IN BRIEF

- The collection of data on adverse reactions to dental materials has shown that gloves produce nearly 50% of all adverse reactions reported.
- The analysis of the reports provides us with the necessary evidence on which to base our judgement of the safe use of dental gloves.
- This article shows that both patients and dental professionals are potentially at risk from an adverse reaction to gloves.
- Although most glove-related adverse reactions were resolved or controlled, a substantial number of those experienced by dental professionals (14%) were potentially life- or career-threatening.

Adverse reactions to protective gloves used in the dental profession: experience of the UK Adverse Reaction Reporting Project

A. Scott,[1] D. J. Gawkrodger,[2] C. Yeoman,[3] W. Egner,[4] R. van Noort,[5] P. V. Hatton[6] and J. Grummitt[7]

The Adverse Reaction Reporting Project (ARRP) was set up to measure the extent and severity of adverse reactions to dental materials in the UK. Further analysis into the use of protective gloves has been carried out to establish the degree to which gloves are having a deleterious effect on the dental profession. In addition the survey aimed to establish the techniques used to manage adverse reactions and their effectiveness.

In a 23-month period, 369 reports were received concerning adverse reactions to protective gloves used in dental practices. Reporters were contacted for further information, and a 92% response rate was achieved. The 330 reports analysed showed dentists to be the largest group to report adverse reactions, whilst dental technicians reported the fewest. The referral rate for staff and patients was similar with a third of adverse reactions being referred (n=110) to a specialist for diagnosis. A confirmed diagnosis was received in 65% of referred cases (n=72), but the symptoms reported suggested a larger degree of Type I reactions occurring than diagnosed. The use of non-powdered gloves appeared to be favoured over powdered gloves in 42% of glove changes, and nitrile gloves were used as an alternative to latex in 39% of changes.

In conclusion, the results from this survey showed that wearing gloves in dental practices in the UK caused a range of adverse reactions. In 79% (n=330) of cases reported and analysed, these reactions were readily resolved or improved by self-medication, prescribed medication and / or changing to a different type of protective glove.

INTRODUCTION

Over the past 20 years there has been a substantial increase in the number of medical and dental personnel wearing gloves to protect against infection and the chemicals used in the administration of treatment to patients.[1] Concurrently there has been an increase in the number of reported glove-related adverse reactions, especially involving powdered latex gloves.[2] As a result the National Institute of Occupational Safety and Health (NIOSH) in the USA issued a safety alert recommending the use of powder-free, reduced protein latex gloves in order to reduce exposure to natural rubber latex (NRL) proteins.[3] The Medical Devices Agency (MDA) Adverse Incident Unit in the UK has also issued guidelines relating to latex medical gloves and powdered latex medical gloves.[4,5] Finally the British Dental Association (BDA) has issued a fact file recommending the use of non-powdered gloves and highlighting the need for latex-free dental practices in association with latex allergy in healthcare workers.[6]

Adverse reactions associated with gloves range from contact dermatitis to life-threatening anaphylaxis. The most commonly reported reaction is irritant contact dermatitis, a non-immunologic inflammation caused by direct damage to the protective layer of the skin, that can result from inadequate hand care, friction, perspiration or extreme humidity and temperature conditions.[7] Allergic contact dermatitis is the next most frequently reported adverse reaction and is often caused by rubber accelerators and antioxidants used in the manufacturing of latex gloves.[6] This is a delayed (Type IV) hypersensitivity reaction mediated by T lymphocytes.[8] The third most common adverse reaction is an immediate (Type I) hypersensitivity by IgE, mainly due to latex proteins present in NRL.[7] These proteins can migrate to the surface of gloves when moistened, or can attach to the cornstarch don-

[1]Research Assistant, *[5]Professor in Dental Materials, [6]Reader of Biomaterials, Department of Adult Dental Care, University of Sheffield, Sheffield [2]Consultant in Dermatology, Department of Dermatology, Sheffield Teaching Hospitals, Royal Hallamshire Hospital, Glossop Road,[3]Consultant in Oral Medicine, Department of Oral and Maxillofacial Surgery, Sheffield Teaching Hospitals, Charles Clifford Dental Hospital, Wellesley Road, Sheffield [4]Consultant in Immunology, Department of Immunology, Sheffield Teaching Hospitals, Northern General Hospital, PO Box 894, Sheffield, [7]Compton Acres Dental Practice, West Bridgford, Nottingham.
*Correspondence to: R. van Noort, Department of Adult Dental Care, University of Sheffield, Sheffield S10 2TA
Email: r.vannoort@sheffield.ac.uk

