

Allergic contact dermatitis in healthcare workers

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Background	Allergic contact dermatitis is a common occupational skin disease among healthcare workers (HCWs).
Aims	This study describes causes of allergic contact dermatitis in New Zealand HCWs.
Methods	All HCWs undergoing patch testing between July 2008 and January 2020 at a public hospital patch test clinic and between June 2019 and January 2020 at a private dermatology clinic were included. Data collected included patient demographics, occupation, results of patch testing and pre- and post-patch test diagnoses.
Results	Out of 837 patients tested, 67 were HCWs. The mean age of HCWs was 41 years (SD 14) and 58 (87%) were female. The most common occupations were nurses (40%), allied health (22%) and doctors (18%). Forty-six (69%) patients had a background of atopic dermatitis. Hand dermatitis was the most common presentation (49%), followed by facial/neck dermatitis (25%). Thirty-eight (57%) had at least one positive reaction on patch testing, including 19 (28%) with a positive result of current relevance. There were 16 relevant reactions to rubber accelerators, 11 to fragrances, 10 to preservatives and 6 to corticosteroids. The most frequent relevant allergens were methylisothiazolinone/methylchlorisothiazolinone (4%), hydroxyisohexyl 3-cyclohexene carboxaldehyde (4%) and methylisothiazolinone (4%).
Conclusions	The most common allergens in HCWs were rubber chemicals, fragrances, preservatives and topical corticosteroids. Important allergens for patch testing HCWs are outlined, in particular, those with hand dermatitis should be tested to a rubber series.
Key words	Allergic contact dermatitis; allied health personnel; irritant contact dermatitis; patch test.

Introduction

Occupational contact dermatitis, including irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD), is common among healthcare workers (HCWs) due to frequent hand washing, contact with chemicals and gloves. The prevalence of ACD in HCWs from Europe is up to 47% and with the emergence of COVID-19 contact dermatitis in HCWs has increased [1,2].

Patch testing has a critical diagnostic role in identifying relevant occupational allergens and early diagnosis with allergen avoidance is essential for good outcomes in ACD. Rubber glove chemicals, preservatives, hand cleanser excipients and antiseptics were major allergens identified in an Australian study [3]. There is limited information on contact allergy among HCWs in New Zealand (NZ).

The aim of this study was to identify allergens among HCWs in NZ.

Methods

This retrospective study identified all patients undergoing patch testing at a public hospital-based tertiary patch test clinic from 1st July 2008 and 31st January 2020 and a private dermatology clinic from 1st June 2019 to 31st January 2020. Patient demographics, occupation, site of dermatosis, patch test series performed, testing of patients own products, predominant pre- and post- patch test diagnoses and results of the patch testing were collected from patient records. Nurses, midwives, healthcare assistants, doctors, medical scientists,

Key learning points

What is already known about this subject:

- Allergic contact dermatitis is a common occupational skin disease among healthcare workers.
- Previous international studies have identified fragrances, preservatives, and rubber chemicals as the most common allergens.

What this study adds:

- To our knowledge, this is the first patch test study specific to healthcare workers in New Zealand.
- Based on our results and literature review, important allergens for patch testing healthcare workers are outlined.
- The importance of testing a rubber series in those with glove use and testing patients own products, particularly topical corticosteroids, is emphasized.

What impact this may have on practice or policy:

- The data presented will help with interpretation of patch test results for healthcare workers.
- This is of particular importance given increased occupational dermatitis in this group in the setting of the global severe acute respiratory syndrome coronavirus 2 pandemic.

dentists/dental assistants, allied health staff, paramedics and nursing home carers were classified as HCWs. All other patients were categorized as non-HCWs.

Patches were applied and then removed on day 2 with a final reading on day 5 or 7. Positive, negative and irritant results were recorded. A positive patch test result was defined as a +, ++ or +++ reaction at the final reading [4]. Positive reactions were further classified as being of current, past or unknown relevance, with current relevance (defining a 'relevant positive' reaction) defined as a positive allergen associated with the presenting dermatosis.

IBM SPSS Statistics for Macintosh, version 26.0 (Armonk, NY, USA) was used for statistical analysis. Fisher's exact test was used to compare characteristics of HCWs to non-HCWs. A *P*-value of <0.05 was considered statistically significant. Ethics approval was granted by the NZ Health and Disability Ethics Committees.

Results

A total of 837 patients were patch tested, including 67 HCWs. The mean age of HCWs was 41 years (SD 14) and 58 (87%) were female. Compared with the

non-HCWs population, HCWs were more likely to be female ($P < 0.001$), have an occupational cause for their skin disease ($P < 0.001$) and have hand dermatitis ($P = 0.035$) (Table 1). Nurses represented 40% of the cohort, followed by allied health staff (22%), doctors (18%) and others (20%). After patch testing, ACD was diagnosed in 28%, atopic dermatitis in 37% and ICD in 18%.

