colleagues reduces symptoms and indices of severity in the affected employee to a similar degree as the use of non-latex gloves by colleagues.

- All but the most severe cases of latex allergy and latex-induced asthma can be managed without the need for redeployment, ill health retirement or termination of employment. Adjustments include careful personal avoidance of latex at work and minor changes in the workplace.
- There is a lack of published primary research comparing occupational interventions for those who are sensitised to latex (without symptoms), with those with clinical latex allergy.
- No reports of new cases of latex allergy arising from non-powdered low protein latex glove use were found.

The evidence does not therefore support a complete ban on the use of latex gloves. Institutions should judge whether their needs would be met better by the use of latex-free or powder-free latex gloves, or use of both in different settings, while taking into account the desirable and undesirable properties of both materials.

1 Introduction

The aim of this review is to provide an evidence-based guideline on the management of latex allergy (LA) in the workplace. It is intended to assist occupational and other healthcare professionals, managers, employees and other interested parties in providing advice on the occupational aspects of the management of latex allergy, based on current evidence. Where evidence does not exist or is not robust, recommendations for further research are made. The review does not deal with issues surrounding the clinical diagnosis of latex allergy, nor is it intended to cover aspects of employers' legal obligations with respect to latex allergy in the workplace. For practical guidance on issues such as health surveillance, see the Health and Safety Executive's website (www.hse.gov.uk).

Use of the term 'latex' in the following text refers to natural rubber latex (NRL) and does not mean that all latex proteins are always allergenic.

Importance of latex allergy in an occupational health setting

Latex allergy imposes a public health burden with costs to the individual and the employer, as well as to the economy.

Impact on the allergic employee

Impact may be considered in terms of both physical and economic impairment. Individuals may experience discomfort, inconvenience and even life-threatening symptoms from latex allergy. There may be impact on their personal lives, eg inability to blow up balloons, or potentially life-threatening symptoms on ingesting food that has been handled with powdered NRL gloves.¹⁻⁴ They may also have periods of sickness absence or be unable to continue working in the same role, resulting in loss or reduction of their income.⁵

Costs to the employer

These include increased levels of sickness absence,⁶ impaired performance, and costly pension benefits and litigation claims.⁷ There may be additional costs incurred in implementing adjustments to work so that latex-allergic employees can be accommodated and remain in employment. Further costs derive from necessary changes to the working environment and from any need for enhanced health surveillance.

Costs to society

These comprise costs to the state arising from early pension payments, sickness absence and medical treatment of latex allergy.

Impact on third parties

There can be considerable implications for latex allergy sufferers (for example, patients in hospitals) whose lives may be at risk from exposure to latex arising from its occupational use.

Latex allergy: occupational aspects of management

This important issue is outside the remit of this guideline.

It is important that occupational health professionals are well informed about latex allergy to enable them to provide accurate occupational health advice to both employees and their employers.

2 Background

Over the past 20 years there has been a steep increase in the use of protective gloves in the UK. The largest increase in use has been by healthcare workers, and stemmed primarily from concerns about occupational exposure to blood-borne viruses. Because of their excellent elasticity, durability, tactile properties, low microbial/fluid penetration rate and low cost, natural rubber latex (NRL) gloves have been most widely used. The use of disposable powdered NRL gloves increased exponentially after 1987.⁸ According to the Medical Devices Agency Bulletin 1996, 117 million pairs of latex gloves were being supplied to the NHS annually in 1992, but few reports of latex sensitivity had been received at that time.⁹ There is now sufficient evidence that healthcare workers are an occupational group at increased risk of latex allergy.¹⁰ In addition, other occupational groups at increased risk of latex allergy include food handlers,¹¹ hairdressers¹² and construction workers.¹³ Other frequent users of latex gloves (eg members of the police and nursery workers) may also be at increased risk.

Types of rubber allergy and causes

Clinical effects of rubber allergy are attributable to either type I (immediate-type) hypersensitivity or type IV (delayed-type) hypersensitivity.¹⁴

Type I, or immediate-type hypersensitivity

Type I, or immediate-type hypersensitivity, is manifest by IgE (immunoglobulin E)-associated reactions to latex proteins, precipitated in individuals who have already developed latex-specific IgE antibodies from previous exposure and sensitisation. At least 13 proteins have been identified by the International Union of Immunological Societies (IUIS) as latex-specific allergens capable of causing type I allergy. Clinical manifestations may be cutaneous, ocular, respiratory or systemic. They range from contact urticaria, itching of the skin and eyes, sneezing, bronchospasm and asthma,¹⁵ to anaphylaxis (which may occur in people previously unknown to be sensitised).^{16–18} Cornstarch powder (absorbable dusting powder) on powdered latex gloves, originally introduced to facilitate donning, increases the risk of sensitisation as the latex proteins are carried and made airborne by the powder particles.^{19–21} The absorbable dusting powder in itself has not been shown to cause type I allergy.

Type IV, or delayed-type hypersensitivity

Type IV hypersensitivity reactions are more common and usually represent cell-mediated reactions to the chemical additives in rubber rather than the latex proteins.²² Strictly speaking, these should therefore be considered as a rubber allergy rather than a latex allergy. The clinical presentation is a vesicular, eczematous, pruritic dermatitis appearing hours to days after contact with the allergen. Large-scale patch-testing studies have been undertaken using individual rubber additives,²¹ and established allergens include rubber accelerators of vulcanisation (mercaptobenzothiazoles, carbamates and especially thiurams),²² antioxidants (eg amines), and organic pigments.²³ In latex gloves, the most common type IV allergens are the thiurams, and screening panels for these are found in the most basic patch-test trays. Since 1992, some

cases have also been reported of type IV allergy to latex proteins, without the presence of rubber chemicals, ie protein contact dermatitis, with or without concomitant type I allergy.^{24–26} However, these are rare.

Epidemiology of latex allergy

During the mid-1990s, latex allergy became a major occupational hazard in the healthcare industry,¹⁰ with the prevalence of type I allergy (based on skin prick testing) estimated to be as high as 17% in healthcare workers.²⁷ Estimates of prevalence in other occupational groups range from 4% in cleaners,¹¹ 6% in painters¹¹ and 7% in construction workers¹³ to just over 17% in food handlers¹¹ and hairdressers.¹²

Incidence/prevalence studies of latex allergy are difficult to compare as they use different selection criteria for inclusion, and different definitions of positivity, which may include any combination of symptoms, skin tests and serological tests.²⁸ Not all individuals with skin test reactions or specific IgE antibodies to NRL ultimately manifest allergic disease.²⁹ Thus, there is a distinction between immunological latex 'sensitisation' (the presence of a positive skin prick test to latex allergens or demonstration of specific IgE antibodies in serum), and clinical latex 'allergy' (immediate-type allergic symptoms caused by contact with latex in a sensitised individual).³⁰ There are no universally agreed standardised symptom questionnaires, and a variety of formulations are used in skin tests and immunological assays, making a standardised comparison across studies difficult. Evidence from the Cochrane Database suggests that, as with all medical practice, a clinical history is essential in establishing type I hypersensitivity to latex and test results should not be used in isolation. The incidence of clinical sensitisation may be seriously overestimated if only laboratory parameters are used.³¹

The Health and Occupation Reporting Network (THOR) Surveillance of Work-Related and Occupational Respiratory Disease (SWORD) scheme run by the University of Manchester Centre for Occupational and Environmental Health has data on latex-induced occupational asthma reported by occupational and respiratory physicians since 1988. These show a decline in the number of reported latex-induced asthma cases from over 60 in 1997, to fewer than five annually in recent years.³²

Issues in healthcare

Other than in gloves, latex may be used in a number of healthcare and non-healthcare devices including urinary catheters, condoms, elastic bands and venepuncture-related equipment. However, the most significant exposure to healthcare workers has come from the use of latex gloves. They are generally cheap, easy to don, afford good tactile sensitivity and manual dexterity, and offer good barrier protection against viruses and bacteria. Their elasticity is an additional advantage in healthcare since any pinhole needlestick perforations in latex gloves tend to close around the site of penetration, thus sealing the hole and potentially reducing blood contamination in needlestick injuries. Evidence from the Cochrane Database suggests that double gloving, eg during orthopaedic or dental surgery, significantly reduces perforations to innermost gloves.³³ Because of the advantageous properties, surgeons and laboratory workers needing fine dexterity tend to prefer latex gloves to those made from alternative materials. However, for routine non-sterile use, alternatives to latex are increasingly being used in healthcare.

Occupational management of latex allergy

Because of the high frequency of glove use, most of the research on latex allergy has been undertaken in healthcare workers. Environmental sampling studies confirm that the frequency of latex glove use is a strong determinant of airborne latex allergen levels in hospitals,³⁴ which in turn are closely correlated with the frequency of latex allergic symptoms in those exposed. Protein and allergen content can vary greatly in natural rubber latex gloves: 20- to 100-fold differences in protein concentrations and 3,000-fold differences in allergen concentration³⁵ have been reported between brands. Protein content may not always reflect the level of allergenicity of gloves,³⁶ but there has been a dramatic decrease in the latex protein content of gloves in recent years. This may be both from an increasing preference for, and therefore manufacture of, powder-free low-protein gloves, and also from improvements in manufacturing processes that generally reduce protein content in gloves. Data from the UK Surgical Materials Testing Laboratory analysing glove protein content suggest that in 1996, powdered latex gloves contained up to 515 µg/g of latex protein, whereas by 2003, powder-free latex examination gloves contained up to 35 µg/g of latex protein, representing a reduction of more than 10-fold.³⁷

Powdered gloves have higher latex allergen content than powder-free gloves³⁸ and there is good evidence that their use is associated with a substantially higher prevalence and rate of latex sensitisation.^{39,40} The cornstarch particles added to gloves as a donning agent have been shown to carry latex particles^{19,20} when airborne and thus greatly increase latex aeroallergen exposure.⁴¹ Latex aeroallergen levels are clearly correlated with latex allergic symptoms.^{39,42}

As with all occupational respiratory allergens, airborne exposure should generally be reduced as far as possible; for latex, no threshold has been established below which there is no risk of sensitisation. Once a diagnosis of type I latex allergy has been made, further exposure of the affected individual to latex allergens should be minimised to prevent further symptom progression.⁴³ However, the optimal occupational management is unclear. Some clinicians may recommend eliminating exposure completely by redeployment, while others may advocate switching to powder-free, low protein and low-allergenic latex gloves. The emergence of alternative glove materials,⁴⁴ such as polyvinylchloride, neoprene, nitrile and others, has offered a third option, not only for managing individual cases of latex allergy, but also as a potential strategy for eliminating glove-related latex allergy completely from the workplace. In cases of confirmed latex allergy, there are issues to consider around whether it is necessary to eliminate the use of latex gloves by co-workers, or if it is reasonable to allow the co-workers to continue with powder-free low protein gloves. As the use of latex alternatives increases, a new set of problems and challenges is emerging such as issues of barrier effectiveness, tactile sensitivity, durability, and type IV hypersensitivity. It is conceivable that changing to latex alternatives may only substitute one set of problems for another. More research is needed in this area in the future. In particular, it is important that national surveillance, to allow early recognition of the onset of any widespread occupational problems, is maintained. The evaluation of alternative materials is outside the remit of this review.

3 Methodology

Key question

A multidisciplinary Guideline Development Group (GDG) was formed in 2005. The following key question was discussed at the first meeting:

What is the optimal occupational management of individuals found to have:

- (1) type I sensitisation or latex-allergic disease
- (2) type IV latex-allergic disease?

In view of the time and resources available to the group, it was decided to focus on latex gloves and exclude from the study those papers looking at comparisons with, and the risks from, non-latex gloves.

The key question to be answered was therefore:

What is the optimal occupational management of individuals found to have:

- (1) type I sensitisation or latex-allergic disease
- (2) type IV rubber-allergic disease?

The following interventions were to be compared:

- (1) Deploy with low-protein gloves (for type I).
- (2) Deploy with non-latex gloves.
- (3) Deploy with gloves in same environment (co-workers continue to wear low-protein latex gloves).
- (4) Deploy with gloves in a 'latex-free' environment (co-workers also change to latex-free gloves).

The NICE guideline development methodology suggests the use of a Population-Intervention-Comparison-Outcome (PICO) table to focus on the key issues addressed by an evidence-based guideline development project. Table 1 summarises the key elements of this review.

Literature review

Details of the literature search strategy are provided in Appendix 1.

