

# Occupational skin disease among Australian healthcare workers: a retrospective analysis from an occupational dermatology clinic, 1993–2014

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## Summary

**Background.** Healthcare workers (HCWs) are at risk of developing occupational skin disease (OSD).

**Objectives.** To ascertain the causes of OSD in Australian HCWs in a tertiary referral clinic.

**Methods.** A retrospective review was performed of patients assessed at the Occupational Dermatology Clinic in Melbourne from 1993 to 2014.

**Results.** Of 685 HCWs assessed in the clinic over a period of 22 years, 555 (81.0%) were diagnosed with OSD. The most common diagnosis was irritant contact dermatitis (ICD) (79.1%), followed by allergic contact dermatitis (ACD) (49.7%). Natural rubber latex allergy was also relatively frequent (13.0%). The major substances causing ACD were rubber glove chemicals (thiuram mix and tetraethylthiuram disulfide), preservatives (formaldehyde, formaldehyde releasers, and isothiazolinones), excipients in hand cleansers, which are hard-to-avoid weak allergens, and antiseptics. ACD caused by commercial hand cleansers occurred more frequently than ACD caused by alcohol-based hand rubs (ABHRs). Occupational ICD was mostly caused by water/wet work and hand cleansers, and environmental irritants such as heat and sweating.

**Conclusions.** Understanding the causes of OSD in HCWs is important in order to develop strategies for prevention. We suggest that skin care advice should be incorporated into hand hygiene education. The use of ABHRs should be encouraged, weak allergens in skin cleansers should be substituted, and accelerator-free gloves should be recommended for HCWs with OSD.

**Key words:** alcohol-based hand rub; allergic contact dermatitis; contact allergy; hand cleanser; hand wash; irritant contact dermatitis; nurses; patch test; preservatives; rubber chemicals; rubber gloves.

Occupational skin disease (OSD) is one of the most common occupational disorders in industrialized countries

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(1). The majority of OSD is caused by occupational contact dermatitis (OCD), including irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD) (1). The consequences of OSD include impaired quality of life and ability to work (2, 3), and economic burdens associated with medical care, sick leave, loss of productivity and workers' compensation (1). Healthcare workers (HCWs) are at high risk of developing OSD, and particularly OCD affecting the hands, as a result of daily exposure to irritants and allergens together with hand hygiene requirements. The reported prevalence of OCD affecting the hands in nurses internationally ranges from 17% to 50% (4), with

higher proportions in intensive care units (5, 6). Given that healthcare and social assistance now represents Australia's largest industry group (7), OSD prevention is a priority.

There is limited information on the exact causes of OSD in Australian HCWs. The incidence rate of OSD in Australian HCWs was recently estimated to be 21 cases per 100 000 person-years, ranking only behind the rates in hairdressers and beauticians, and machine and plant operators (8). However, as there is no national registry for OSD in Australia, this figure may be an underestimate. To investigate current trends in this area, we retrospectively reviewed the patients seen in the Occupational Dermatology Clinic, Melbourne over the last 22 years. The aims of this study were to: (i) evaluate the causes of OSD in HCWs assessed in our tertiary-level clinic; (ii) ascertain the spectrum of occupational allergens and irritants affecting HCWs; and (iii) with this information, enable professionals in the Australian and international healthcare community to better target initiatives for the management and prevention of OSD.

## Methods

### Study population

This retrospective study was based on an analysis of records from all patients seen in the Occupational Dermatology Clinic, Melbourne, Victoria, now based at the Skin and Cancer Foundation Inc., between 1 January 1993 and 31 December 2014. Patients are referred to our specialist tertiary clinic for assessment of suspected OSD, predominantly with patch testing. Referrals are made primarily by dermatologists, but also by allergists, occupational physicians, and general practitioners. Patients are largely from Victoria, but occasionally from other states.

Patients were classified as HCWs according to the following subgroups: nurses (including personal care attendants and midwives), doctors, medical scientists, dental practitioners and assistants, allied health staff, paramedics, and hospital porters. There were no exclusion criteria. All clinical records and patient data, including history, patch test reactions, and diagnoses, were collected in our secure Contact Allergy Management Systems ('PatchCams') database. The present analysis focused on HCWs in whom a final diagnosis of OSD was made (the 'study group'). The MOAHLEA index was used to describe baseline demographic characteristics (9).