Refereed Paper
Received 01.02.02; Accepted 31.03.03
doi:10.1038/sj.bdj.4810821

ning agent, which carry additional NRL protein to the skin.[9] In addition the protein-powder particles from powdered NRL gloves can become airborne during donning and removal of gloves, causing respiratory exposure.[10]

The Adverse Reaction Reporting Project (ARRP), funded by the NHS National Research and Development Programme on Primary Dental Care (hosted at the University of Sheffield) was set up in July 1999 to measure the extent and severity of adverse reactions to dental materials in the UK. As a result of this reporting scheme a database of adverse reactions has been established which includes glove reactions (n=369).

The aim of this survey was to gather further glove information in an attempt to validate the reports already received. To achieve this it was necessary to determine the rate of referral and whether the adverse reactions were causing deleterious effects on the dental profession in the UK. In addition information was gathered on glove use to assess whether or not changing gloves was an effective option for dealing with adverse reactions in dental practice.

MATERIALS AND METHODS

During a 23 month period from December 1999 to October 2001 the ARRP received 369 reports of adverse reactions associated with gloves used by dental professionals. Questionnaires and a single reminder were sent to each reporting individual in order to collect further specific information for analysis. Three hundred and forty two reports were returned (92% response rate), although 12 of these were excluded due to insufficient data, therefore 330 reports were available for further analysis.

RESULTS

Number of adverse reactions per subject group

The total number of occupational adverse reactions to gloves in the data set was 257, and the number of patient adverse reactions was 73 (n=330). Figure 1 shows dentists were the largest group to report adverse reactions associated with glove use (47%), then dental nurses (25%), patients (22%), hygienists (4%) and technicians (2%).

Number and type of referrals

Of the 330 reported adverse reactions, 33% (n=110) were referred to a specialist and 67% (n=220) were self-diagnosed. Of these referrals 75% concerned dental staff and 25% involved patients. Referrals were generally to a specialist such as a dermatologist or a general practitioner (GP), (Figs 2 and 3).

From the 110 reports that were referred to a specialist, 72 had a confirmed diagnosis (but 17 diagnoses were not known by the reporter), ie 65% after diagnosis. However, because 220 cases were not referred to a specialist, it is therefore impossible to say accurately the number of Type I, Type IV or irritant adverse reactions that were occurring within the dental practices and laboratories in the UK.

The types of adverse reactions that were referred to a specialist are shown in Table 1 (n=72). It can be seen that Type I and Type IV reactions were the most commonly diagnosed, 32% (n=23) and 35% (n=25) respectively. Of the type I reactions 17% concerned patients and 83% staff, and for type IV reactions 28% concerned patients and 72% staff. However, when we consider the symptoms described by all reporters (n=330) it is evident that there may be more Type I, and similarly Type IV reactions, occurring than have been diagnosed. The prevalence of Type I reactions when we consider only confirmed diagnoses is 7% (n=23), however when we consider other reported symptoms such as eye and respi-

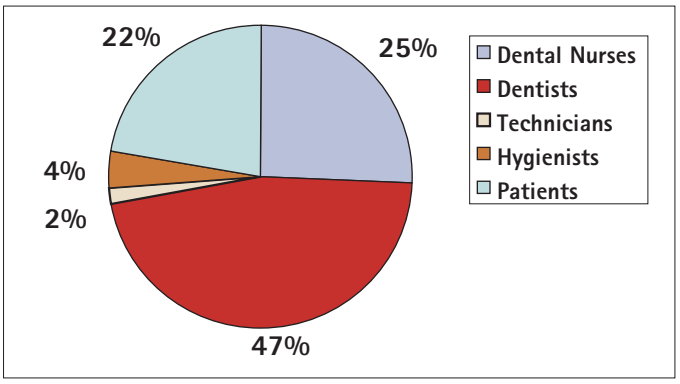

Figure 1 Adverse reactions by subject type (n=330)