Search dates

Papers from 1 January 1990 to 1 January 2006 were searched but only papers from 1997 onwards were considered so as to look at the literature published following the UK Medical Devices Agency issued latex advice (Device Bulletin DB 9601) in 1996.⁹

Table 1 PICO table showing key issues addressed by the Guideline Development Group

Population	Known latex type I sensitivity	Known clinical latex allergic disease Type I allergy	Type IV contact allergy
Intervention/ comparison	Deploy with low protein gloves	Deploy with low protein gloves*	
	Deploy with non-latex gloves	Deploy with non-latex gloves	Deploy with gloves free of the causative allergen (usually chemical additives)
	Deploy with non-latex gloves in same environment* – others use low-protein latex gloves	Deploy with non-latex gloves in same environment* – others use low-protein latex gloves	
	Deploy with non-latex gloves in 'latex safe' environment – others use latex-free gloves	Deploy with non-latex gloves in 'latex safe' environment – others use latex-free gloves	
Outcome	Prevention of allergic disease progression	Prevention of disease progression	Prevention of disease
	Reduction in sensitisation markers	Reduction in symptoms	Reduction in symptoms
		Reduction in sensitisation markers	
		Abolition of symptoms	Abolition of symptoms
Study design	RCTs, systematic reviews, cross-sectional and longitudinal studies, case control studies, case reports		

*Some literature suggests that even those with type I clinical allergy can become less symptomatic or even asymptomatic with demonstrable reduction in sensitisation markers, by changing gloves used to those which are (powder-free) low protein gloves.

RCT = randomised controlled trial.

Method

The published literature was searched using the following databases: Medline, PubMed, Embase, HSE line, OSH-ROM, The Health Development Agency Public Health Evidence Base, Health Periodicals Database, Evidence Based Periodicals Database, Cochrane Library, CINAHL, Faculty of Occupational Medicine Library.

Limitations

The search was carried out for all languages but limited to human subjects.

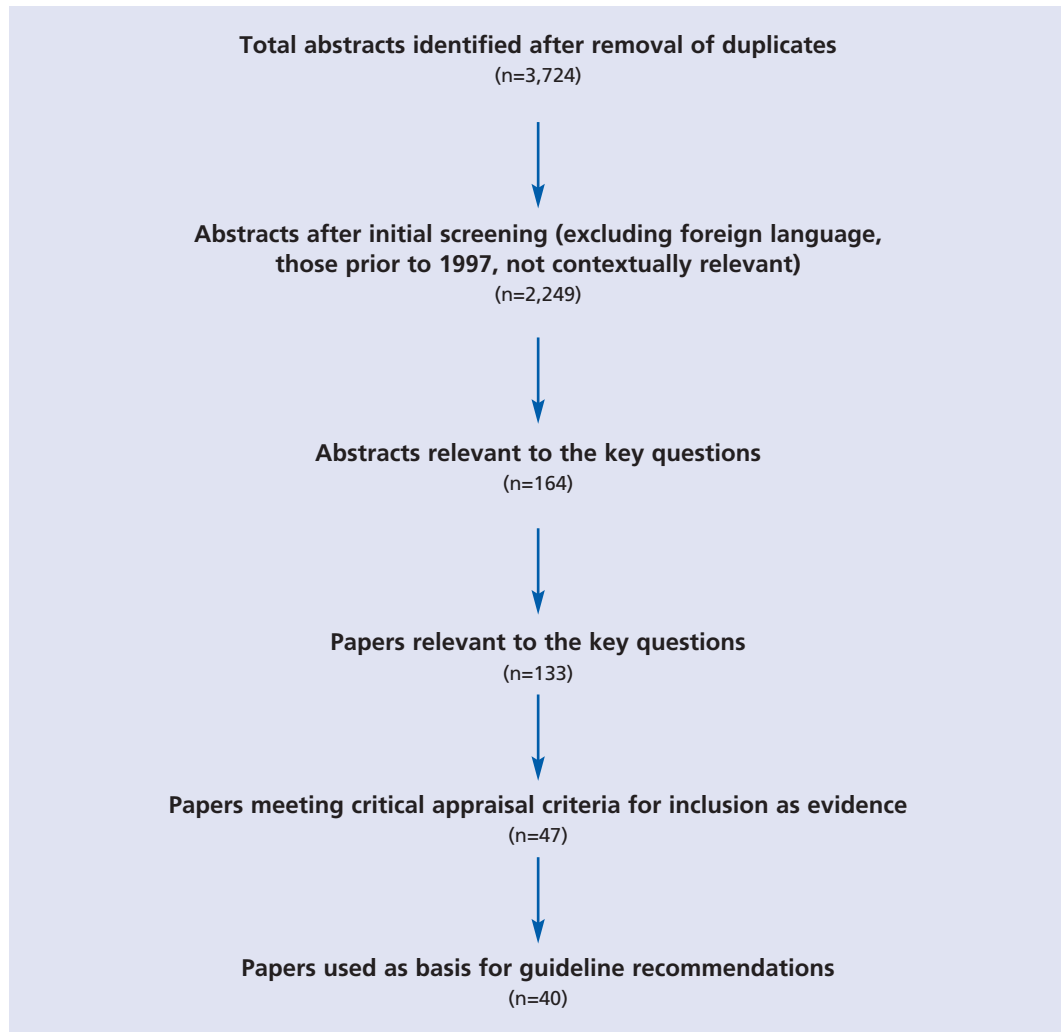
The abstracts were obtained from all papers that had an abstract.

Those papers which did not have abstracts, but met the search criteria were also listed. The GDG chose to study the published literature from 1997, the year following publication of latex advice (Device Bulletin DB 9601) by the Medical Devices Agency in 1996.⁹

Selection of papers for critical appraisal

The GDG leader (GDGL) undertook the literature search outlined in Appendix 2, with support from an information scientist. After discarding duplicates, there were over 3,700 abstracts (see Fig 1). For each year from 1997 to 2006, the GDGL and two senior members of the GDG

Fig 1 Flow chart showing selection of papers



reviewed the abstracts. A total of 133 papers that appeared to be related to the key questions were selected for full review by the GDG. The full papers were obtained and distributed to pairs of reviewers from the GDG for independent critical appraisal. All appraisers undertook training in critical appraisal skills. The appraisers were asked to identify any follow-on papers listed in the references of the papers they were appraising. The papers were assessed for methodological quality, using a form adapted from the Critical Appraisal Skills Programme (Appendix 2). The revised Scottish Intercollegiate Guidelines Network (SIGN) grading system (2000) was used to grade each paper (see Box 1). In the event that a pair of appraisers could not reach agreement on the SIGN grading, the paper was passed to the GDGL for discussion with the project director to make a final decision.

Development of recommendations

Draft recommendations for the occupational health management of latex allergy were produced by the GDGL and circulated to the group for comments and feedback. The recommendations were then redrafted, incorporating this feedback, as well as that of the

Box 1 Revised SIGN grading system

Levels of evidence	
1++	High quality meta-analyses, systematic reviews of randomised controlled trials (RCTs) , or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
1–	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
2++	High quality systematic reviews of case-control or cohort studies High quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
2+	Well conducted case-control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal
2–	Case-control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal
3	Non-analytic studies, eg case reports, case series
4	Expert opinion
Grades of recommendation	
A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; <i>or</i> A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; <i>or</i> Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; <i>or</i> Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; <i>or</i> Extrapolated evidence from studies rated as 2+

external assessors. As with NICE guidelines, papers with a ‘minus’ grade (indicating a high level of bias or confounding) or grade 3/4 were only used as a basis for a recommendation where there was a paucity of stronger evidence.

Many appraised papers were concerned with laboratory measurements rather than with clinical data. Thus it became apparent that the conventional SIGN grading system was inappropriate in some cases. Such studies were graded using a system adapted from the SIGN grading by NICE for studies looking at the efficacy of interventions (see *Methods for development of NICE public health guidance*, NICE, March 2006).⁴⁵

Good practice points

Good practice points (GPPs) are practical points that the GDG wishes to emphasise but for which there is not, nor is there likely to be, any research evidence – for example, some aspect of management or treatment that is regarded as such sound clinical advice that nobody is likely to question it. These are not alternatives to evidence-based recommendations, and are only used where there is no other way of highlighting the issue.

Limitations of the literature review

Limitations of the literature review include:

- *Publication bias* – there is a tendency for studies with positive results to be published preferentially.
- *Conflicts of interest* – no conflicts of interest were declared by members of the GDG. However, there were papers where potential conflicts of interest had been declared by or could be surmised from the affiliations of the authors (eg Malaysian Rubber Council) or the organisations that had fully or in part sponsored the research. Where identified, these have been flagged in the Evidence tables (Appendix 3).
- *An element of subjectivity in the reviews depending on reviewers* – this could be seen as a potential weakness of the study, although the SIGN methodology followed is well validated. It is commonly used for grading evidence for guidelines, and the system has been subject to international peer review.⁴⁶

4 Recommendations for occupational management of latex allergy

This section lists the full evidence-based recommendations developed from the systematic literature review. See Appendix 3 for the complete evidence tables. Although the search strategy used included terms to identify research on type IV hypersensitivity, the screening process identified extremely few papers on type IV allergy that could address the key questions. The vast majority of research dealt with type I allergy and the lack of evidence on type IV allergy is clearly a shortcoming that warrants further research. According to expert opinion, for sufferers of type IV allergy to rubber gloves, the chemical agent should be identified and avoided, bearing in mind that non-latex gloves may also contain the same chemical additives.

The search terms also included those for health surveillance. There was no direct evidence concerning the effectiveness of health surveillance techniques in the early detection of latex allergy or sensitivity. The main findings for type I allergy to latex proteins are in the following sections:

- 1 Airborne levels of latex protein
- 2 Glove and cost analysis
- 3 Substitution by powder-free latex/latex-free gloves: individuals
- 4 Substitution by powder-free latex/latex-free gloves: institutions/‘primary prevention’
- 5 Respiratory protection
- 6 Use of hand creams
- 7 Immunotherapy
- 8 Education and policy issues
- 9 Quality of life/employment
- 10 Smoking

1 Airborne levels of latex protein

Statements

There is a positive exposure–response relationship between latex aeroallergen concentrations and the frequency of latex allergic symptoms. Latex aeroallergen measurement may be helpful in defining and reducing latex exposures with consequent effect on symptom prevalence.

(This is an area for further research.)

Evidence

Baur 1998⁴⁷
Allmers 1998³⁹

Recommendation

Those concerned with managing the health risks arising from latex should minimise the concentration of latex protein in the air in order to reduce eye and respiratory symptoms of latex allergy, as well as the incidence of sensitisation to latex.

Latex aeroallergen measurement may be helpful in confirming the effects of allergen reduction measures.

Grade

C

GPP

Statement

Where latex gloves are used, the use of non-powdered gloves is the most effective method of reducing occupational latex aeroallergen exposure.

Evidence

Hermesch 1999⁴⁰
Allmers 1998³⁹
Kujala 2002⁴⁸

Recommendation

If latex products are used in the workplace, employers should provide powder-free latex products, if such alternatives exist. Employers should particularly ensure that powdered latex gloves are not used in the workplace.

Grade

C

2 Glove and cost analysis

Statement

Examination gloves tend to have higher latex allergen content than surgical gloves. Powdered gloves have higher latex allergen content than powder-free gloves.

Evidence

Koh 2005³⁸

Recommendation

Users of latex gloves and purchasers should be aware that the risk of developing latex allergy is highest with the use of powdered latex gloves, and that examination gloves may contain more latex allergen than surgical gloves.

Grade

D

Statement

Non-latex surgical gloves have higher failure rates in use and lower user satisfaction than latex gloves.

Evidence

Korniewicz 2004⁴⁹

Recommendation

Those concerned with glove purchasing policy should be aware that alternatives to latex gloves may have other associated problems, particularly with failure rates, user satisfaction, and barrier effectiveness.

Grade

B

Some other materials may be better than latex for protection against certain chemicals.

GPP

4 Recommendations for occupational management of latex allergy

Both non-latex and latex gloves should be changed after two to three hours of use because the barrier of either type of glove becomes compromised with extended use.

Statement/recommendation	Grade	Evidence
Those concerned with glove purchasing policy should be aware that latex glove protein content may be a poor guide to allergenicity.	D	Mahler 2000 ³⁶

Statements/recommendations	Grade	Evidence
Those concerned with glove purchasing policy should be aware that a switch to powder-free latex gloves can be cost effective (in terms of glove costs, and compensation).	D	Korniewitz 2005 ⁵⁰ Latzka 2005 ⁵¹
Those concerned with glove purchasing policy should be aware that a switch to non-latex gloves can also be cost effective.	D	Philips 1999 ⁵²

(This is an area for further UK-based research.)

3 Substitution by powder-free latex/latex-free gloves: individuals

Statements	Evidence
In employees with latex allergy or latex sensitisation , the personal avoidance of latex gloves at work reduces symptoms, indices of disease severity and immunological markers of sensitisation.	Nettis 2004 ⁵³ Rueff 2004 ⁵⁴ Allmers 1998 ³⁹
In employees with latex-induced asthma , the personal avoidance of latex gloves at work reduces symptoms and indices of severity.	Vandenplas 2002 ⁵⁵ Bernstein 2003 ⁵⁶
Recommendation	Grade
Employees with latex allergy, latex sensitisation and latex-induced asthma should use non-latex gloves instead of powdered latex gloves as an effective way of reducing their symptoms and/or eliminating them, and reducing markers of sensitisation.	C

Statement	Evidence
In employees with latex allergy , the use of powder-free low protein latex gloves at work by their colleagues reduces symptoms, indices of disease severity and immunological markers of sensitisation in the index case.	Turjanmaa 2002 ⁴³ Nettis 2004 ⁵³ Rueff 2004 ⁵⁴ Allmers 1998 ³⁹
Recommendation	Grade
Those concerned with glove purchasing policy should switch co-workers from powdered to powder-free low protein gloves or non-latex gloves as an effective way of reducing symptoms in affected employees.	C

Statements

In employees with **latex-induced asthma**, the use of **powder-free low protein latex gloves at work by their colleagues** reduces symptoms, and indices of disease severity.