### Patch testing

All patients were patch tested with either a modified European baseline series (prior to 2012) (10) or

thereafter the Australian baseline series (ABS) (11), with healthcare-specific allergens such as our nurse's series (containing antiseptics and commonly used skin cleansers), often with the rubber series, and additionally with their own contactants appropriately diluted. Allergens were sourced from Chemotechnique Diagnostics (Vellinge, Sweden), Hermal (Reinbek, Germany), and allergEAZE® by SmartPractice® (Phoenix, AZ, USA). Testing was performed with allergEAZE® Patch Test Chambers (Smart Practice®) or Finn Chambers® (Epitest, Tuusula, Finland; now Smart Practice®) on Scanpor® tape (Norgesplaster, Vennesla, Norway). Patches were applied to the upper back for 48 h, and readings were performed on day 2 and day 4 according to the ICDRG criteria (12).

### Diagnoses and definitions

**OSD.** The diagnosis of OSD was made in reference to the Mathias criteria, with fulfilment of four of the seven criteria considered to be suggestive of an occupational cause (13). These are, in brief: clinical appearance consistent with contact dermatitis; known workplace exposure to the potential irritant/allergen; temporal relationship between exposure and onset consistent with contact dermatitis; anatomical distribution of dermatitis consistent with workplace exposure; exclusion of non-occupational causes; improvement with time away from work; and, in cases of ACD, a relevant positive patch test or provocation test result.

**Work-relatedness.** The diagnosis of OSD was considered to be either significantly or partially work-related. An example of partial work-relatedness would be an HCW with endogenous eczema of the hands, aggravated by irritants at work (8). As patients could have multiple diagnoses, non-work-related conditions such as psoriasis or ACD resulting from a domestic exposure could be included as one of the final diagnoses in patients who also had a work-related diagnosis.

**OCD.** OCD was considered to be present if there was a diagnosis of occupational-related ACD, and/or ICD, and/or natural rubber latex (NRL) allergy, and/or contact urticaria/protein contact dermatitis (causes other than NRL allergy), and/or occupational autoeczematization.

**Occupational autoeczematization.** Occupational autoeczematization was considered to be present if there was a diagnosis of generalized endogenous-like eczema, precipitated by OCD, in atopic individuals who may not have had eczema since childhood, if at all (14).

**Atopic.** Patients were classified as atopic if they had a personal history of atopic eczema or asthma or allergic rhinitis (hay fever).

**Wet work.** Wet work was defined as the performance of activities for a considerable part of the working time with the hands in contact with water, wearing water-impermeable gloves, or washing the skin frequently or intensively (15).

The majority of the HCWs attending the clinic were diagnosed by the same experienced dermatologist and occupational physician (R.N.).

### Prick testing, serum analysis, and skin biopsy

Investigations were performed when indicated, including serology for allergen-specific IgE against NRL, prick testing, skin biopsy, and bacterial/fungal culture.

### Statistical analysis

Descriptive analyses were used to identify baseline patient characteristics and frequencies of diagnoses. Data from HCWs with a final diagnosis of OSD were compared with those from the remainder of the clinic population by use of a Pearson chi-square test (or Fisher's exact test, two-tailed, when appropriate). *p*-Values of <0.05 were considered to be statistically significant. Data were managed in with Excel (Microsoft Corporation, Redmond, WA, USA), and evaluated with STATA software (College Station, StataCorp, TX, USA).

## Results

### Participant demographics

Of the 3654 patients assessed in the Occupational Dermatology Clinic during the study period, 685 (18.7%) were classified as HCWs on the basis of their primary occupation. Of all HCWs assessed, 81.0% (555/685) had a final diagnosis of OSD, and these were designated the 'study group'. Participant characteristics according to the MOAHLFA index are shown in Table 1. All differences between the study group and remainder of the clinic population were statistically significant, with the exception of proportions of atopic dermatitis and face dermatitis. The mean patient age was 35.4 years (range 18–73 years). Two-fifths of the study group (40.4%, 224/555) had a history of atopic dermatitis, as compared with 45.6% (1413/3099) of the remaining clinic population. The majority of HCWs with OSD were nurses (72.6%, 403/555), followed by doctors and medical scientists (11.2%), dental practitioners and assistants (8.1%),