The most common positive allergens in HCWs were nickel sulfate (17/67, 25%), fragrance mix II (7/67, 10%), hydroxyisohexyl 3-cyclohexene carboxaldehyde (lyral) (6/67, 9%), cobalt chloride (6/67, 9%) and formaldehyde (5/67, 7%). There were nine reactions to patients' own substances and six of them were of current relevance including hand sanitizers, moisturizers, cosmetics and gloves.

The most frequent *relevant* positive reactions were to methylisothiazolinone (MI)/methylchlorisothiazolinone, hydroxyisohexyl 3-cyclohexene carboxaldehyde (lyral) and MI at 4% (3/67) each, followed by thiuram mix, cobalt chloride, fragrance mix I, fragrance mix II and *Myroxylon Pereirae* (balsam of Peru) at 3% (2/67) each.

Overall, there were 19 positive (16/19 relevant) reactions to rubber allergens, 22 positive (11 relevant)

Table 1. Characteristics of HCWs undergoing patch testing in Auckland from 2008 to 2020

Characteristic	HCWs (<i>N</i> = 67), <i>n</i> (%)	Non-HCWs (<i>N</i> = 770), <i>n</i> (%)	<i>P</i> -value
Male	9 (13)	265 (34)	<0.01
Occupational cause	20 (30)	55 (7)	<0.01
Age ≥ 40 years	33 (49)	459 (60)	0.12
Hand dermatitis	33 (49)	277 (36)	0.04
Leg ulcer or dermatitis	1 (1)	19 (2)	1.00
Facial dermatitis	17 (25)	159 (21)	0.35
Atopic dermatitis	46 (69)	453 (59)	0.12
≥1 positive reaction	38 (57)	415 (54)	0.70

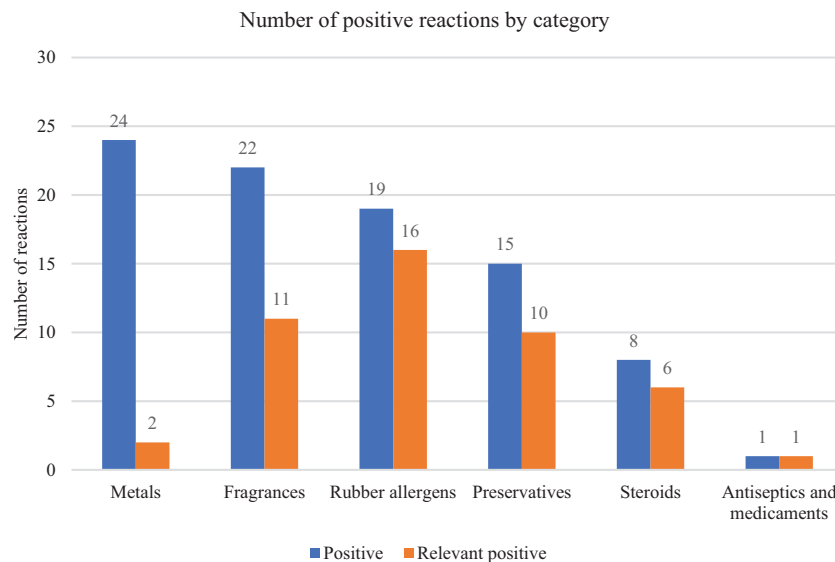


Figure 1. Positive reactions in healthcare workers patch-tested in Auckland 2008–2020

reactions to fragrances, 15 positive (10 relevant) reactions to preservatives and 8 positive (6 relevant) reactions to steroids (Figure 1). Results of patch testing in HCWs are shown in Table S1 (available as Supplementary data at *Occupational Medicine* Online).

Nine patients (13%) were diagnosed with occupation-related ACD, of which five had both work and home allergen exposures while seven had hand dermatitis (Table S2, available as Supplementary data at *Occupational Medicine* Online).

Discussion

The majority of HCWs who underwent patch testing were women with atopy presenting with hand dermatitis, an association noted in previous studies [5,6]. Our study showed a higher rate of ACD as the final diagnosis compared with ICD. This differs from international studies where occupational ICD is often the most frequent diagnosis [3,7]. Potential explanations for this include limited access to patch testing in NZ (due to resource constraints) and primary management of non-allergic occupational skin disease by occupational health departments rather than dermatology.

The most common relevant allergens in our cohort were fragrances, preservatives and rubber chemicals. This is similar to studies from Australia and Denmark where the most frequent positive reactions were nickel, thimerosal, fragrances, rubber and colophonium [3,8]. Nickel was a common reaction in our patients; however, all reactions were of past relevance (most related to jewellery exposure). Allergies to fragrances in our cohort related to personal care products as well as occupational

exposures via hand sanitizers and cleansers. Ideally, products used for hand hygiene should be fragrance-free.

Reactions to rubber accelerators in HCWs usually relate to rubber glove use. Thiurams are the most common cause of rubber accelerator allergy worldwide; however, rates may be declining [3]. In recent years, most international manufacturers have replaced thiurams with carbamates or mercaptobenzothiazole, partly explaining the increasing prevalence of carba allergy among HCWs [9].

We found a high prevalence of positive reactions to patients' own substances. These included substances from both home and occupational settings. Exact allergens may be hard to identify particularly when ingredients are not listed. Testing patients' own substances is therefore essential.