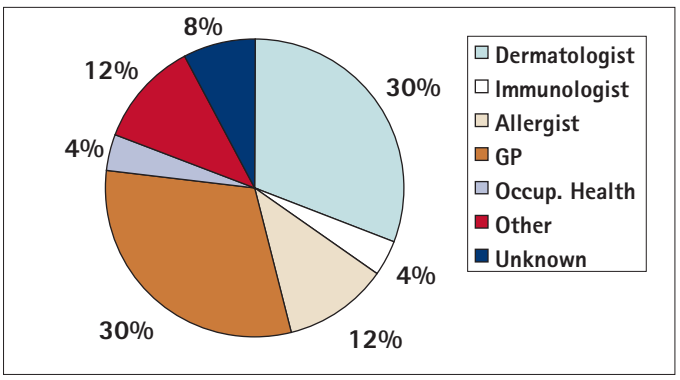

Figure 2 Occupational referral type (n=83) NB: Some cases were referred to more than one specialist. Other includes: 2 eye hospital, 1 asthma specialist, 2 research groups and 1 chest physician.

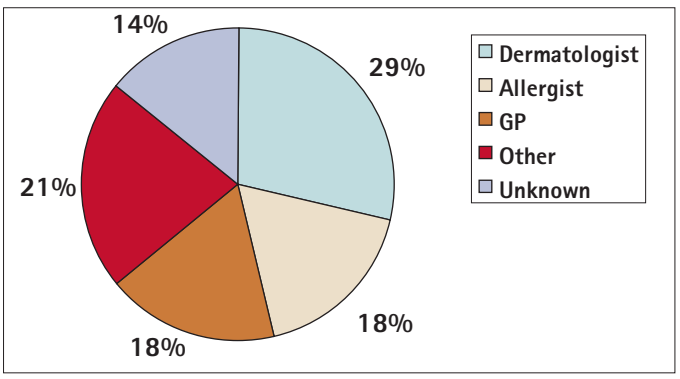

Figure 3 Patient referral type (n=27) NB: Some cases were referred to more than one specialist.Other includes: 3 consultants in oral surgery, 2 paediatric gastroenterologists and 1 hospital referral.

Table 1 Types of adverse reaction as confirmed by specialist referral (n=72)

Type I Immediate hypersensitivity to NRL protein.
Type IV Delayed hypersensitivity reaction to chemicals present in rubber gloves.

	Irritant contact dermatitis	Type I	Endogenous Eczema	Type IV	Unknown	Other
Dental Nurses	1	8	2	4	2	1
Dentists	9	10	3	14	8	2
Hygienists	1	1	0	0	1	0
Patients	0	4	0	7	6	0
Technicians	0	0	0	0	0	0
Total	11	23	5	25	17	3

NB Some gave more than one reaction type per adverse reaction.
Other includes 2 asthma and 1 psoriasis

Table 2 Types of glove used (n=330)

	Powdered latex	Non-powdered latex	Powdered nitrile	Non-powdered nitrile	Other
Dental nurses	58	30	1	1	1
Dentists	112	64	5	3	2
Hygienists	7	9	0	0	0
Patients	36	39	0	3	0
Technicians	5	1	0	0	0
Total	218	143	6	7	3

NB Some reports identified more than one glove type per person.
Other includes 2 vinyl and 1 not known.

Table 3 Patterns of glove change (n=330)

Change to:-	PL	NPL	PN	nPN	Vinyl	No Change	Other
Change from:							
PL	10	102	10	51	30	4	19
nPL		17	2	72	18	15	22
PN		2	1	2	3		
nPN			1	1	4	1	1
Vinyl				2	1	1	

NB Changes between same glove types are with different brands.
Key: PL = powdered latex, nPL = non-powdered latex, PN = powdered nitrile, nPN = non-powdered nitrile
Other includes From PL to 4 no gloves, 1 ill health, 14 not known
From nPL to 5 no gloves, 3 liners, 1 left job, 1 ill health, 12 unknown
From nPN to 1 no gloves

ratory symptoms, this could potentially be as high as 18% (n=61).

Types of gloves and glove change patterns

The most commonly used glove prior to an adverse reaction appeared to be latex gloves (Table 2). Powdered latex gloves were worn in 58% of cases and non-powdered latex gloves in 38%.