**Table 1.** MOAHLFA index of healthcare workers with occupational skin disease (study group) and Occupational Dermatology Clinic population

MOAHLFA category	Study group (N = 555) n (%)	Occupational Dermatology Clinic (excluding study group) (N = 3099) n (%)	<i>p</i> -Value
(M) Male	74 (13.3)	1856 (59.9)	<0.001
(O) Occupational dermatitis	555 (100.0)	2060 (66.5)	<0.001
(A) Atopic dermatitis	224 (40.4)	1413 (45.6)	0.022
(H) Hand dermatitis	497 (89.5)	1781 (57.5)	<0.001
(L) Leg dermatitis	18 (3.2)	240 (7.7)	<0.001
(F) Face dermatitis*	86 (15.5)	494 (15.9)	0.79
(A) Age ≥40 years	175 (31.5)	1383 (44.6)	<0.001

\*Includes eyelids.

allied health practitioners (5.4%), and hospital porters (0.2%). Approximately one-quarter of the study group (27.2%, 151/555) had lost time from work because of their condition; 11.2% (62/555) reported that they were currently on leave without pay, were on sick leave, had modified duties, or were receiving WorkCover payments.

### Diagnoses

Among the 555 HCWs with OSD, the most common final diagnosis was ICD (79.1%, 439/555). This was followed by ACD (49.7%, 276/555), endogenous eczema (37.1%, 206/555), and NRL allergy (13.0%, 72/555). The final diagnoses are shown in Table 2. In total, 96.9% (538/555) of OSD in HCWs was attributable to ACD, ICD, NRL allergy, contact urticaria/protein contact dermatitis (causes other than NRL allergy), or occupational autoeczematization. Two-thirds of the study group (65.0%, 361/555) were assessed as having multiple contributory factors to their condition. HCWs with OSD were significantly more likely than others attending the Occupational Dermatology Clinic to have a diagnosis of ICD, NRL allergy, or endogenous eczema ( $p < 0.001$ ). Rates of ACD were also higher in the study group than in the clinic population, although the difference was not statistically significant. The vast majority of patients suffered from hand eczema (89.5%, 497/555). Other commonly affected sites included the arms (13.0%), face (9.9%), legs (3.2%), eyelids (3.1%), and neck (2.5%) (patients could have multiple primary sites of dermatitis).

### ICD and irritants

Occupational ICD was the primary diagnosis in 52.4% (291/555) of the patients and the secondary diagnosis in

**Table 2.** Final diagnoses in healthcare workers with occupational skin disease (study group) as compared with the Occupational Dermatology Clinic population

Final diagnosis	Study group (N = 555) n (%) <sup>a</sup>	Occupational Dermatology Clinic (excluding study group) (N = 3099) n (%) <sup>a</sup>	p-Value
ICD	439 (79.1)	1523 (49.1)	<0.001
ACD	276 (49.7)	1409 (45.5)	0.064
Endogenous eczema	206 (37.1)	913 (29.5)	<0.001
NRL allergy	72 (13.0)	113 (3.6)	<0.001
Contact urticaria (excluding latex allergy)/protein contact dermatitis	21 (3.8)	183 (5.9)	0.045
Psoriasis	12 (2.2)	168 (5.4)	0.001
Persistent post-occupational dermatitis	11 (2.0)	45 (1.5)	0.35
Dermographism/urticaria	9 (1.6)	29 (0.9)	0.14
Other inflammatory skin disease	7 (1.3)	NA	NA
Paronychia	3 (0.5)	NA	NA
Bacterial/fungal infections	3 (0.5)	NA	NA
Occupational autoeczematization	2 (0.4)	6 (0.2)	0.35
Rosacea	2 (0.4)	20 (0.6)	0.56
Perioral dermatitis	2 (0.4)	NA	NA
Other	0 (0.0)	453 (14.6)	NA
Total diagnoses <sup>a</sup>	1068	4862	–

ACD, allergic contact dermatitis; ICD, irritant contact dermatitis; NA, data not available; NRL, natural rubber latex.