In employees with **latex-induced asthma or rhinitis who are using non-latex gloves**, the use of **powder-free low protein gloves by their colleagues** reduces symptoms and indices of severity in the affected employee to a similar degree as the use of **non-latex gloves by colleagues**.

Evidence

Allmers 1998³⁹
Vandenplas 2002⁵⁵

Vandenplas 2002⁵⁵

Recommendation

Those concerned with glove purchasing policy should be aware that for employees with latex-induced asthma or rhinitis, switching co-workers from powdered latex gloves to powder-free low protein gloves is **similarly effective** in reducing symptoms in the affected employee as switching co-workers to non-latex gloves. **The evidence does not therefore support a need to ban latex completely from the workplace.**

Grade

C

4 Substitution by powder-free/latex-free gloves: institutions/'primary prevention'

Statements

The use of powder-free, low protein gloves reduces the incidence of latex allergy.

National strategies to encourage switching to powder-free gloves can be effective at reducing the incidence of latex allergy.

Evidence

Jones 2004⁵⁷
Allmers 2004⁵⁸
Allmers 2002⁵⁹

Allmers 2004⁵⁸
Allmers 2002⁵⁹

Recommendations

Those involved in health and safety policy decisions should switch their organisations from powdered to powder-free low protein gloves as an effective method of reducing the incidence of latex allergy in their organisation.

At a national level, a policy that encourages switching to powder-free low protein gloves is a proven effective method of reducing the incidence of latex allergy.

Grade

C

5 Respiratory protection

Statement

The use of respiratory protective equipment by sensitised individuals with latex-related symptoms from use of powder-free latex gloves may be helpful in reducing inhalation exposure to latex allergens and symptoms.

Evidence

Mitakakis 2002⁶⁰
Laoprasert 1998⁶¹

Recommendations

Where powder-free latex gloves are being used, but there remains a significant risk to highly sensitive latex-allergic employees that cannot otherwise be adequately controlled, the use of certain respiratory protective equipment can help in reducing inhalation exposure. As with all personal protective equipment this should be a last resort when other control measures are insufficient.

Grade

B/C

6 Use of hand creams

Statement/recommendation	Grade	Evidence
In people who are going to wear powder-free low protein latex gloves, the prior use of hand creams as a protective agent for latex sensitisation cannot be recommended.	C	Allmers 2001 ⁶² Baur 1998 ⁶³

7 Immunotherapy

Statement/recommendation	Grade	Evidence
Immunotherapy is recommended as a treatment option for those with NRL allergy, where switching to other glove options to reduce the symptoms is either not feasible or is ineffective. (Side effects and long-term efficacy are areas for further research.)	A/B	Cistero Bahima 2004 ⁶⁴ Abramson 2003 ⁶⁵ Pereira 2003 ⁶⁶ Sastre 2003 ⁶⁷ Patriarca 2002 ⁶⁸ Leynadier 2000 ⁶⁹ Pereira 1999 ⁷⁰

8 Education and policy issues

Statements	Evidence
At an institutional level, a complete ban on the use of powdered latex gloves reduces the incidence of sensitisation and prevalence of latex allergic symptoms. An institutional policy based on voluntary restrictions may not be as effective.	Trape 2000 ⁷¹

Recommendation	Grade
A complete ban on powdered latex gloves should be used by those planning institutional change as it is more effective than a policy based on voluntary restrictions.	C

Statements	Evidence
Hospital latex policies may be poorly understood and implemented. A switch to latex-free gloves is achievable but meets with resistance, especially for surgical use.	Bell 2005 ⁷² Brown 2003 ⁷³

Recommendation	Grade
Institutional change concerning latex use should be accompanied by a detailed implementation and communications plan, recognising that there may be resistance because of user preferences and concerns.	D

Statements/recommendations	Grade	Evidence
Appropriately targeted and sustained educational interventions, using different methods (eg leaflets, training, educational feedback analysis for different occupational groups) induce important positive behavioural changes in latex glove use. Poorly targeted information may be less effective. (This is an area for further research on UK-based occupational groups.)	C	Carrozzi 2002 ⁷⁴ Maxfield 2000 ⁷⁵ Nettis 2004 ⁵³ Trape 2000 ⁷¹

9 Quality of life/employment

Statements

In employees with latex-induced asthma, where clinical considerations allow it, reduction of exposure to latex may be a useful alternative associated with similar symptom reduction and fewer socioeconomic consequences than with complete removal from exposure.

Virtually all healthcare workers and others with latex allergy can retain their jobs with careful attention to latex avoidance at work and minor changes in the workplace.

Evidence

Vandenplas 2002⁵⁵
Bernstein 2003⁵⁶
Filon 2006⁷⁶

Turjanmaa 2002⁴⁴
Filon 2006⁷⁶
Al-Otaibi 2005⁷⁷
Bernstein 2003⁵⁶

Recommendation

All but the most severe cases of latex allergy and latex-induced asthma should be managed without redeployment or redundancy, by careful personal avoidance of latex at work and minor changes in the workplace.

Grade

C

10 Smoking

Statement

There appears to be no effect of smoking on the development of latex-induced asthma.

Grade

B

Evidence

Nielsen 2005⁷⁸

5 Recommendations for further research

The following areas are recommended for further research.

- 1 UK-based research on the cost effectiveness of switching to powder-free low-protein gloves, or latex-free gloves.
- 2 Long-term effectiveness of targeted educational interventions in reducing latex allergy in healthcare workers.
- 3 A randomised controlled trial of the long-term efficacy and effects of immunotherapy in individuals with clinical latex allergy.
- 4 A detailed, comprehensive comparison of properties of latex gloves versus latex-free gloves comparing tactile sensitivity, microbiological impermeability, user satisfaction, and allergic reactions.
- 5 A follow up-study of UK healthcare workers diagnosed with latex allergy to determine employment outcomes.
- 6 A study to establish the optimal diagnostic procedures for latex allergy to be used by occupational health services.
- 7 A comparison of NHS latex allergy/glove usage policies.

6 Suggested audit criteria

Key priority for implementation	Audit criterion
Institutions should switch from powdered latex gloves to powder-free, low-protein gloves.	% of institutions using powder-free, low-protein gloves (national)
Employees with latex allergy, latex sensitivity and latex-induced asthma should be using latex-free gloves.	% of employees with latex allergy, latex sensitivity and latex induced asthma using non-latex gloves (local)
All but the most severe cases of latex allergy and latex-induced asthma to be usually managed without the need for redeployment or redundancy by careful personal avoidance of latex at work and minor changes in the workplace.	Numbers of ill health retirements or redundancies due to latex allergy (national or local)
Appropriately targeted and sustained educational interventions, using different methods (eg leaflets, training, educational feedback analysis) for different occupational groups to induce important positive behavioural changes in latex glove use.	% of latex user groups appropriately targeted with educational interventions (local)
Those planning institutional change concerning latex use should be aware that there may be resistance because of user preferences and concerns. In addition the policy may be poorly understood.	% of institutions using latex gloves with a latex policy (national) % compliance with latex policy (national or local)

References

- 1 Bernardini R, Novembre E, Lombardi E *et al.* Anaphylaxis to latex after ingestion of a cream-filled doughnut contaminated with latex. *J Allergy Clin Immunol* 2002;110(3):534–5.
- 2 Beezhold DH, Reschke JE, Allen JH, Kostyal DA, Sussman GL. Latex protein: a hidden ‘food’ allergen? *Allergy Asthma Proc* 2000;21(5):301–6.
- 3 Lee A, Nixon R, Frowen K. Reduction of use of latex gloves in food handlers: an intervention study. *Contact Dermatitis* 2001;44(2):75–9.
- 4 Schwartz HJ. Latex: a potential hidden ‘food’ allergen in fast food restaurants. *J Allergy Clin Immunol* 1995;95(1 Pt 1):139–40.
- 5 Taylor M. Cost of latex device-related occupational illness, workmen's compensation and legal issues. *Eur J Surg Suppl* 1997(579):49–51.
- 6 Tyler D. Disability and medical management of natural latex sensitivity claims. *J Allergy Clin Immunol* 2002;110(2 Suppl):S129–36.
- 7 Horwitz IB, Kammeyer-Mueller J, McCall BP. Workers' compensation claims related to natural rubber latex gloves among Oregon healthcare employees from 1987–1998. *BMC Publ Health* 2002;2:21.
- 8 Sussman GL, Beezhold DH, Liss G. Latex allergy: historical perspective. *Methods* 2002;27(1):3–9.
- 9 Medical Devices Agency. *Latex sensitisation in the health care setting (use of latex gloves)*. Device Bulletin MDA DB 9601. London: MDA, 1996.
- 10 Bousquet J, Flahault A, Vandenplas O *et al.* Natural rubber latex allergy among health care workers: a systematic review of the evidence. *J Allergy Clin Immunol* 2006;118(2):447–54.
- 11 Valks R, Conde-Salazar L, Cuevas M. Allergic contact urticaria from natural rubber latex in healthcare and non-healthcare workers. *Contact Dermatitis* 2004;50(4):222–4.
- 12 Nettis E, Dambra P, Soccio AL, Ferrannini A, Tursi A. Latex hypersensitivity: relationship with positive prick test and patch test responses among hairdressers. *Allergy* 2003;58(1):57–61.
- 13 Conde-Salazar L, Gatica ME, Barco L *et al.* Latex allergy among construction workers. *Contact Dermatitis* 2002;47(3):154–6.
- 14 Slater JE. Latex allergy. *J Allergy Clin Immunol* 1994;94(2 Pt 1):139–49; quiz 150.
- 15 Seaton A, Cherrie B, Turnbull J. Rubber glove asthma. *BMJ (Clin Res Ed)* 1988;296(6621):531–2.
- 16 Taylor JS, Cassettari J, Wagner W, Helm T. Contact urticaria and anaphylaxis to latex. *J Am Acad Dermatol* 1989;21(4 Pt 2):874–7.
- 17 Dreyfus DH, Fraser B, Randolph CC. Anaphylaxis to latex in patients without identified risk factors for latex allergy. *Conn Med* 2004;68(4):217–22.
- 18 Lieberman P. Anaphylactic reactions during surgical and medical procedures. *J Allergy Clin Immunol* 2002;110(2 Suppl):S64–9.
- 19 Crippa M, Belleri L, Mistrello G *et al.* Prevention of latex allergy among health care workers: evaluation of the extractable latex protein content in different types of medical gloves. *Am J Ind Med* 2003;44(1):24–31.
- 20 Palosuo T, Makinen-Kiljunen S, Alenius H *et al.* Measurement of natural rubber latex allergen levels in medical gloves by allergen-specific IgE-ELISA inhibition, RAST inhibition, and skin prick test. *Allergy* 1998;53(1):59–67.
- 21 Barbara J, Santais MC, Levy DA, Ruff F, Leynadier F. Immunoadjuvant properties of glove cornstarch powder in latex-induced hypersensitivity. *Clin Exp Allergy* 2003;33(1):106–12.
- 22 Conde-Salazar L, del-Rio E, Guimaraens D, Gonzalez Domingo A. Type IV allergy to rubber additives: a 10-year study of 686 cases. *J Am Acad Dermatol* 1993;29(2 Pt 1):176–80.
- 23 Heese A, van Hintzenstern J, Peters KP, Koch HU, Hornstein OP. Allergic and irritant reactions to rubber gloves in medical health services. Spectrum, diagnostic approach, and therapy. *J Am Acad Dermatol* 1991;25(5 Pt 1):831–9.
- 24 Wilkinson SM, Beck MH. Allergic contact dermatitis from latex rubber. *Br J Dermatol* 1996;134(5):910–4.