Most glove changes were from powdered latex gloves to non-powdered latex gloves (Table 3) although changes from latex gloves to nitrile gloves (powdered and non-powdered) was also a common occurrence. Seventy nine per cent of glove changes improved the overall symptoms of the adverse reaction.

Location and symptoms experienced by subject group

Table 4 outlines the site of the adverse reaction symptoms as reported by the dental health professionals. The location of symptoms was different for dental staff and patient. Symptoms were noted on the hands and fingers in 41% of staff reports (n=258), and on the face and lips in 48% of patient reactions (n=72).

Redness and itching were the most common symptoms experienced by all subject groups (Table 5), often with soreness, swelling and blistering too. The table shows respiratory symptoms such as wheezing, coughing and sneezing in most subject groups, which are typical Type I symptoms.[11] The occurrence of these symptoms is noted in 18% of dental staff and 18% of patients.

Treatment sought and outcome

The treatment for the adverse reaction carried out by each affected person was similar for all subject groups. Table 6 outlines the techniques or treatments used to manage the symptoms of an adverse reaction to gloves. Due to the nature of glove-related adverse reactions causing several different symptoms most people used more than one treatment type. In general for contact dermatitis and urticaria symptoms, such as redness, itching and soreness most people changed their glove type and applied topical creams. For respiratory symptoms, such as sneezing and wheezing, glove changes appeared to be the preferred option, in addition to using inhalers.

It was reported that the adverse reaction was resolved or relieved in 271 cases, however, 22 of these noted they had experienced periodic relief. In addition, symptoms worsened or did not change in 20 cases (n=330; 39 gave no information).

DISCUSSION:

Since December 1999 the ARRP has collected 1,075 reports of adverse reactions. A total of 507 reports (47%) relate to gloves,[12] showing them to be the single most common cause of adverse reactions in the dental surgery environment in the UK. Thus in addition to the 369 reports forming the basis of this survey a further 138 glove-related adverse reactions have been reported since this survey was carried out. Meyer[10] identified rubber as the most common cause of irritant and / or allergic contact dermatitis in dentists, dental nurses and laboratory technicians. Similarly Jolanki[13] identified dental personnel in Finland, particularly dentists, as being the highest group at risk from occupational allergic contact urticaria due to NRL in gloves.

The degree of exposure to latex gloves is a determining factor for adverse reactions.[8] Tarlo *et al.*[14] found that an increasing number (a 10-fold increase) of dental students became sensitised to latex proteins between their first and fourth year of training. Similarly the more exposure one has to the chemicals in latex gloves the higher the chances of becoming sensitised to the allergens and thus suffering an adverse reaction.[10,15] Equally irritant contact dermatitis is more prevalent in individuals who wear gloves for longer periods of time.[16] It is not surprising that dentists reported more adverse reactions relating to glove use than the other subject groups. Dentists wear gloves for longer periods of time, as com-

Table 4 Location of adverse reaction symptoms by subject group (n=330)

	Hands	Fingers	Face	Neck	Eyes	Arms	Wrists	Lips	Other
Dental nurses	71	55	13	7	18	8	2	0	31
Dentists	121	74	28	9	33	9	7	2	63
Hygienists	12	10	2	0	4	3	1	0	11
Patients	6	3	54	8	9	5	1	15	12
Technicians	5	2	0	0	1	0	0	0	0
Total	215	144	97	24	65	25	11	17	22

NB Some reports indicated more than one location where symptoms were noted.
Other includes
Dental nurses; 2 torso and 1 legs
Dentists; 3 torso, 2 legs and 1 hair loss
Hygienists; 1 legs
Patients; 9 mouth, 1 chest and 2 systemic

Table 5 Symptoms experienced by subject group (n=330)

	Redness	Itching	Soreness	Blistering	Swelling	Sneezing	Wheezing	Runny nose/eyes	Dry / Cracking	Other
Dental nurses	69	79	44	14	18	12	9	1	0	7
Dentists	121	131	90	47	37	26	19	3	12	17
Hygienists	12	11	9	6	3	2	0	0	1	2
Patients	45	36	23	17	43	5	4	1	2	6
Technicians	3	5	5	1	0	0	0	0	1	0
Total	250	262	171	85	101	45	32	5	16	37