<sup>a</sup>Patients could have multiple diagnoses; therefore, the total number of diagnoses exceeds the number of patients.

22.0% (122/555). ICD represented 41.1% (439/1068) of the total diagnoses. Among the 439 HCWs with ICD, water/wet work was assessed as being the causative irritant in 59.2% (260/439), and hand cleansers in 39.0% (171/439). Heat and/or sweating were the cause in 13.9% (61/439), and solvents in 1.3% (6/439).

### ACD and allergens

Occupational ACD was the primary diagnosis in 23.8% (132/555) of the patients and the secondary diagnosis in 18.7% (104/555), and represented 25.8% (276/1068) of total diagnoses. Table 3 shows the 25 leading clinically relevant allergens in patients with occupational ACD. The most common allergens were rubber accelerators – thiuram mix (9.1%, 49/537) and tetraethylthiuram disulfide (8.4%, 42/502), with three other thiurams among the top 10 allergens. Annual proportions of ACD caused by thiuram mix showed a marked downward trend during the study period, with no cases in 2012–2014 (Fig. 1a). ACD caused by carbamates was less frequent overall; specifically, zinc diethyldithiocarbamate (1.2%, 6/491) and carba mix (4.4%, 7/159). Although testing with carba mix was only undertaken more recently after it was included in the ABS, explaining the lower denominator, a high proportion of the study group were tested with the complete rubber series, which contains several carbamates, as well as their own gloves. Preservatives were frequent allergens,

in particular formaldehyde (5.2%, 28/534), formaldehyde releasers (quaternium 15, 3.4%; imidazolidinyl urea, 1.5%; diazolidinyl urea, 1.4%; DMDM hydantoin, 1.1%), methylisothiazolinone (MI) (9.9%, 10/101), and methylchloroisothiazolinone (MCI)/MI (2.4%, 13/536).

A number of commercial hand cleansers and surgical scrubs were among the most frequent causes of ACD. Patch testing was performed with the commercial products themselves, appropriately diluted [10% in aq. for hand cleansers/scrubs; 'as is' for alcohol-based hand rubs (ABHRs)]. The proportion of ACD caused by all commercial hand cleansers and surgical scrubs tested over the study period (in total 16 products) was 12.4% (69/555), as compared with 1.6% (9/555) caused by all ABHRs (in total five products), although the introduction of ABHRs into healthcare settings occurred during the study period. The predominant allergens in hand cleansers were preservatives, excipients such as coconut diethanolamide (cocamide DEA), and antiseptics, in that order.

### NRL allergy

NRL allergy causing contact urticaria was diagnosed in 13.0% (72/555) of the study group: it was the primary diagnosis in 7.7% (43/555) and the secondary diagnosis in 3.6% (20/555), and represented 6.7% (72/1068) of the total diagnoses overall. The annual rate of NRL allergy peaked at 60.0% of HCWs assessed in 1999, when the numbers evaluated were much smaller, and has



**Table 3.** The 25 most frequent relevant allergens in healthcare workers with occupational allergic contact dermatitis, N = 276

Allergen	Concentration (%)/ vehicle*	Relevant reactions	Total tested	Proportion of total tested
		n	n	%
Thiuram mix	1.0 pet.	49	537	9.1
Tetraethylthiuram disulfide	1.0 pet.	42	502	8.4
Formaldehyde	1.0 aq.	28	534	5.2
Coconut diethanolamide	0.50 pet.	26	492	5.3
Dipentamethylenethiuram disulfide	1.0 pet.	23	502	4.6
Dowicil™ 200 (quaternium 15)	1.0 pet.	18	534	3.4
Tetramethylthiuram monosulfide	1.0 pet.	16	502	3.2
Tetramethylthiuram disulfide	1.0 pet.	13	502	2.6
Methylchloroisothiazolinone/Methylisothiazolinone	0.01 aq.	13	536	2.4
Fragrance mix	8.0 pet.	12	534	2.2
Chlorhexidine diacetate	0.5 aq.	11	496	2.2
Chlorhexidine digluconate	0.5 aq.	11	497	2.2
Methylisothiazolinone	0.2 aq.	10	101	9.9
Amerchol® L-101	50.0 pet.	10	513	1.9
Lanolin alcohol	30.0 pet.	9	538	1.7
Germall 115 (imidazolidinyl urea)	2.0 pet.	8	535	1.5
Germall II (diazolidinyl urea)	2.0 pet.	7	514	1.4
2-Hydroxyethyl methacrylate	2.0 pet.	6	100	6
Glutaraldehyde	0.2 pet.	6	52	11.5
Zinc diethyldithiocarbamate	1.0 pet.	6	491	1.2
DMDM hydantoin	2.0 aq.	5	442	1.1
Methyl methacrylate	2.0 pet.	5	35	14.3
Nickel sulfate	5.0 pet.	5	534	0.9
<i>Myroxolon pereirae</i>	25.0 pet.	4	534	0.7
Carba mix	3.0 pet.	7	159	4.4