- 25 Gottlob P, Gall H, Peter RU. Allergic contact dermatitis from natural latex. *Am J Contact Dermat* 2001;12(3):135–8.
- 26 Shaffrali FC, Gawkrödger DJ. Allergic contact dermatitis from natural rubber latex without immediate hypersensitivity. *Contact Dermatitis* 1999;40(6):325–6.
- 27 Turjanmaa K, Alenius H, Reunala T, Palosuo T. Recent developments in latex allergy. *Curr Opin Allergy Clin Immunol* 2002;2(5):407–12.
- 28 Lagier F, Vervloet D, Lhermet I, Poyen D, Charpin D. Prevalence of latex allergy in operating room nurses. *J Allergy Clin Immunol* 1992;90(3 Pt 1):319–22.
- 29 Brown RH, Schauble JF, Hamilton RG. Prevalence of latex allergy among anesthesiologists: identification of sensitized but asymptomatic individuals. *Anesthesiology* 1998;89(2):292–9.
- 30 Cullinan P, Brown R, Field A *et al*. Latex allergy. A position paper of the British Society of Allergy and Clinical Immunology. *Clin Exp Allergy* 2003;33(11):1484–99.
- 31 Pridgeon C, Wild G, Ashworth F, Egner W, Ward AM. Assessment of latex allergy in a healthcare population: are the available tests valid? *Clin Exp Allergy* 2000;30(10):1444–9.
- 32 Personal communication from the University of Manchester.
- 33 Tanner J, Parkinson H. Double gloving to reduce surgical cross-infection. *Cochrane Database Syst Rev* 2006;3:CD003087.
- 34 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(2):325–30.
- 35 Yunginger JW, Jones RT, Fransway AF *et al*. Extractable latex allergens and proteins in disposable medical gloves and other rubber products. *J Allergy Clin Immunol* 1994;93(5):836–42.
- 36 Mahler V, Fischer S, Fuchs T *et al*. Prevention of latex allergy by selection of low-allergen gloves. *Clin Exp Allergy* 2000;30(4):509–20.
- 37 Personal communication from UK Surgical Materials Testing Laboratory at Latex Allergy Conference, Royal Free Hospital 2007.
- 38 Koh D, Ng V, Leow YH, Goh CL. A study of natural rubber latex allergens in gloves used by healthcare workers in Singapore. *Br J Dermatol* 2005;153(5):954–9.
- 39 Allmers H, Brehler R, Chen Z *et al*. Reduction of latex aeroallergens and latex-specific IgE antibodies in sensitized workers after removal of powdered natural rubber latex gloves in a hospital. *J Allergy Clin Immunol* 1998;102(5):841–6.
- 40 Hermes CB, Spackman GK, Dodge WW, Salazar A. Effect of powder-free latex examination glove use on airborne powder levels in a dental school clinic. *J Dent Educ* 1999;63(11):814–20.
- 41 Edlich RF, Woodard CR, Pine SA, Lin KY. Hazards of powder on surgical and examination gloves: a collective review. *J Long Term Eff Med Implants* 2001;11(1–2):15–27.
- 42 Baur X, Chen Z, Liebers V. Exposure-response relationships of occupational inhalative allergens. *Clin Exp Allergy* 1998;28(5):537–44.
- 43 Turjanmaa K, Kanto M, Kautiainen H, Reunala T, Palosuo T. Long-term outcome of 160 adult patients with natural rubber latex allergy. *J Allergy Clin Immunol* 2002;110(2 Suppl):S70–4.
- 44 Kotilainen HR, Brinker JP, Avato JL, Gantz NM. Latex and vinyl examination gloves. Quality control procedures and implications for health care workers. *Arch Intern Med* 1989;149(12):2749–53.
- 45 National Institute for Health and Clinical Excellence. *Methods for development of NICE public health guidance*. London: NICE, 2006.
- 46 Harbour R, Miller J. A new system for grading recommendations in evidence based guidelines. *BMJ* 2001;323(7308):334–6.
- 47 Baur X, Chen Z, Allmers H. Can a threshold limit value for natural rubber latex airborne allergens be defined? *J Allergy Clin Immunol* 1998;101(1 Pt 1):24–7.
- 48 Kujala V, Alenius H, Palosuo T *et al*. Extractable latex allergens in airborne glove powder and in cut glove pieces. *Clin Exp Allergy* 2002;32(7):1077–81.
- 49 Korniewicz DM, Garzon L, Seltzer J, Feinleib M. Failure rates in nonlatex surgical gloves. *Am J Infect Control* 2004;32(5):268–73.

- 50 Korniewicz DM, Chookaew N, El-Masri M, Mudd K, Bollinger ME. Conversion to low-protein, powder-free surgical gloves: is it worth the cost? *AAOHN J* 2005;53(9):388–93.
- 51 Latza U, Haamann F, Baur X. Effectiveness of a nationwide interdisciplinary preventive programme for latex allergy. *Int Arch Occup Environ Health* 2005;78(5):394–402.
- 52 Phillips VL, Goodrich MA, Sullivan TJ. Health care worker disability due to latex allergy and asthma: a cost analysis. *Am J Public Health* 1999;89(7):1024–8.
- 53 Nettis E, Colanardi MC, Ferrannini A. Type I latex allergy in health care workers with latex-induced contact urticaria syndrome: a follow-up study. *Allergy* 2004;59(7):718–23.
- 54 Rueff F, Schopf P, Putz K, Przybilla B. Effect of reduced exposure on natural rubber latex sensitization in health care workers. *Ann Allergy Asthma Immunol* 2004;92(5):530–7.
- 55 Vandenplas O, Jamart J, Delwiche JP, Evrard G, Larbanois A. Occupational asthma caused by natural rubber latex: outcome according to cessation or reduction of exposure. *J Allergy Clin Immunol* 2002;109(1):125–30.
- 56 Bernstein DI, Karnani R, Biagini RE *et al*. Clinical and occupational outcomes in health care workers with natural rubber latex allergy. *Ann Allergy Asthma Immunol* 2003;90(2):209–13.
- 57 Jones KP, Rolf S, Stingl C, Edmunds D, Davies BH. Longitudinal study of sensitization to natural rubber latex among dental school students using powder-free gloves. *Ann Occup Hyg* 2004;48(5):455–7.
- 58 Allmers H, Schmengler J, John SM. Decreasing incidence of occupational contact urticaria caused by natural rubber latex allergy in German health care workers. *J Allergy Clin Immunol* 2004;114(2):347–51.
- 59 Allmers H, Schmengler J, Skudlik C. Primary prevention of natural rubber latex allergy in the German health care system through education and intervention. *J Allergy Clin Immunol* 2002;110(2):318–23.
- 60 Mitakakis TZ, Tovey ER, Yates DH *et al*. Particulate masks and non-powdered gloves reduce latex allergen inhaled by healthcare workers. *Clin Exp Allergy* 2002;32(8):1166–9.
- 61 Laoprasert N, Swanson MC, Jones RT, Schroeder DR, Yunginger JW. Inhalation challenge testing of latex-sensitive health care workers and the effectiveness of laminar flow HEPA-filtered helmets in reducing rhinoconjunctival and asthmatic reactions. *J Allergy Clin Immunol* 1998;102(6 Pt 1):998–1004.
- 62 Allmers H. Wearing test with two different types of latex gloves with and without the use of a skin protection cream. *Contact Dermatitis* 2001;44(1):30–3.
- 63 Baur X, Chen Z, Allmers H, Raulf-Heimsoth M. Results of wearing test with two different latex gloves with and without the use of skin-protection cream. *Allergy* 1998;53(4):441–4.
- 64 Cistero Bahima A, Sastre J, Enrique E *et al*. Tolerance and effects on skin reactivity to latex of sublingual rush immunotherapy with a latex extract. *J Investig Allergol Clin Immunol* 2004;14(1):17–25.
- 65 Abramson MJ, Puy RM, Weiner JM. Allergen immunotherapy for asthma. *Cochrane Database Syst Rev* 2003(4):CD001186.
- 66 Pereira C, Pedro E, Tavares B *et al*. Specific immunotherapy for severe latex allergy. *Allerg Immunol (Paris)* 2003;35(6):217–25.
- 67 Sastre J, Fernandez-Nieto M, Rico P *et al*. Specific immunotherapy with a standardized latex extract in allergic workers: a double-blind, placebo-controlled study. *J Allergy Clin Immunol* 2003;111(5):985–94.
- 68 Patriarca G, Nucera E, Pollastrini E *et al*. Sublingual desensitization: a new approach to latex allergy problem. *Anesth Analg* 2002;95(4):956–60, table of contents.
- 69 Leynadier F. Occupational latex allergy. *J Allergy Clin Immunol* 1996;98(3):716–7.
- 70 Pereira C, Rico P, Lourenco M *et al*. Specific immunotherapy for occupational latex allergy. *Allergy* 1999;54(3):291–3.
- 71 Trape M, Schenck P, Warren A. Latex gloves use and symptoms in health care workers one year after implementation of a policy restricting the use of powdered gloves. *Am J Infect Control* 2000;28(5):352–8.
- 72 Bell L, Watt AD, Straine L. Impact of a latex policy on an acute NHS hospital: an audit. *Occup Med (Lond)* 2005;55(6):501–3.
- 73 Brown RH, Hamilton RG, McAllister MA. How health care organizations can establish and conduct a program for a latex-safe environment. *Jt Comm J Qual Saf* 2003;29(3):113–23.
- 74 Carrozzi FM, Katelaris CH, Burke TV, Widmer RP. Minimizing the risks of latex allergy: the effectiveness of written information. *Aust Dent J* 2002;47(3):237–40.

- 75 Maxfield A, Lewis J, Lachenmayr S, Tisdale J, Lum M. A National Institute for Occupational Safety and Health alert sent to hospitals and the intentions of hospital decision makers to advocate for latex allergy control measures. *Health Educ Res* 2000;15(4):463-7.
- 76 Filon FL, Radman G. Latex allergy: a follow up study of 1,040 healthcare workers. *Occup Environ Med* 2006;63(2):121-5.
- 77 Al-Otaibi S, Tarlo SM, House R. Quality of life in patients with latex allergy. *Occup Med (Lond)* 2005;55(2):88-92.
- 78 Nielsen GD, Olsen O, Larsen ST *et al.* IgE-mediated sensitisation, rhinitis and asthma from occupational exposures. Smoking as a model for airborne adjuvants? *Toxicology* 2005;216(2-3):87-105.
- 79 Leynadier F, Doudou O, Gaouar H *et al.* Effect of omalizumab in health care workers with occupational latex allergy. *J Allergy Clin Immunol* 2004;113(2):360-1.
- 80 Leynadier F, Herman D, Vervloet D, Andre C. Specific immunotherapy with a standardized latex extract versus placebo in allergic healthcare workers. *J Allergy Clin Immunol* 2000;106(3):585-90.
- 81 Hamilton RG, Brown RH. Impact of personal avoidance practices on health care workers sensitized to natural rubber latex. *J Allergy Clin Immunol* 2000;105(4):839-41.
- 82 Kujala VM, Karvonen J, Laara E *et al.* Postal questionnaire study of disability associated with latex allergy among health care workers in Finland. *Am J Ind Med* 1997;32(3):197-204.

Appendices

Appendix 1 Terms used in search strategy

Appendix 2 Critical appraisal form

Appendix 3 Evidence tables

Appendix 1 Terms used in search strategy

Latex Allergy evidence-based GDG search strategy

Terms	Papers	Terms	Papers
Latex and allergy	2,535	Rubber and allergy	561
Latex and hypersensitivity, delayed	373	Rubber and hypersensitivity, delayed	330
Latex and hypersensitivity, immediate	1,199	Rubber and hypersensitivity, immediate	530
Latex and dermatitis	754	Rubber and dermatitis	888
Latex and dermatitis, contact	679	Rubber and dermatitis, contact	845
Latex and dermatitis, allergic contact	307	Rubber and dermatitis, allergic contact	160
Latex and dermatitis, occupational	333	Rubber and dermatitis, occupational	238
Latex and disease	61	Rubber and disease	2
Latex and workplace	21	Rubber and workplace	4
Latex and occupations	21	Rubber and occupations	20
Latex and occupational groups	721	Rubber and occupational groups	142
Latex and employment	26	Rubber and employment	10
Latex and industry	248	Rubber and industry	511
Latex and healthcare	229	Rubber and healthcare	42
Latex and health care	602	Rubber and health care	112
Latex and healthcare sector	2	Rubber and healthcare sector	0
Latex and health personnel	709	Rubber and health personnel	137
Latex and manufacture	65	Rubber and manufacture	74
Latex and gloves, protective	1,143	Rubber and gloves, protective	335
Latex and gloves, surgical	771	Rubber and gloves, surgical	228
Latex and protective devices	630	Rubber and protective devices	428
Latex and surgeons	111	Rubber and surgeons	16
Latex and dentist	61	Rubber and dentist	18
Latex and guidelines	55	Rubber and guidelines	6
Latex and pre-employment	4	Rubber and pre-employment	0
Latex and mass screening	119	Rubber and mass screening	17
Latex and questionnaires	157	Rubber and questionnaires	32
Latex and risk assessment	63	Rubber and risk assessment	25
Latex and health surveillance	6	Rubber and health surveillance	1
Latex and asthma	211	Rubber and asthma	31
Latex and disease management	1	Rubber and disease management	0
Latex and case management	1	Rubber and case management	0
Latex and skin	39	Rubber and skin	66
Latex and skin diseases, eczematous	344	Rubber and skin diseases, eczematous	561
Latex and skin tests	691	Rubber and skin tests	282
Latex and RAST	163	Rubber and RAST	45
Latex and spirometry	8	Rubber and spirometry	7
Latex and patch tests	143	Rubber and patch tests	138
Latex and health facility environment	5	Rubber and health facility environment	3
Latex and aeroallergen	36	Rubber and aeroallergen	7
Latex and low-protein	23	Rubber and low-protein	5
Latex and tactile	12	Rubber and tactile	6
Latex and permeability	106	Rubber and permeability	80

Terms	Papers	Terms	Papers
Latex and dexterity	14	Rubber and dexterity	3
Latex and alternatives	47	Rubber and alternatives	11
Latex and randomised controlled trial	121	Rubber and randomised controlled trial	45
Latex and systematic review	209	Rubber and systematic review	218
Latex and cross-sectional studies	16	Rubber and cross-sectional studies	13
Latex and longitudinal studies	65	Rubber and longitudinal studies	123
Latex and case control studies	28	Rubber and case control studies	72
Latex and cohort studies	72	Rubber and cohort studies	170
Latex and case report	276	Rubber and case report	381
Latex and sensitivity and specificity	77	Rubber and sensitivity and specificity	36
Latex and urticaria	171	Rubber and urticaria	69
Latex and reaction	0	Rubber and reaction	0
Latex and epidemiology	10	Rubber and epidemiology	0
Latex and exposure	101	Rubber and exposure	217
Latex and incidence	32	Rubber and incidence	34

Bold font indicates MeSH term, normal font indicates keyword.