NB Some reports gave more than one symptom type per person.
Other includes
Dental nurses; 1 high temp., 1 anxiety and 4 bumps/rash
Dentists; 2 blister fluid, 5 bumps/rash, 2 fatigue, 1 loss pigmentation, 2 eczema, 1 anxiety and 1 coughing
Hygienists; 1 fatigue and 1 eczema
Patients; 3 stinging, 1 general aches, 1 fatigue and 1 anaphylaxis

Table 6 Techniques and treatment used to manage glove related adverse reactions (n=330)

Technique or treatment type	Number reported
Changing glove type	312
Topical hand, steroid and/or antihistamine cream	99
Avoiding clinical environment / material	28
Antihistamine, antibiotics or steroids (tablets)	24
Regular hand washing / glove changes	13
Inhaler	10
Epi-pen	8
Wearing glove liners	8
Sought advice	5
Stop wearing gloves	3
No treatment	3
Remove jewellery, rings	2
Other: Nasal spray, eye drops, Vaseline dressings and bathing with sterile water.	11

NB Some reports indicated more than one technique or treatment used to manage the adverse reaction symptoms.

pared with other dental staff, as identified by Wrangsjo *et al*[11] where 40% of the dentists questioned wore gloves for more than six hours per day.

The results indicate that 31% of staff and 36% of patients were referred to a specialist, showing there to be little difference in referral rate whether the sufferer is a member of staff or a patient. This low referral rate may be due to constraints placed by the practice regarding referrals, or it may depend on the availability of specialists in a particular geographical area. In addition, the ease of getting a referral appointment or the length of waiting lists may be another factor encouraging self-diagnosis and treatment rather than referral.

Allergic and irritant adverse reactions are difficult to diagnose without appropriate tests carried out by specialists,[17] and due to the nature of Type I reactions being potentially life-threatening it is essential that confirmed diagnoses are sought rather than self-treatment.[17] Our results have shown that 79% of adverse reactions relating to glove use show improvement, when using a variety of techniques and / or treatments. Nevertheless, there is still a need for further investigation to confirm and determine the true extent of any Type I or Type IV reactions in order to try and to avoid potentially life- or career- threatening allergic reactions.

Our confirmed results (n=72) show Type I and Type IV hypersensitivity reactions to be more prevalent than irritant contact dermatitis reactions, despite the literature where the majority of skin complaints from gloves are caused by skin irritation rather than by allergy.[16,18] However due to a low referral rate and a high degree of self-treatment and management of skin problems associated with gloves, the true extent of the irritant and allergic contact dermatitis reactions is not known. Symptoms associated with irritant, Type I and Type IV reactions include redness, swelling, itching, dry cracking skin and / or blisters[9] so without appropriate diagnostic tests it is difficult to differentiate between them. Other symptoms noted during this survey indicate that Type I hypersensitivity reactions were likely to be more prevalent than the confirmed diagnoses indicate. The large number of respiratory symptoms reported, such as coughing, sneezing and wheezing when using latex gloves is indicative of a Type I hypersensitivity reaction. In addition nausea, runny nose/eyes, and anaphylaxis are symptoms of Type I latex allergy.[9]

Hamann *et al*, carried out a study on latex hypersensitivity in dental professionals in the USA.[17] They reported a frequency of dental professionals with a suspected Type I allergy to NRL as 24.8% (478 out of 1931 subjects). In addition they reported a frequency of confirmed Type I allergic reactions to NRL as 6.2% (105 out of 1,701 subjects). The results from the ARRP survey show comparable findings with suspected Type I allergic reactions being reported by 18% of dental professionals who have experienced a glove-related adverse reaction (48 out of 258 subjects), and those with a confirmed Type I allergy were 7% (19 out of 258 subjects).

When healthcare workers were first advised to wear gloves during routine examination procedures the glove manufacturers were put under increased pressure to provide them.[19] Tomazic *et al*[20] have shown convincingly that the cornstarch powder with which gloves are dusted is a potent carrier of latex proteins. It is not surprising therefore to find that an increasing number of people have changed from powdered to non-powdered gloves. Meyer[10] highlighted that occupational contact urticaria was declining, probably through the use of non-latex or non-powdered latex gloves, which confirms the ARRP results where an improvement was seen in the adverse reaction symptoms when glove changes occurred.