\*pet., in petrolatum; aq., in aqueous solution.

remained low since 2004 (Fig. 1b). However, we still see occasional cases of NRL allergy, although uncommonly, in HCWs.

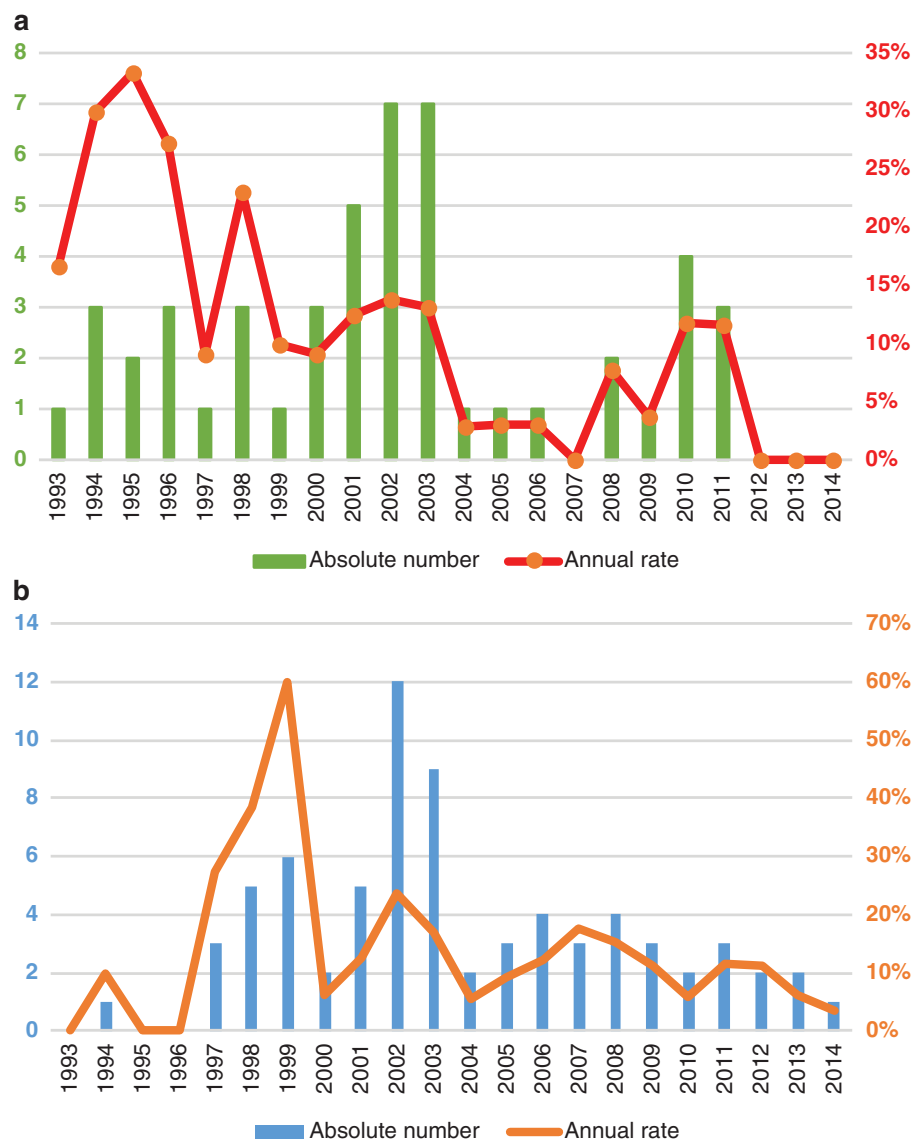
## Discussion

This 22-year analysis is the largest study of OSD among HCWs in Australia. The vast majority of OSD among HCWs was caused by contact dermatitis. Notably, two-thirds of our study group had multiple contributing diagnoses, highlighting the complexity of occupational dermatitis. For some patients, endogenous disease may be exacerbated by exogenous factors. In others, ICD may disrupt the skin surface protective lipid layer, predisposing to the development of ACD (16). Our group has previously suggested that identifying all factors contributing to a patient's skin condition aids optimal management (8).

Approximately 90% of the study group had OCD involving the hands. HCWs are known to be at high risk of developing hand eczema (4, 17), with most irritants and allergens contacting the hands, such as gloves and hand cleansers. Approximately 40% of the study group

had a history of atopic dermatitis, which is similar to the frequency reported by Molin et al. (18), but higher than in other studies (4, 19). This probably contributed to the high share of ICD, as individuals with atopic dermatitis (but not mucosal atopy) are known to be at greater risk of developing ICD (1, 20). The risk is further exacerbated in those with a large burden of wet work and irritant exposure (21). The majority of the study group (86.7%) were women; this is attributed to the large proportion of nurses in the study group, as women constitute the majority of nursing staff. Notably, one-quarter of patients had lost time from work because of their condition, showing the large burden of disease associated with OSD.

Occupational ICD was more frequent than occupational ACD (79.1% versus 49.7%). Additionally, occupational ICD was a more common diagnosis overall (41.1% versus 25.8%). This trend reflects international findings (1, 16, 22, 23). Several authors have reported higher rates of ACD than ICD among HCWs (24–27); however, in the latter studies, rates varied with occupational subgroup, and disease was not always