The search was carried out using the above MeSH/keyword pairings, and the parameter 'NOT condom'.

After discarding duplicates, there were 3,724 references in total.

Appendix 2 Critical appraisal form

Reviewer(s): _____

Author, title: _____

Study type (tick all that apply)

- Randomised controlled trial
- Systematic review
- Meta-analysis
- Qualitative research
- Literature review
- Case-control study
- Longitudinal/cohort study
- Other

(Please describe)

Initial comments: _____

SCREENING QUESTIONS

1. Does the paper have a clearly focused aim or research question?

Yes No Can't tell

Consider:

1. population studied
2. interventions delivered
3. outcomes

2. Is the chosen method appropriate?

Yes No Can't tell

Consider whether:

1. the authors explain their research design
2. the chosen method address the research question

Is it worth continuing?

Yes No

Please explain _____

Detailed questions

3. Has the research been conducted rigorously?

Yes No Can't tell

Consider:

1. search strategy described
2. inclusions and exclusions
3. more than one researcher
4. resolving issues of bias

4. Is it clear how data has been analysed?

Yes No Can't tell

Consider:

1. were study results combined
2. if so was this reasonable
3. in-depth description of the analysis process
4. all participants accounted for
5. contradictory findings explained

5. Is there a clear statement of findings?

Yes No Can't tell

Consider:

1. sufficient evidence to support conclusions
2. do findings support the research question
3. precision of results
4. all important variables considered

6. How are the results presented?

Consider:

1. are the results presented numerically, i.e. p-value, OR (odds ratio)
2. are the results presented narratively

7. What is the main result?

Consider:

1. how large is the size of the result
2. how meaningful is the result
3. how would you sum up the bottom-line result in one sentence

8. Are there limitations to the research?

Yes No Can't tell

Consider:

1. was the sample size large enough
2. were all important outcomes considered
3. was the intervention process adequately described
4. was there any follow-up data
5. do the authors acknowledge weaknesses

9. Can the results be applied to a UK context?

Yes No Can't tell

Consider:

1. any discussion on how the findings can be used
2. findings considered in relation to current practice
3. estimation of benefits and costs

Accept for inclusion as evidence Yes No Can't tell

Refer to guideline leader Yes No

Guideline leader's notes

Any references to be followed up from this article?

Please attach this form to your recording sheet for appraising and grading and return to guideline leader

Appendix 3 Evidence tables

Authors	Title/aims	Study design	Study population/ methodology	Main results
Korniewicz, Chookaew, El-Masri, Mudd, Bollinger, 2005 ⁵⁰	Conversion to low-protein, powder-free surgical gloves: is it worth the cost?	Longitudinal study	The aim of this study was to determine changes in overall costs associated with conversion to powder-free gloves including cost of workers' compensation cases for natural rubber latex (NRL)-related symptoms and healthcare workers' glove satisfaction. It was a two-year longitudinal study of 103 healthcare workers' use of powder-free, low-protein NRL gloves, sensitisation, cost, and glove satisfaction, but with the main focus on cost benefits.	Before glove conversion, nearly half (44%, 36 of 82) of the operating room staff reported symptoms related to NRL exposure. At the end of the 14-month data collection period, only 27% (22 of 82) reported symptoms. A cost saving of US \$10,000 per year for gloves was evident with reports of increased user satisfaction. There was a low participation rate.
Latza, Haamann, Baur, 2005 ⁵¹	Effectiveness of a nationwide interdisciplinary preventive programme for latex allergy	Evaluation of nationwide intervention programme	Evaluation of an interdisciplinary German campaign targeting 5 million healthcare and welfare employees recommending powdered gloves are replaced with powder-free low allergen gloves. The campaign used various methods including brochures, video tapes, information packages, the press and trade fairs.	Endpoints used before and after the campaign were: number of compensation claims (as a proportion of all claims), total costs of compensation, and powdered glove usage. Over the three years following the campaign, the total number of compensation claims and total compensation costs dropped for latex type I allergic respiratory and skin disease, as did the use of powdered latex gloves.
Phillips, Goodrich, Sullivan, 1999 ⁵²	Healthcare worker disability due to latex allergy and asthma: a cost analysis	A cost analysis using presumptive data	The basis of this study is presumptive data and its relationship to state compensation for worker ill health. The purpose was to determine the cost of a latex-safe approach, compared with that of continued latex glove use, and to identify the level of worker disability required to make the latex-safe approach financially preferable to a healthcare institution. The costs of two strategies – latex-safe versus the status quo – were calculated from the perspective of three healthcare institutions. A break-even point was calculated for each facility.	On the assumptions made it was found that change to non-latex gloves would be cost effective with low numbers of healthcare workers (1.07%) becoming fully disabled according to the Georgia state compensation criteria. However, compensation criteria will vary. The assumption of sensitisation rate (8%) to powdered latex gloves is a relatively high estimate. The assumptions regarding equivalent sensitisation rates with non-powdered low-protein latex gloves are not supported by references. The assumptions made seem to overestimate the likely prevalence of type 1 latex allergy and do not take account of the possible reduction in costs of latex alternatives as their use becomes more widespread. The option of change to non-powdered low protein latex gloves is given cursory consideration and is perhaps dismissed too readily.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2-	Cost analysis (change to powder free)	Conversion to the use of powder-free, low-protein NRL gloves reduces healthcare worker NRL symptoms, and reduces the costs of glove purchases and workers' compensation claims.	None declared	Those concerned with glove purchasing policy should be aware that a switch to powder-free latex gloves can be cost effective (in terms of glove costs, compensation).	C/D	Yes (UK based)
2-	Cost analysis (change to powder free)	National campaigns in other countries encouraging switching from powdered to powder-free latex gloves, when successfully implemented, have led to a reduction in the total number and cost of compensation claims for type 1 latex allergic skin and respiratory disease. They have also been effective in reducing the use of powdered gloves.	None declared	-	-	-
3	Cost analysis	Glove selection and purchasing should take account of occupational health and safety evidence.	None declared	Those concerned with glove purchasing policy should be aware that a switch to non-latex gloves can be cost effective.	D	Yes (UK based)