As adverse reactions to latex gloves has been recognised the manufacturers have responded by providing a wider choice of glove types. Our results show vinyl gloves to be a preferred change from latex. This was also noticed in a recent study in Sweden where vinyl gloves were preferred.[21] Although dynamic tests have shown the permeability of vinyl gloves to be poor compared with latex gloves they are still preferred by many because they were powder free and did not irritate the skin as readily as powdered latex gloves.[22]

Many individuals are changing from powdered latex gloves to low-protein or non-powdered latex gloves with an

improvement in their symptoms. Turjanmaa and Lanti[23,24] identified that low-protein gloves reduce adverse reactions in sensitised people and reduce the risk of occupational asthmatic reactions in subjects with latex induced asthma.[25] A recent study identified a reduction in the number of glove-related adverse reactions in hospital employees since the introduction of low allergenic gloves.[26]

Avoidance is the only effective option for latex-allergic glove wearers. In the MDA guidelines[5] it is recommended that following an adverse reaction to latex gloves the affected person should initially change to non-powdered latex gloves, if this is unsuccessful they should change to non-latex gloves or wear glove liners under their latex gloves. These procedures were carried out by a number of dental health professionals in this survey. However, the number of possible Type I allergic reactions occurring in dental health professionals and dental patients may be higher than those diagnosed, so avoidance of latex allergens should be implemented until proven unnecessary rather than risk continued exposure and the possibility of a potentially fatal adverse reaction.

The use of hand creams and/or changing gloves ensured the improvement or resolution of the symptoms in 79% of cases. Even though there were few referrals, the dental staff seemed to manage the symptoms themselves. This has also been seen in previous studies where dental nurses who develop hand dermatitis often treated themselves by self-medication and changing gloves rather than be referred to a specialist.[27]

CONCLUSION

This study has shown that gloves account for 47% of all reactions reported to the ARRP, and thus contribute significantly to the incidence of adverse reactions in the dental surgery. The vast majority of the reactions considered in detail in this study were experienced by dental professionals (257 out of 330). Of the 257 glove adverse reactions experienced by dental professionals, 19 were Type I and 18 were Type IV reactions. This means that a substantial number of the reported adverse reactions to gloves experienced by dental professionals were potentially life- or career- threatening reactions (14%). Because of the constraints of the study it was not possible to establish a precise figure for the incidence of hypersensitivity reactions due to the low overall level of referrals. Encouragingly most glove-related adverse reactions were resolved or controlled. However, the underlying cause of all symptoms of a suspected adverse reaction should always be investigated to reduce the risk of a chronic (Type I) reaction.

RECOMMENDATIONS

The reports from dental professionals received through the ARRP survey have identified several methods for managing adverse reactions associated with gloves. It must be stressed that these did not work in all cases and often a combination of methods may need to be used.

- Changing from powdered latex gloves to non-powdered, non-latex gloves
- Improving hand care regime
  - Topical use of hand, steroid and/or antihistamine creams
  - Regular hand washing
  - Regular glove changes
- Adopting a latex-free environment
- Seek specialist confirmation and advice

This project was supported by the NHS National Research and Development Programme on Primary Dental Care. We would also like to thank all the dental health professionals who have contributed reports of adverse reactions to the ARRP.