**Fig. 1.** (a) Annual change in occupational allergic contact dermatitis caused by thiuram mix, N = 49. (b) Annual change in occupational natural rubber latex allergy, N = 72. Note: the columns show the absolute number of diagnoses; the lines show annual prevalences (number of diagnoses/total healthcare workers with occupational skin disease).

specifically work-related. Analyses of single-profession groups showed that occupational ICD was more common than ACD in Swedish dentists (67% versus 28%) (28), whereas occupational ACD was more common in physical therapists (24% versus 17%); this is probably related to the use of essential oil for massage (29). There are many reasons for the variability in reported frequencies, including geographical area, age/sex distribution, selection bias in referral for patch testing, and patch testing.

NRL allergy was diagnosed in 13.0% of the study group overall, with annual rates peaking in the late 1990s/early 2000s. With powder-free gloves now being fairly ubiquitous in Australian healthcare settings, the annual rate has remained low since 2004, but is not yet zero. Internationally, a 3–12% prevalence of NRL allergy

among HCWs was reported in the 1990s (30), but more recent analyses have shown prevalences at the lower end of this range (31). Larese Filon et al. reported an 8-year decline in NRL allergy from 5.9% to zero following a changeover to powder-free gloves in the year 2000 (32). Similarly, Kadivar and Belsito reported no new cases of NRL allergy after 2004 (33).

### Allergens

The major allergens causing occupational ACD in HCWs were rubber glove chemicals, preservatives, hand cleanser excipients, and antiseptics. This spectrum of allergens is generally in accordance with international experience (16, 18, 23, 26, 27, 33, 34). Specific comparison

with other studies can be difficult, as allergen data are frequently presented in different forms, for example as number of positive reactions only, or as crude sensitization rates without clinical relevance always being clearly delineated or occupational-relatedness being established, as we have done. It is particularly noteworthy that we found ACD caused by commercial hand cleansers and scrubs to be eight times more frequent than ACD caused by ABHRs, although ABHRs were introduced partway through the study period. Twenty-three of the 25 leading allergens were included in the ABS, our rubber series, or the nurse's series, showing the usefulness of these series in patch testing HCWs.