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Carrozzi, Katelaris, Burke, Widmer, 2002 ⁷⁴	Minimising the risks of latex allergy: the effectiveness of written information	Longitudinal/cohort	An Australian survey of 157 dental personnel with clinical latex allergy, or at high risk from latex exposure, who were educated verbally and in written form about latex allergy symptoms, hand-care strategies, latex avoidance measures and workplace implications. After six weeks a questionnaire was mailed out, designed to assess whether appropriate steps to reduce latex exposure had been taken.	Questionnaires were returned in 70% of cases. All respondents felt the information was easy to understand and informative. While 50% of respondents indicated that they had changed to powder-free or non-latex gloves, only five respondents were fully compliant with all instructions. Compliance with instructions regarding minimising exposure to latex in a group of latex-allergic dental personnel was poor.
Lee, Nixon, 2001 ³	Reduction of use of latex gloves in food handlers: an intervention study	Intervention study	The aim of this study was to assess both the use of latex gloves by food handlers and the impact of an intervention study on reducing latex glove use in Australian food market stalls.	They found that 10 out of 30 stalls (33%) used latex gloves, and that following a short education program, this was reduced to one stall (3%, p=0.006). The potential to reduce latex glove use by using this intervention study was 93% (95% confidence interval of 54–100%). This highlights the need for any intervention to consider occupational groups other than healthcare workers and tailor advice to specific job roles. Reduction of latex glove use was achieved, however, long-term issues were not considered. Latex gloves are not required or appropriate for this occupation.
Maxfield, Lewis, Lachenmayr, Tisdale, Lum, 2000 ⁷⁵	A National Institute for Occupational Safety and Health alert sent to hospitals and the intentions of hospital decision makers to advocate for latex allergy control measures	Randomised controlled trial	Evaluation of an alert notice concerning the risk and prevention of latex allergy among healthcare workers. The alert contained four recommendations for administrative control measures that hospital decision makers could adopt to reduce the risk of latex allergy to employees; it was mailed to a random selection of directors of infection control and directors of nursing in hospitals in the USA. A random sample of these targeted recipients and a control group were surveyed by telephone (N=298).	Although nearly all of the respondents were concerned about latex allergy (96%), those reporting having seen the alert were significantly more likely to report an intention to advocate for one or more of the control measures; none of the differences was statistically significant. Interpretation limited by low study power, low response rates (44%) and contamination of assigned groups.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Education	Recommendation: Information designed to produce behavioural changes in occupational groups must be presented in different approaches, leaflets, training, feedback etc and be part of an ongoing educational programme to achieve the rates for compliance.	None declared	Appropriately targeted educational interventions, using different methods, induces important positive behavioural changes in latex glove use. Poorly targeted information may be less effective.		–
2–	Education	Targeted short-term education has an impact on latex use but long-term effect was not studied.	None declared		C	UK occupational groups
1–	Education	General untargeted alerts concerning latex allergy may not be effective.	None declared	–	–	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Baur, Chen, Allmers, 1998 ⁴⁷	Can a threshold limit value for natural rubber latex airborne allergens be defined?	Cross-sectional quantitative survey with a joint symptom prevalence survey	This aimed to study the relationship between exposures to different latex aeroallergen levels and type I allergic reactions in subjects with occupational contact with latex, and to assess a threshold value for latex airborne allergens required for sensitisation and symptom elicitation. A total of 145 subjects working in 32 hospitals or operating rooms with different latex aeroallergen levels were screened. The quantified latex aeroallergen concentrations in the 32 rooms were compared with latex-related allergic symptoms.	Different latex aeroallergen concentrations could be detected in rooms where powdered latex gloves were used and no effective ventilation systems were installed. In environments with latex aeroallergen levels of 0.6 ng/m³ or greater, the reported workplace-related symptoms were significantly increased (p<0.02). All 22 subjects with latex-specific IgE antibodies worked in rooms contaminated with latex aeroallergens (p<0.05). By the method of aeroallergen measurement used in this study it was found that all sensitised persons and those with conjunctival or respiratory symptoms worked in rooms with >0.6 ng/m³ latex allergen. However, the assay method is an inhibition immunoassay which depends on the activity of the pooled serum used and the particular latex allergens present in the system. This means the results cannot be generalised without an agreed reference standard. Similar assays could be used to produce threshold values for that assay system or to monitor latex aeroallergen levels before and after reduction measures.
Koh, Ng, Leow, Goh, 2005 ³⁸	A study of natural rubber latex allergens in gloves used by healthcare workers in Singapore	Laboratory-based latex glove allergen content study	Analysis of specific latex allergen content of 49 rubber gloves used in Singapore's major hospitals and healthcare departments, focusing on Hev b1, b3, b5, b6.02 latex proteins.	Examination gloves had higher latex allergen content than surgical gloves; and powdered gloves had higher latex allergen content than non-powdered gloves. Of all examination gloves tested, 83% had allergen levels exceeding a clinically relevant threshold for type I latex allergy, as demonstrated by another study.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Exposure-response	Latex aeroallergen measurement may be helpful in defining and reducing latex exposures with a consequent effect on symptom prevalence.	None declared	Latex aeroallergen measurement may be helpful in defining and reducing latex exposures with consequent effects on symptom prevalence.	C	Yes
2+	Glove analysis	Examination gloves tend to have higher latex allergen content than surgical gloves. Powdered gloves have higher latex allergen content than powder-free gloves.	None declared	–	C	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Korniewicz, Garzon, Seltzer <i>et al</i> , 2004 ⁴⁹	Failure rates in non-latex surgical gloves	Randomised controlled trial	This study analysed 6,386 gloves used by 101 surgeons and 164 residents representing 15 surgical services. The purpose was to compare the frequency of glove defects for non-latex surgical gloves while surgeons performed routine surgery and to evaluate surgeons' satisfaction with non-latex sterile gloves. Two brands of latex gloves and six brands of non-latex gloves were tested. Gloves were collected at the end of each surgical procedure and tested for visual defects and barrier integrity using an automated calibrated water test machine consistent with FDA's recommended standards.	Higher after-use defect rates occurred in non-latex surgical gloves than in latex gloves. Higher times of use were related to higher defect rates for some surgical specialties, and both surgeons and residents were less satisfied with non-latex surgical gloves. Intact latex and non-latex surgical gloves provide adequate barrier protection. Non-latex surgical gloves have higher failure rates and lower user satisfaction than latex gloves. Both non-latex and latex gloves should be changed after two to three hours of use because the barrier of either type of glove becomes compromised with extended use.
Crippa, Belleri, Mistrello <i>et al</i> , 2003 ¹⁹	Prevention of latex allergy among health care workers: evaluation of the extractable latex protein content in different types of medical gloves	Quantitative research of an experimental design	The total protein content and the allergic latex protein contents were evaluated with Lowry modified method and RadioAllergosorbent test inhibition assay in samples and extracts of 29 different types of medical gloves to acquire information useful for preventing latex allergy in hospital personnel.	Gloves vary in total protein content by manufacturer and nitrile but not vinyl gloves were also found to contain latex reactive protein. Unfortunately, although both powdered and non-powdered surgical latex gloves were tested only powdered latex examination-type gloves were studied. Some of these glove types are used in the UK. They conclude that protein content correlates with allergenicity.
Kujala, Alenius, Palosuo <i>et al</i> , 2002 ⁴⁸	Extractable latex allergens in airborne glove powder and in cut glove pieces	Experimental glove study	This was an experimental study that analysed NRL aeroallergens from medical gloves in joint relation to total airborne dust concentration and NRL allergen concentration in gloves.	Elevated NRL aeroallergen levels were related to a high level of airborne glove powder rather than to a high concentration of extractable NRL allergen in medical gloves. Interpretation was limited by no mention of blinding.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
1+ (Strong)	Glove analysis	Non-latex surgical gloves have higher failure rates and lower user satisfaction than latex gloves. Good practice point: both non-latex and latex gloves should be changed after two to three hours of use because the barrier of either type of glove becomes compromised with extended use.	None declared	–	B	–
2++	Glove analysis	Some nitrile gloves made by some manufacturers may also contain latex allergenic proteins. Purchasing bodies should ensure that non-latex gloves are latex free.	None declared	Those concerned with glove purchasing policy should be aware that some non-latex gloves may contain latex allergens.	C	–
Moderate 2+	Glove analysis	Glove powder may be a more important determinant of airborne latex allergens than glove extractable latex content.	None declared	The use of non-powdered gloves is the most effective method of reducing occupational aeroallergen exposure to latex arising from gloves.	–	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Laoprasert, Swanson, Jones <i>et al</i> , 1998 ⁶¹	Inhalation challenge testing of latex-sensitive healthcare workers and the effectiveness of laminar flow HEPA-filtered helmets in reducing rhinoconjunctival and asthmatic reactions	Experimental	Eleven latex-sensitive volunteers with occupational asthma underwent seven sequential inhalation challenge tests by donning and discarding either vinyl gloves (challenge 1), low latex-allergen powder-free gloves (challenge 2), or high latex-allergen powdered gloves (challenges 3 to 7) for up to one hour. Volunteers wore a laminar flow helmet during all challenges but HEPA filters in the helmet were in place only during challenges 3 and 4. Flow-volume loops, symptom scores, and latex aeroallergen concentrations were measured before and during each test. The study also aimed to investigate acceptable latex aeroallergen concentrations below which latex-sensitive healthcare workers do not experience symptoms.	Powder-free/low allergenic latex gloves significantly reduced latex aeroallergenic concentrations and therefore exposure. Laminar flow HEPA-filtered helmets were effective in significantly reducing latex-induced rhinoconjunctivitis and asthmatic symptoms. Small numbers were used in this study.
Mitakakis, Tovey, Yates <i>et al</i> , 2002 ⁶⁰	Particulate masks and non-powdered gloves reduce latex allergen inhaled by healthcare workers	Controlled trial	This was a study of the extent to which inhalation of latex particles could be reduced by the use of protective masks or by replacing powdered latex gloves with non-powdered latex gloves. Twenty hospital workers wore nasal air samplers (NAS) and Institute of Occupational Medicine (IOM) samplers for four 20-minute periods. Subjects used powdered gloves, non-powdered gloves and no gloves during three sampling periods. In a fourth, they wore an aerosol barrier facemask or a particulate facemask (N=95) while wearing powdered gloves.	The number of particles inhaled while wearing powdered gloves was 24-fold higher than when not wearing gloves and 10-fold higher than when wearing non-powdered latex gloves ($p < 0.0001$). Wearing an aerosol barrier mask did not significantly reduce the number of particles inhaled ($p = 0.108$), while use of particulate masks significantly reduced the number of particles inhaled by 17-fold ($p = 0.003$). The use of non-powdered gloves was the most effective method of reducing occupational aeroallergen exposure to latex arising from gloves. However, secondary protection using particulate masks is a valid alternative.
Mahler, Fischer, Fuchs, <i>et al</i> , 2000 ³⁶	Prevention of latex allergy by selection of low-allergen gloves	Laboratory analysis of latex glove allergen content and examination of diagnostic methods for low-allergenicity gloves	An investigation of the differential allergenicity of different glove brands. Separate extracts were obtained by standard aqueous extraction from the inner and outer surfaces of 15 different (10 examination, 5 surgical) commonly used glove brands. The extracts were analysed by quantitative (bicinchoninic protein assay, IgE-ELISA, ELISA competition) and qualitative (SDS-PAGE, silver staining, IgE immunoblotting) methods for their protein and allergen contents. In addition, the glove extracts were analysed for their capacity to induce basophil histamine release and immediate skin reactions.	Glove brands vary in protein content; protein content is a poor guide to allergenicity. While the determination of total protein contents was not sufficient to identify low-allergen gloves, IgE measurements, basophil histamine release and skin testing were in good agreement and allowed the selection of low-allergen products. Findings were limited by no attempt to examine their repeatability.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Industrial hygiene	HEPA filtered helmets can be effective in reducing latex induced symptoms. Powder-free low allergenic gloves use leads to a reduction in airborne latex levels and a reduction in latex symptoms.	-		-	-
1+	Glove analysis	The use of non-powdered gloves is the most effective method of reducing occupational aero-allergen exposure to latex arising from gloves. However, secondary protection using particulate masks is a valid alternative, and may be helpful for preventing respiratory sensitisation.	None relevant	The use of respiratory protective equipment may be helpful in reducing inhalational exposure to latex allergens and latex-related symptoms.	B	-
3	Glove analysis	Glove brands vary in protein content; protein content is a poor guide to allergenicity.	None relevant	Those concerned with glove purchasing policy should be aware that latex glove protein content is a poor guide to allergenicity.	C/D	-