1 Burke F J T, Wilson N H F, Cheung S W. Trends in glove use by dentists in England and Wales: 1989-1992. *Int Dent J* 1994; **44**: 195-201.
2 Wakelin S H, White I R. Natural rubber latex allergy. *Clin Exp Dermatol* 1999; **24**: 245-248.
3 Center for Devices and Radiological Health. *Medical glove powder report.* USA: Food and Drug Administration, 1997. Http://www.fda.gov/cdrh/glvpwd.html
4 Medical Devices Agency. *Latex sensitisation in the health care setting (use of latex gloves).* UK: Department of Health, 1996, publication no. MDA DB9601. Http://www.medical-devices.gov.uk/
5 Medical Devices Agency. *Latex medical gloves (surgeons' and examination). Powdered latex medical gloves (surgeons' and examination).* UK: Department of Health, June 1998, publication no. MDA SN9825.
6 British Dental Association Fact File. *Hand dermatitis and latex allergy.* UK: British Dental Association, June 1998. Http://www.bda-dentistry.org.uk/
7 Spina A M, Levine H J. Latex allergy: a review for the dental professional. *Oral Surg, Oral Med, Oral Path, Oral Radiol Endod* 1999; **87**: 5-11.
8 Smedley J, Jury A, Bendall H, Frew A, Coggon D. Prevalence and risk factors for latex allergy: a cross sectional study in a United Kingdom hospital. *Occup Enviro Health* 1999; **56**: 833-836.
9 ADA Council on Scientific Affairs. The dental team and latex hypersensitivity. *J Am Dent Assoc* 1999; **130**: 257-64.
10 Meyer J D, Chen Y, Holt D L, Beck M H, Cherry N M. Occupational contact dermatitis in the UK: a surveillance report from EPIDERM and OPRA. *Occup Med* 2000; **50**: 265-273.
11 Wrangsjo K, Wallenhammar L M, Örtengren U, Barregard L, Andreasson H, Bjorkner B, Karlsson S, Meding B. Protective gloves in Swedish dentistry: use and side-effects. *Br J Dermatol* 2001; **145**: 32-37.
12 *Adverse Reaction Reporting Project survey results summary.* Department of Adult Dental Care, University of Sheffield, UK. April 2002. http://www.shef.ac.uk/~arrp
13 Jolanki R, Estlander T, Alanko K, Savelo A, Kanerva L. Incidence rates of occupational contact urticaria caused by natural rubber latex. *Contact Dermatitis* 1999; **40**: 329-331.
14 Tarlo S M, Sussman G L, Holness D L. Latex sensitivity in dental students and staff: a cross-sectional study. *J Allergy Clin Immunol* 1997; **99**: 396-401.
15 Poley G E, Slater J E. Latex allergy. *J Allergy Clin Immunol* 2000; **105**: 1054-1062.
16 Kujala V M, Reijula K E. Glove-induced dermal and respiratory symptoms among health care workers in one Finnish hospital. *Am J Ind Med* 1995; **28**: 89-98.
17 Hamann C P, Turjanmaa K, Rietschel R, Siew C, Owensby D, Gruninger S E, Sullivan K M. Natural rubber latex hypersensitivity: incidence and prevalence of type I allergy in dental professionals. *J Am Dent Ass* 1998; **129**: 43-54.
18 Wrangsjo K, Osterman K, van Hage-Hamsten M. Glove-related skin symptoms among operating theatre and dental care unit personnel. *Contact Dermatitis* 1994; **30**: 102-107.
19 Tinsley D, Chadwick R G. The permeability of dental gloves following exposure to certain dental materials. *J Dent* 1997; **25**: 65-70.
20 Tomazic V J, Shampaine E L, Lamanna A, Withrow T J, Adkinson N F, Hamilton R G. Cornstarch powder on latex products is an allergen carrier. *J Allergy Clin Immunol* 1994; **93**: 751-758.
21 Lönnroth E C, Shahnavaz H. Hand dermatitis and symptoms from the fingers among Swedish dental personnel. *Swed Dent J* 1998; **22**: 23-32.
22 Olsen R J, Lynch P, Coyle M B, Cummings J, Bokete T, Stamm W E. Examination gloves as barriers to hand contamination in clinical practice. *J Am Med Assoc* 1993; **270**: 350-353.
23 Urjanmaa K, Lahti A. Prick and use tests with 6 glove brands in patients with immediate allergy to rubber proteins. *Contact Dermatitis* 1992; **26**: 259-262.
24 Mahler V, Fischer S, Fuchs T, Ghannadan M, Valent P, Fartasch M, Kraft D, Schuler G, Valenta R. Prevention of latex allergy by selection of low-allergen gloves. *Clin Exp Allergy* 2000; **30**: 509-520.
25 Vandenplas O, Delwiche J P, Depelchin S, Sibille Y, Vande-Weyer R, Delaunois I. Latex gloves with a lower protein content reduce bronchial reactions in subjects with occupational asthma caused by latex. *Am J Respir Crit Care Med* 1995; **151**: 887-891.
26 Turjanmaa K, Makinen-Kiljunen S. Latex allergy: prevalence, risk factors, and cross-reactivity. *Methods* 2002; **27**: 10-14.
27 Strauss R M, Gawkrodger D J. Occupational contact dermatitis in nurses with hand eczema. *Contact Dermatitis* 2001; **44**: 293-296.