*Rubber glove accelerators.* Seven of the 25 leading occupational allergens were rubber accelerators. Overall, ACD caused by thiurams was more frequent than ACD caused by dithiocarbamates, as reported by other authors (26, 35), although cross-reactivity may occur. As previously observed, the high rate of ACD may be attributable to a greater burden of exposure to thiurams, particularly in cheaper latex gloves, past exposure (especially in the 1990s, when increased glove demand led to poorer technical quality and higher levels of accelerator residues), cross-reactivity, and non-glove exposures (26, 35, 36). Our data suggest that thiuram ACD in HCWs is showing a downward trend, mirroring trends observed by other authors (37, 38). However, over the years, occupational ACD caused by rubber accelerators has been a significant problem for HCWs. Allergen substitution is critical for the secondary prevention and management of rubber accelerator allergy; that is, switching to gloves that do not contain the causative allergen(s). To facilitate this, we support mandatory labelling of accelerators on glove packaging (35), readily accessible technical data sheets, and comparison tables listing the chemicals (at a minimum by group) in each glove model. The use of accelerator-free gloves is recommended in HCWs who are allergic to multiple accelerators, but should also be considered in all patients with OSD from other causes.

*Methylisothiazolinone/methylchloroisothiazolinone.* We found that the preservatives MI and MCI were common causes of occupational ACD in HCWs. MI has gained notoriety in recent years as an emerging contact allergen (39). It is a common ingredient in toiletries such as wet wipes, skin cleansers, liquid soaps, lotions, shampoos, and conditioners. In the healthcare setting, we identified MI in at least one well-known hospital hand cleanser, and in a baby shampoo, a bath cleanser, and in wipes used on paediatric wards. Interestingly, the rate of occupational ACD caused by MI (9.9%) seen in our HCWs was higher than has been

reported in similar studies internationally (18, 19). This may be attributable to increased sensitization through occupational or non-occupational sources, or a greater burden of ongoing exposure to MI-containing products in healthcare settings.

*Hand cleansers and hard-to-avoid allergens.* We found high prevalences of ACD caused by many constituents of commonly used healthcare products, particularly commercial hand cleansers. We term these 'hard-to-avoid' allergens. They are frequently weak sensitizers, but their potential to cause allergy is influenced by considerable exposure and often coexisting ICD. For example, cocamide DEA, a foam stabilizer contained in various brands of hospital hand cleanser, was the fourth most frequent occupational allergen in our HCWs (5.3%). ACD caused by cocamide DEA has been shown to be relatively frequent among patients with occupational hand eczema (34), with sensitization primarily occurring through hand cleanser use. However, our rate is higher than has been described in both HCWs (33) and general patch test populations (34). Formaldehyde-releasing preservatives, including quaternium 15, imidazolidinyl urea, and diazolidinyl urea, are still present in some hand cleansers and emollients: occupational ACD caused by these preservatives in hand cleansers and moisturizers in the healthcare setting has been noted by other authors (33). Ultimately, reducing occupational ACD caused by commonly used healthcare products such as hand cleansers requires allergen substitution at the manufacturing level. The onus should be on manufacturers to provide products containing minimal amounts of allergens. Importantly, we found that ABHRs overall caused substantially less ACD than commercial hand cleansers, which has not been reported before. Healthcare institutions should promote increased use of ABHRs over hand washing where clinically indicated, and must ensure that HCWs suffering from occupational ACD can access alternative products. The prevention and management of concurrent ICD in HCWs will also help to reduce the risk of developing ACD.

### Irritants

The main causes of occupational ICD in HCWs were water and wet work, followed by hand cleansers, particularly soap-based cleansers, but also ABHRs. However, this was assessed subjectively, as no testing is available for the determination of ICD. This is in accordance with numerous studies that have identified wet work as the key irritant in the healthcare setting (40–42). Other irritants included heat from contact with warm water, sweating as a result of the wearing of occlusive gloves, and contact with paper towels. It is well known that HCWs have higher

rates of hand dermatitis caused by ICD than the general population, because of the need for frequent hand hygiene and long periods of glove wearing (41–43). Compounding the problem, we noted anecdotal reports from our HCWs that they often washed their hands when an ABHR should actually have been used. ABHRs are indicated for hand hygiene when hands are not visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood/body fluids (44). They are extremely effective in infection control, and are associated with very low rates of cutaneous reactions (44–46). However, because ABHRs sting broken, eczematous skin, HCWs commonly perceive them to be more damaging than hand washing. This misconception leads to the avoidance of ABHRs, with further hand washing exacerbating existing dermatitis (47). It can be difficult to break this cycle, especially if the problem is inadequately treated or the HCW does not take time off work for the hands to recover. Increasing the use of ABHRs over hand washing is a key target for HCW education.