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Cistero, Bahima, Sastre, <i>et al</i> , 2004 ⁶⁴	Tolerance and effects on skin reactivity to latex of sublingual rush immunotherapy with a latex extract	Longitudinal	Twenty-six patients (mean age 35.5 years) with an average history of 7.5 years of cutaneous symptoms plus respiratory symptoms (23/26) due to NRL were studied. All underwent rush sublingual therapy (four days) with a standardised NRL extract followed by a nine-week maintenance treatment. Local and systemic adverse reactions were monitored throughout the treatment. Skin reactivity to NRL extract was evaluated before, during and at the end of the treatment by latex glove-use test, rubbing test and skin prick test.	Out of 1,044 administered doses, 257 (24.6%) produced adverse reactions from which 21.4% were local. Only 10.1% of cases required treatment, mainly with anti-histamines alone (5.8%). The glove-use test improved significantly after five days and ten weeks of treatment (p=0.003, p=0.0004 respectively), whereas the rubbing test improved significantly only after ten weeks of treatment. Doctor's assessments confirmed the results obtained with the glove-use test (p=0.003 after five days, and p=0.004 after ten weeks) but not those obtained with the rubbing test. No change was detected for SPTs. Good study but requires more testing and longer follow-up.
Leynadier, Doudou, Gaouar <i>et al</i> , 2004 ⁷⁹	Effect of omalizumab in healthcare workers with occupational latex allergy	Randomised controlled trial	Double-blind randomised controlled trial of 16-weeks treatment with omalizumab in 18 healthcare workers (nine active, nine placebo treatment); two on active treatment dropped out (one following an adverse event). All patients continued in their normal jobs.	At the end of the trial, 57% of those in the active group, but none in the placebo group, achieved a negative score on conjunctival challenge (p=0.006). Following a subsequent 'open treatment' phase with omalizumab, 11 of 15 patients had a negative latex glove challenge. Interpretation was limited by small size, sparse description of randomisation and blinding procedures, lack of confidence intervals and no information on costs.
Abramson, Puy, Weiner, 2003 ⁶⁵	Allergen immunotherapy for asthma	Systematic Cochrane review	A Cochrane review of specific immunotherapy for asthma presented narratively and numerically with meta-analysis.	Specific allergen immunotherapy reduces symptoms, medication use and the response to allergen challenge. Measures of lung function were not consistently improved. The review only lists one study relating to latex (Leynadier, 2000) and this is the only study of the effect on occupational asthma. Many studies included are based on child populations and these may differ in response to adult onset sensitisation.
Pereira, Pedro, Tavares, 2003 ⁶⁶	Specific immunotherapy for severe latex allergy	Case series	Four patients (three female adults and a 13 year old boy) with latex allergy. All four patients were treated with specific immunotherapy (SIT) with aqueous extract (ALK-ALK-ABELLO SA, Spain) administered subcutaneously at the hospital, by a modified rush schedule. A maintenance dose (MD) of 0.35 µg protein was established according to the magnitude of local reactions.	Three patients with severe latex allergy responded to specific immunotherapy. However, a fourth patient who had spina bifida did not. There was a very small number in the study.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2++	Immuno-therapy	Recommendation: sublingual immunotherapy would be a recommended treatment option for those with NRL allergy, where switching to other glove options to reduce the symptoms is not feasible. This suggests that the long-term effects of this treatment are an area of further research.	None declared	Recommendation: immunotherapy can be recommended as treatment option for those with NRL allergy, where switching to other glove options to reduce the symptoms is either not feasible or is ineffective.	–	–
1–	Immuno-therapy	Omalizumab may have a place in the management of symptomatic latex allergy in healthcare workers.	None declared	–	–	–
1++	Immuno-therapy	Specific allergen immunotherapy reduces symptoms, medication use and the response to allergen challenge. However, there is limited evidence for its use in occupational asthma and it should therefore be considered an experimental approach.	None declared	–	B	–
3	Immuno-therapy	–	None declared	–	–	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Sastre, Fernandez-Nieto, Rico <i>et al</i> , 2003 ⁶⁷	Specific immunotherapy with a standardised latex extract in allergic workers: a double-blind, placebo-controlled study	Randomised controlled trial	The study comprised 24 patients allergic to NRL with contact urticaria (N=8) and rhinitis or asthma (N=16) were included (16 in the active group and 8 in the placebo group). Treatment started in a cluster immunotherapy protocol, with injections every week for three months and then every other week for another three months.	Clinical efficacy was shown mainly on cutaneous reactivity, although an improvement in rhinitis and asthma symptoms was also observed during specific inhalation challenges. There was no change in specific IgE to latex, or daily self-reported symptom reports. Latex-specific immunotherapy may be a useful approach for the treatment of latex allergy in sensitised workers. Latex allergen immunotherapy shows potential to reduce clinical measures of sensitisation but not sufficient to be recommended as a treatment. It is not without the risk of systemic reactions although no severe adverse responses occurred in this study.
Patriarca, Nucera, Pollastrini <i>et al</i> , 2002 ⁶⁸	Sublingual desensitisation: a new approach to latex allergy problem	Randomised controlled trial	Randomised trial of sublingual rush (four-day) desensitisation in 24 patients with latex allergy (12 in active group, 12 in placebo).	After three months, significant improvement ($p < 0.003$) in symptom scores after sublingual, mucous and cutaneous latex challenges in the treated group as compared with the controls. In seven actively treated patients there was a reduction in specific IgE. Following active desensitisation, all patients were reported to be able to wear latex gloves, work in an environment with latex exposure and undergo medical procedures without any symptoms. Interpretation limited by no mention of blinding and poor quality of reporting.
Leynadier, Herman, Vervloet, 2000 ⁸⁰	Specific immunotherapy with a standardised latex extract versus placebo in allergic healthcare workers	Randomised controlled trial	Randomised, double-blind, placebo-controlled trial of one-year specific immunotherapy in 17 patients with latex skin allergy and rhinitis including nine with asthma (nine in active group, eight in placebo). Treatment started with a two-day course of rush immunotherapy in hospital. Efficacy assessed after six and twelve months by means of symptom and medication scores recorded on diary cards. Conjunctival provocation tests were also performed.	There was significant improvement in rhinitis, conjunctivitis and cutaneous symptoms, but adverse side effects were common and significant. Immunotherapy also decreased allergen-specific conjunctival reactivity. No details were provided on patient selection or process of randomisation; it was unclear how results from 'dropouts' (N=3, all placebo) were analysed.
Pereira, Rico, Lourenco <i>et al</i> , 1999 ⁷⁰	Specific immunotherapy for occupational latex allergy	Case report	This describes the response of a single subject with type 1 latex allergy to SIT by subcutaneous injection with increasing allergen potencies.	The subject appears to have been successfully tolerised to latex while on maintenance dosing with allergen extract. Objective evidence of decrease in wheal size on SPT before and after SIT was demonstrated together with a negative specific inhalation challenge and the ability to work in exposure without symptoms. The limited evidence makes this of experimental interest only.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
1+	Immuno-therapy	Subcutaneous immunotherapy with natural rubber latex extract, at adequate doses, may be a useful treatment in reducing cutaneous reactivity, respiratory and ocular symptoms, but has significant side effects.	None declared	–	–	This would also suggest that the long-term effects of this treatment are an area of further research.
1–	Immuno-therapy	Specific, sublingual immunotherapy may be helpful in managing the symptoms of latex allergy and in allowing affected employees to remain in work.	None declared	–	–	–
1+	Immuno-therapy	Specific immunotherapy may be helpful in managing the symptoms of latex allergy and in allowing affected employees to remain in work. Significant risk of adverse effects.	Study supported by Stallergènes SA	–	–	–
3	Immuno-therapy	SIT may allow individual workers to become tolerant of continued latex exposure.	None declared	–	D	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Bernstein, Karnani, Biagini, 2003 ⁵⁶	Clinical and occupational outcomes in healthcare workers with natural rubber latex allergy	Case series	A total of 67 healthcare workers with NRL allergy (recruited by advertisement for a study of a skin test reagent) completed a questionnaire to evaluate clinical and economic outcomes of active work and environmental interventions subsequent to recognition of work-related symptoms associated with NRL gloves.	Interventions designed to reduce or eliminate latex exposure in latex allergic healthcare workers with urticaria were universally effective (11/11 who switched to non-latex gloves); and highly effective among those with rhinitis (15/18, 83%) or asthma (20/20, 100%) . Four (of 24) employees with asthma changed jobs because of their allergy but only two out of healthcare work; in each case their symptoms resolved. On average these four lost income . Simple workplace interventions – switching to non-latex gloves – had been in most cases effective in the management of latex allergy among these healthcare workers. Interpretations were limited by sparse information on numbers recruited and excluded, lack of a referent population, and a small sample size of questionable representativeness.
Hamilton, Brown, 2000 ⁸¹	Impact of personal avoidance practices on healthcare workers sensitised to natural rubber latex	Longitudinal cohort	In this study, 20 US anaesthetists with latex sensitisation (80% without symptoms) followed after ‘avoidance practice education’ and provision with non-latex gloves.	Changes in IgE titre and SPT reactivity after latex ‘avoidance’ are unpredictable; but probably require at least 15 months’ avoidance . Some symptoms disappeared after personal avoidance of latex gloves at work. Interpretation limited by small size of study population, lack of detail on how rigid latex avoidance had been and lack of clarity over length of follow-up.
Nettis, Colanardi, Ferrannini, 2004 ⁵³	Type I latex allergy in healthcare workers with latex-induced contact urticaria syndrome: a follow-up study	Longitudinal cohort	The aim of this follow-up study to determine long-term health consequences in healthcare workers with type I latex allergy with latex-related contact urticaria syndrome , of providing appropriate information and practical avoidance education. Evaluation of immunological markers and use test for latex allergy following avoidance measures three to seven years after diagnosis of latex allergy in 17 healthcare workers. All follow-up subjects stopped using latex gloves. Co-workers either switched to non-latex or used powder free, low protein gloves if necessary . Initial and follow-up visits included: a detailed questionnaire, skin prick test (SPT) with glove eluates and with commercial latex extract, SPT with common inhalant and food extracts, serum specific immunoglobulin (Ig)E to latex and some foods and the glove use test.	Decreased SPT reactivity, and serum specific IgE with increased time to positive use test in all but one subject suggesting that NRL avoidance can reduce markers of sensitisation and symptoms in the workplace . On re-examination, 11 (64.7%) subjects showed positive SPTs to extemporaneous extract and 10 (58.8%) patients showed a positive SPT to commercial extract. Of the nine patients with detectable levels of serum latex specific IgE at first evaluation, four (44.4%) became negative and four were assigned to at least one class lower. Only one (11.1%) employee had higher radioallergo-sorbent test values than those at the latex allergy diagnosis. At follow-up, the 17 individuals had positive latex challenge results, although the duration of exposure caused a reaction increased. Problems were a small sample size, and the extractable latex content of the gloves in use test is not given for either the initial or follow-up test.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
3	Latex-free follow-up, jobs	Switching to non-latex gloves may be effective at abolishing or controlling symptoms of latex induced rhinitis/asthma, and to a lesser extent urticaria.	None declared		D	–
2–	Latex-free follow-up/ education	The effects of the removal of powdered gloves and of personal latex avoidance on latex IgE sensitisation is uncertain.	One author entitled to royalties for skin test reagents	In employees with latex allergy or sensitisation, the personal avoidance of latex gloves at work reduces symptoms, indices of disease severity and immunological markers of sensitisation. In employees with latex allergy, the use of powder-free latex gloves at work by their colleagues reduces symptoms, indices of disease severity and immunological markers of sensitisation in the index case.	–	–
2+	Latex-free follow-up – management/ education	NRL avoidance can reduce markers of sensitisation and symptoms in the workplace.	None declared		C	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Rueff, Schopf, Putz, Przybilla, 2004 ⁵⁴	Effect of reduced exposure on natural rubber latex sensitisation in healthcare workers	Longitudinal cohort study	Immunological follow-up of 88 healthcare workers with NRL allergy or NRL sensitisation after preventive measures (NRL free gloves) and introduction of powder-free latex gloves for all other healthcare workers	Avoidance measures reduce immunologic markers of NRL sensitisation and symptoms over a period of three years. At the last follow-up, a loss of skin prick test reactivity to NRL was observed in one of 29 subjects with NRL allergy (3.4%) and 16 of 35 with NRLs (45.7%) with previous skin test reactions ($p < .001$). Among those subjects who demonstrated a kU/L level (CAP class) equal to or greater than class I to NRL at the initial examination, NRL-specific IgE was absent at the last follow-up in 8 (32.0%) of 25 subjects with NRL allergy and 14 of 36 (38.9%) with NRL sensitisation. At the final examination, they could no longer demonstrate sensitisation to NRL by any method in 24 of 88 (27.3%) healthcare workers. Complete loss of NRL sensitisation was less frequent in subjects with NRL allergy than in those with NRL sensitisation (1 of 33 or 3% versus 23 of 55 or 41.8%; $p < .001$).
Vandenplas, Jamart, Delwiche <i>et al</i> , 2002 ⁵⁵	Occupational asthma caused by natural rubber latex: outcome according to cessation or reduction of exposure	Longitudinal/cohort	The purpose of this study was to compare the health and socio-economic outcomes of subjects with latex-induced asthma before and after reduction (latex-free exam gloves and low allergen latex sterile gloves) or cessation (latex gloves never used in their environment) of exposure to latex. The study investigates 36 subjects with latex-induced asthma as ascertained by specific inhalation challenges after a median follow-up of 56 months (range: 12 to 92 months). Initial and follow-up visits included use of a detailed questionnaire and measurement of the concentration of histamine causing a 20% fall in FEV(1) (PC(20)). At follow-up, information on employment, financial status and quality of life was collected.	At follow-up, 16 subjects were no longer exposed to latex, whereas 20 subjects had reduced exposure. In the subjects who avoided exposure, asthma severity decreased from a median score of 8.5 to 3.5 ($p = .001$) and the median histamine PC(20) value increased from 0.4 mg/mL to 2.3 mg/mL ($p = .002$). In the subjects who reduced their exposure, asthma-severity score improved from 6.5 to 2.5 ($p < .001$) and PC(20) values rose from 0.5 mg/mL to 2.4 mg/mL ($p < .001$). Cessation of exposure to latex was associated with asthma-related work disability (69%) and loss of income (62%) more frequently than was reduction of exposure (35% and 30%, respectively). Note: participants were not randomly assigned to reduction or removal so for some who were removed this may have been the only pragmatic course of action. Compensation systems are different which may affect the likelihood of removal from exposure.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2++	Latex-free follow-up – management	NRL avoidance can reduce markers of sensitisation and symptoms in the workplace.	None		C	–
				In employees with latex allergy or sensitisation, the personal avoidance of latex gloves at work reduces symptoms, indices of disease severity and immunological markers of sensitisation. In employees with latex allergy, the use of powder-free latex gloves at work by their colleagues reduces symptoms, indices of disease severity and immunological markers of sensitisation in the index case.		
2+	Latex-free follow-up – quality of life	Where clinical considerations allow it, reduction of exposure to latex may be a useful alternative associated with fewer socioeconomic consequences to removal from exposure.	None declared		C	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Turjanmaa, Kanto, Kautiainen <i>et al</i> , 2002 ⁴⁴	Long-term outcome of 160 adult patients with natural rubber latex allergy	Longitudinal/cohort	A study of 160 (of 174) NRL allergic patients (healthcare and non-healthcare workers) looking at occupational outcomes when all gloves in the working environment were changed either to low allergen latex gloves, or non-latex gloves. Outcomes assessed by both questionnaire and examination for hand eczema.	None of the healthcare workers had changed work because of natural rubber latex allergy; and only 38% had continuing hand eczema (significant decrease from 54% in healthcare workers , p=0.019). Nearly all (98%) of the non-healthcare workers continued with their previous jobs. There was no evidence of any fall in specific IgE. Interpretation limited by lack of comparison groups and variable length of follow-up.
Allmers, Brehler, Chen <i>et al</i> , 1998 ³⁹	Reduction of latex aeroallergens and latex-specific IgE antibodies in sensitised workers after removal of powdered natural rubber latex gloves in a hospital	Longitudinal/cohort	A prospective study in healthcare workers to appraise the efficacy of preventing exposure by eliminating powdered NRL gloves from the workplace and giving NRL-free material to sensitised workers. Sensitisation of healthcare workers to NRL was determined by SPTs and measurements of specific IgE antibodies. NRL allergen concentrations in room air were measured before and after substitution of powdered NRL gloves with powder-free or synthetic gloves in different departments of a hospital and determined by a competitive inhibition immunoassay.	The prevalence of healthcare workers with positive skin prick test responses and NRL-specific IgE-positive healthcare workers was 8% (N=7) among the 90 examined staff members before the intervention started. All 7 reported glove-related allergic symptoms. Six of seven sensitised subjects had a significant decrease of latex-specific IgE antibody concentrations during follow-up examinations. Within 24 hours after substitution took place, NRL aeroallergen levels fell below the detection limit in areas with synthetic gloves or powder-free NRL gloves alike. Use of asthma medication and antiallergic drugs could be discontinued by two healthcare workers with NRL-related respiratory tract symptoms. However, the latex content of powdered gloves used during the study period changed to a lower level due to manufacturing changes. The provision of non-latex gloves to sensitised subjects may explain the fall in specific IgE levels as much as any changes in environmental aeroallergen.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Latex powdered glove substitution and latex free – management, jobs	Virtually all healthcare workers and others with latex allergy can retain their jobs with careful attention to latex avoidance at work. The prevalence of hand eczema in allergic healthcare workers falls if they start to use latex-free or low-allergen gloves.	Supported by grant from Ansell Healthcare	–	C	–
2+	Latex powdered glove/latex free substitution – management, aeroallergens	A change from powdered latex gloves to non-powdered or non-latex gloves is likely to significantly reduce measurable aeroallergen levels. Such measures may allow latex sensitised or allergic subjects to remain in their jobs and may prevent the progression of allergy.	None declared	–	C	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Jones, Rolf, Stingl <i>et al</i> , 2004 ⁵⁷	Longitudinal study of sensitisation to natural rubber latex among dental school students using powder-free gloves	Longitudinal/cohort	This was a cohort study of first-year dental students throughout four study years during exposure to powder-free low protein latex gloves . Their atopic status was determined by skin prick testing using a panel of common allergens, and any sensitivity to latex proteins and the cross-reacting food allergens assessed. Skin prick testing was carried out on the volunteers using latex, avocado, kiwi, banana, grass pollens, tree pollen, house dust mites and cat dander. Each volunteer completed a questionnaire detailing allergic history and any previous latex exposure.	The study concluded that exposure to powder-free low protein latex gloves was not associated with subsequent sensitisation over five years in a population with a high atopic incidence. No evidence of sensitisation to latex was found after the exposure period once the baseline sensitisation rate had been established. Initial latex skin testing was positive in 3 of the 63 students followed throughout their period of study. Subsequent testing gave a negative result in one student and one declined retesting. The third continued to give a positive response on each testing; she wore only nitrile gloves and remained free of clinical NRL allergy symptoms.
Filon, Radman, 2006 ⁷⁶	Latex allergy: a follow-up study of 1,040 healthcare workers	Longitudinal	This was a prospective three-year follow-up study of 1,040 Italian healthcare workers (90% of those exposed to latex) before and after change from powdered to powder free latex gloves . It looked at latex-related symptoms and sensitisation by means of a questionnaire, a medical examination, SPTs and IgE specific antibody assay, and had a 92% response rate .	<ol style="list-style-type: none"> 1. Most glove-related symptoms (prevalence 22%) were mild. 2. Prevalence of positive SPT to latex 6%; poor agreement with measurement of specific IgE. 3. No evidence of job change or loss from latex allergy over three years of follow-up. 4. Most symptoms improved over the period of follow-up – perhaps attributable to improved latex policy and careful case handling. Hand eczema was significantly reduced ($p=0.0001$) at follow-up and disappeared in seven cases (29% of those with eczema at baseline). Urticaria disappeared in 44% of those with this symptom at baseline but was still present on contact with latex gloves in 24%. Subjects with rhinitis had to use non-latex gloves but continued to work in the same place. There was a reduction in symptoms among asthmatic subjects, but in these cases too, symptoms reappeared on occasional contact with latex gloves.
Allmers, Schmengler, John, 2004 ⁵⁸	Decreasing incidence of occupational contact urticaria caused by natural rubber latex allergy in German healthcare workers	Longitudinal	The study measured the impact of a national ban on powdered latex gloves in German healthcare workers, using insurance data of 1.8 million German healthcare workers.	Banning powdered NRL gloves resulted in an 80% decrease in suspected/confirmed cases of NRL contact urticaria being reported.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Latex powder glove substitution – primary prevention	Powder-free low protein latex gloves may not induce latex allergy.	None declared	For those involved in institutional health and safety policy decisions, the use of powder-free, low protein gloves reduces the incidence of latex allergy.	D	–
2+	Latex powdered glove substitution – management, jobs	For healthcare workers, substitution of powdered latex gloves to powder-free, low allergenic protein gloves can reduce symptoms of both type I and type IV rubber glove allergy; and allow, with careful case handling, affected employees to continue in their job.	None declared	–	C	–
2+	Latex powdered glove substitution – primary	National strategies to encourage switching to powder-free gloves can be effective at reducing the incidence of latex allergy	None declared	–	D	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Allmers, Schmengler, Skudlik, 2002 ⁵⁹	Primary prevention of natural rubber latex allergy in the German healthcare system through education and intervention	Longitudinal study	This study assessed the effects of intervention to reduce the occurrence of NRL allergy in personnel working in healthcare facilities insured by the German statutory accident insurance company for healthcare workers, by switching to powder-free NRL gloves nationally . The timing of introduction of intervention strategies, such as education of both physicians and administrators, together with regulations demanding that healthcare facilities only purchase low-protein, powder-free NRL gloves are reported. Annual numbers of reported suspected cases of NRL-caused occupational allergies and the amount and type of gloves used in German acute care hospitals since 1986 are reviewed using information from the Statutory Insurance Database.	Primary prevention of occupational allergies can be achieved on a national scale. Reduction of powdered NRL gloves in a hospital environment led to a decrease in allergy incidence after a two-year lag. Reported cases of sensitisation increased when educational campaign was mounted, followed by a decrease in conjunction with reduction in powdered NRL glove use.
Trape, Schenck, Warren, 2000 ⁷¹	Latex gloves use and symptoms in healthcare workers one year after implementation of a policy restricting the use of powdered gloves	Longitudinal study using two cross-sectional surveys to establish point prevalence of self-reported latex glove-related symptoms	This comprised two independent cross-sectional surveys on healthcare workers carried out one year after implementation of a latex policy. A population-based survey of hospital healthcare workers (National Surveillance System for Hospital healthcare workers (NaSH), N=1,073), and a more detailed survey of healthcare workers stratified by exposure to latex gloves, the Latex Symptom Survey (LSS), N=475. The latex policy offered healthcare workers a choice of powder-free latex and latex-free gloves for non-sterile procedures. Powdered latex gloves were still available for sterile procedures for the duration of the study but after a year the policy was extended to sterile procedures also.	Prevalence of dermatitis symptoms self-reported by latex glove users was 40.3% (NaSH survey), and 50.0% (LSS) but one of the surveys had only a 34% response rate. Increasing latex glove exposure correlated with increasing symptom reports. Dermatitis symptoms related to latex glove use were reported much more frequently than aerosol or urticarial symptoms. Healthcare workers, and even those with symptoms continued to prefer and use latex gloves in more than 80% of cases. They conclude that a latex policy that restricts the availability of powdered latex gloves is not enough to reduce skin symptoms or prevalence of latex sensitisation in healthcare workers. Employee education at a pre-placement evaluation should be carried out to identify and protect employees sensitised to latex.
Hermesch, Spackman, Dodge, Salazar, 1999 ⁴⁰	Effect of powder-free latex examination glove use on airborne powder levels in a dental school clinic	Experimental study	A study describing the airborne cornstarch levels before and during the use of non-powdered latex gloves with further results after the reintroduction of powdered gloves.	The use of non-powdered latex gloves produced a significant reduction in airborne powder levels. Additionally when powdered gloves were used airborne powder counts rose significantly during the clinic session but this was not seen with non-powdered gloves.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2+	Latex powdered glove substitution – primary	National strategies to encourage switching to powder-free gloves may be effective at reducing the incidence of latex allergy.	None declared	–	–	–
2+	Latex powdered glove substitution – primary, policy	As part of a latex policy, employee education at a pre-placement evaluation should be carried out to identify and protect employees sensitised to latex.	None declared	At an institutional level, a complete ban on the use of powdered latex gloves reduces the incidence of sensitisation and prevalence of latex allergic symptoms. An institutional policy based on voluntary restrictions may not be as effective.	D	–
2+	Latex powdered glove substitution – primary prevention and management	The use of non-powdered gloves reduces airborne powder levels.	–	–	C	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Nielsen, Olsen, Larsen <i>et al</i> , 2005 ⁷⁸	IgE-mediated sensitisation, rhinitis and asthma from occupational exposures. Smoking as a model for airborne adjuvants?	Systematic literature review	This study describes the effect of smoking on IgE mediated allergy found in various studies, including only two on latex.	There is no effect of smoking on the development of asthma in latex allergy. Only two studies are available for latex and the effect of smoking was not the major research question for these studies.
Bell, Watt, Straine, 2005 ⁷²	Impact of a latex policy on an acute NHS hospital: an audit	Audit/cross-sectional survey	This describes the impact of latex policy on a large (5,000 staff) acute UK hospital.	The latex policy was not implemented effectively. Generally there was poor compliance with latex policy and better compliance where a senior staff member had latex allergy. Interpretation limited by no details on base population, no details on blinding, most information self-reported and interpreted; but some objective criteria such as glove availability. Only managers were interviewed; and there are descriptive results only.
Brown, Hamilton, McAllister, 2003 ⁷³	How healthcare organisations can establish and conduct a program for a latex-safe environment	Report of a hospital latex task force	A summary report of a US (Johns Hopkins Hospital) interdisciplinary latex task force addressing the issue of creating, implementing and evaluating a latex-safe environment. Some interesting experiences with a 'latex-safe' policy but not strictly 'research'.	A switch to vinyl gloves was unacceptable; a switch to nitrile was more acceptable but there was significant cost implications and surgical resistance. The switch to nitrile examination gloves was successfully completed, but conversion to non-latex surgical gloves was less successful, with costs being the overwhelming impediment. Staff education is important.
Al-Otaibi, Tarlo, House, 2005 ⁷⁷	Quality of life in patients with latex allergy	Case series	This is the results of a questionnaire about quality of life completed by 31 (of 56) latex allergic patients attending clinic at a Toronto hospital. Thirty respondents were healthcare workers.	Results analysed with simple descriptive statistics only: 42% had changed their jobs (not occupations) to reduce latex exposure; 13% had stopped work for the same reason. No major effects on quality of life; any negative effects seem to diminish with time. The various manifestations of latex allergy can be managed so there is no significant interference with quality of life'. The interpretation was limited by small numbers and poor response rate.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2++	Miscellaneous	There appears to be no effect of smoking on the development of latex induced asthma.	None declared	–	B	–
3	Policy	Hospital latex policies may be poorly understood and implemented.	None declared	–	–	–
4	Policy	A switch to latex-free gloves is achievable but meets with resistance, especially for surgical use. Staff education is valuable.	Support from Center for Disease Control grant	Those planning institutional change concerning latex use should be aware that there may be resistance, and the policy may be poorly understood.	–	–
3	Quality of life	Occupational exposures for healthcare workers with latex allergy can usually be managed so that there is no significant effect on quality of life.	None declared	–	D	–

continued

Authors	Title/aims	Study design	Study population/ methodology	Main results
Kujala, Karvonen, Laara <i>et al</i> , 1997 ⁸²	Postal questionnaire study of disability associated with latex allergy among healthcare workers in Finland	Case-control study	This small study looked at the different responses to the self-completed Work Ability Index (WAI) between 32 latex allergic healthcare workers and 51 controls. A secondary aim of the study was to evaluate sensitivity and specificity of a self-administered latex allergy questionnaire as a screening tool for latex allergy.	There was a significant reduction in WAI for latex allergic health-care workers when compared with controls. The sensitivity and specificity of a questionnaire was estimated at 84 and 98% respectively when there was a positive response to one of three skin symptoms and one mucosal symptom. A weighting was applied to some of the WAI items, however the evidence for using the weighting applied is not given. Untransformed data is provided in results. Sample size was small but with a good response rate. Matching for atopy was not discussed in detail although it was recognised that this may be a confounder and some efforts to control for this were made. Subjects with latex allergy were drawn nationally but controls were recruited locally. This could influence WAI responses.
Allmers, 2001 ⁶²	Wearing test with two different types of latex gloves with and without the use of a skin protection cream	Longitudinal/cohort	This study aimed to determine if skin protection cream can reduce adverse reactions to latex: 72 subjects reporting symptoms indicative of Type I hypersensitivity reactions to natural rubber latex (NRL) gloves were included. Forty-four subjects had a positive prick test to NRL and all underwent wearing tests using 2 types of NRL gloves with high (n=63) and low (n=70) allergen contents. The outcome recorded was frequency of skin prick test responses.	There were 18 hypersensitive reactions induced in 63 subjects wearing NRL gloves with high allergen contents , which was reduced to 11 with skin protection cream. No change was observed in the reaction in NRL gloves of low allergen content , when cream was used/not used, however the low allergen content gloves only triggered a response in 2/70 individuals.
Baur, Chen, Allmers, Raulf-Heimsoth, 1998 ⁶³	Results of wearing test with two different latex gloves with and without the use of skin-protection cream	Controlled trial (not randomised)	This was a comparison of the use of NRL gloves in 109 latex allergic subjects with and without the prior skin application of a skin protection cream . Two glove types were used with differing allergen contents.	The application of a so-called skin protective cream increased the number of positive use tests in subjects demonstrated to have sensitisation and reporting glove allergy. A positive use test when wearing high soluble allergen NRL gloves was significantly associated with both positive SPT and CAP tests to latex. Only two subjects reacted to low protein non-powdered gloves used and then only when the skin protection cream had been applied. Skin protective creams may cause leaching of NRL allergen from gloves and enhance its skin penetration.

SIGN	Result category	Statements	Conflict of interest declared?	Recommendation	Recommendation grading	Further research area
2-	Quality of life	Latex allergy has an adverse effect on workability scores.	None declared	Jobs do not have to be changed! Most cases can be managed with minor changes in the workplace.	D	-
2-	Skin cream	The biggest improvement in skin reaction came as a result of wearing low allergen gloves, part of the method of testing. The improvement using the hand cream was not significant, nor would it be cost effective. Recommendation: replacement of high allergen content gloves with low allergen content latex gloves	None declared	-	-	-
-	Skin cream	High allergen contents in latex gloves frequently elicit skin responses in NRL-sensitised subjects Skin-protection creams may favour the uptake of allergens from gloves, thus increasing allergic reactions. This finding should be considered when recommending skin care protocols.	None declared	In people who are going to wear latex gloves, the prior use of hand creams cannot be recommended.	D	Creams eluting chemicals from other types of gloves.