### Education, and primary and secondary prevention

A variety of other factors may have influenced the high rates of OSD, particularly ICD, observed in our HCWs. These include: inadequate education regarding prevention and management; a lack of pre-employment counselling for atopic individuals; and delayed referral and treatment. Studies have shown that many nurses have already developed hand dermatitis by the time of completion of their traineeships (40). In countries such as Denmark, Germany, The Netherlands, and the United Kingdom, educational initiatives including training courses, individual counselling, working groups and peer role models have been effective in reducing the risk of HCWs and trainees developing OSD and hand eczema (4, 17, 48–52). In several countries, overarching guidelines incorporate such initiatives into the national healthcare system (53, 54). We believe that a similar standardized national education programme targeted at the trainee level is critical to reduce OSD among HCWs in Australia. This should address: the aetiology of OSD and especially ICD; risk factors, including atopy; potential sources of exposure to irritants, including wet work, and allergens; preventive strategies, which have been well described (53, 55–57); and when to seek specialist assessment. Most importantly, however, information on skin care, particularly on the proactive use of hand moisturizers to prevent ICD, should be incorporated into hand hygiene training.

### Strengths and limitations of the study

One of the strengths of our study is its diagnostic capability, with the vast majority of patients being assessed by the same occupational dermatologist (R.N.). Our patients undergo rigorous exposure assessment, comprehensive patch testing, and ascertainment of all the factors contributing to their skin condition. We present allergen data of clinical relevance only, allowing us to appropriately target preventive activities. Unfortunately, although all of our allergen data are of current relevance, our database is currently unable to distinguish occupational relevance from non-occupational relevance, for example an HCW diagnosed with occupational ACD caused by formaldehyde releasers in a work-based hand cleanser who also had ACD caused by nickel in jewelry. Thus, two of the allergens listed in Table 3, namely nickel and *Myroxylon pereriae*, may not always be relevant to the occupational setting. Some allergens, such as glutaraldehyde, were associated with cases of ACD that occurred some years ago.

Although there were 555 HCWs in the study group, it appears that not all were patch tested: there were a small number of straightforward cases where patients presented only with a history of intermittent contact urticaria, not dermatitis, and were diagnosed with NRL allergy via serology for allergen-specific IgE. Patch testing was not performed in these individuals, who numbered <20. Having said that, we cannot explain the slight differences in the numbers of patients patch tested with baseline allergens (Table 3): it is possible that this represents small errors in data entry. As our study data originate from a specialist tertiary referral centre, the results should be interpreted in context, taking into account referral bias. As our clinic is the only one of its type in Victoria, our data will probably capture the majority of cases of severe OSD among Victorian HCWs referred for patch testing. However, from this study, we cannot estimate the true prevalence of OSD among the broader Victorian or Australian HCW population. We also know that patch testing rates in Australia are suboptimal as compared with European recommendations (58), so it is likely that there are HCWs with OSD who are not referred for patch testing.

### Conclusion

OSD causes a significant burden of disease in HCWs, both in Australia and worldwide. A number of countries have developed national guidelines for the prevention and management of OSD in HCWs, and Australia and others should follow suit. We suggest incorporating recommendations for skin care, particularly moisturizer use, into hand hygiene education. We emphasize that our



data showed fewer cases of ACD caused by ABHRs than by commercial hand cleansers. It is also important to raise awareness among HCWs and employers about the current spectrum of allergens and irritants encountered in the healthcare setting. In particular, we draw attention to the appreciable number of reactions to so-called 'hard-to-avoid' weak allergens present in commercial hand cleaners. We therefore support and encourage allergen substitution where possible, mandatory labelling of chemical constituents such as rubber accelerators and the 'non-hazardous' components of hand cleansers, and accessible technical data sheets. Finally, the use of accelerator-free gloves is not only recommended in HCWs

who are allergic to multiple accelerators, but should also be considered in all patients with OSD from other causes.

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