Based on the present study and literature review, Table S3 (available as Supplementary data at *Occupational Medicine* Online) summarizes selected allergens which should be considered when assessing a HCW for ACD. We also recommend those with hand dermatitis are patch tested to a specific rubber series along with their own products, particularly topical corticosteroids.

The limitations of this study included the retrospective design. We relied on clinical notes to determine the relevance of reactions, final diagnoses and relation to occupation. The non-HCW group included non-workers.

In summary, the most common allergens in NZ HCWs were fragrances, preservatives and rubber chemicals. Common exposures were gloves, hand sanitizers, hand lotions and antiseptic products. We report suggested allergens for patch testing HCWs and recommend HCWs with hand dermatitis are tested to a specific rubber series. Topical products in healthcare settings should be fragrance-free where possible.

Funding

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Competing interests

None declared.

References

1. Pesonen M, Jolanki R, Larese FF *et al.* Patch test results of the European baseline series among patients with occupational contact dermatitis across Europe—analyses of the European Surveillance System on Contact Allergy network, 2002–2010. *Contact Dermatitis* 2015;**72**:154–163.
2. Lan J, Song Z, Miao X *et al.* Skin damage among health care workers managing coronavirus disease-2019. *J Am Acad Dermatol* 2020;**82**:1215.
3. Higgins CL, Palmer AM, Cahill JL, Nixon RL. Occupational skin disease among Australian healthcare workers: a retrospective analysis from an occupational dermatology clinic, 1993–2014. *Contact Dermatitis* 2016;**75**:213–222.
4. Johansen JD, Aalto-Korte K, Agner T *et al.* European Society of Contact Dermatitis guideline for diagnostic patch testing—recommendations on best practice. *Contact Dermatitis* 2015;**73**:195–221.
5. Prodi A, Rui F, Fortina AB, Corradin MT, Filon FL. Healthcare workers and skin sensitization: north-eastern Italian database. *Occup Med (Lond)* 2016;**66**:72–74.
6. Kadivar S, Belsito DV. Occupational dermatitis in health care workers evaluated for suspected allergic contact dermatitis. *Dermatitis* 2015;**26**:177–183.
7. Suneja T, Belsito DV. Occupational dermatoses in health care workers evaluated for suspected allergic contact dermatitis. *Contact Dermatitis* 2008;**58**:285–290.
8. Ibler KS, Jemec GB, Garvey LH, Agner T. Prevalence of delayed-type and immediate-type hypersensitivity in healthcare workers with hand eczema. *Contact Dermatitis* 2016;**75**:223–229.
9. Warburton KL, Bauer A, Chowdhury MMU *et al.* ESSCA results with the baseline series, 2009–2012: rubber allergens. *Contact Dermatitis* 2015;**73**:305–312.

Table S1: Positive and relevant reactions in healthcare workers patch-tested in Auckland 2008-2020 (n= 67 patients)

Allergen	Positive, N(%)	Relevant, N(%)	Relevant/ Positive, %
Nickel sulfate	17 (25)	0 (0)	0
Fragrance mix II	7 (10)	2 (3)	29
Hydroxyisohexyl 3-cyclohexene carboxaldehyde	6 (9)	3 (4)	50
Cobalt chloride	6 (9)	2 (3)	33
Formaldehyde	5 (7)	1 (1)	20
Thiuram mix	4 (6)	2 (3)	50
Fragrance mix I	4 (6)	2 (3)	50
MI/MCI	3 (4)	3 (4)	100
Methylisothiazolinone	3 (4)	3 (4)	100
<i>Myroxylon Pereirae</i>	2 (3)	2 (3)	100
Quaternium 15	2 (3)	1 (1)	50
Hydrocortisone-17-butyrate	2 (3)	1 (1)	50
Sesquiterpine lactone mix	2 (3)	0 (0)	0
Textile dye mix	2 (3)	0 (0)	0
Neomycin sulfate	1 (1)	1 (1)	100
Mercapto mix	1 (1)	1 (1)	100
2-Mercaptobenzothiazole	1 (1)	1 (1)	100
Budesonide	1 (1)	1 (1)	100
Dermol ointment 0.05%	1 (1)	1 (1)	100
Dermol cream 0.05%	1 (1)	1 (1)	100

Locoid lipocream 0.1%	1 (1)	1 (1)	100
Locoid ointment 0.1%	1 (1)	1 (1)	100
Dodecyl gallate	1 (1)	1 (1)	100
Jasmine synthetic	1 (1)	1 (1)	100
p-chloro-m-cresol	1 (1)	1 (1)	100
Imidazolidinyl urea	1 (1)	1 (1)	100
Diazolidinyl urea	1 (1)	1 (1)	100
Zinc diethyldithiocarbamate	1 (1)	1 (1)	100
Zinc dibenzylthiocarbamate	1 (1)	1 (1)	100
Tetramethylthiuram disulfide	1 (1)	1 (1)	100
Tetraethylthiuram disulfide	1 (1)	1 (1)	100
Tetramethylthiuram monosulfide	1 (1)	1 (1)	100
Dipentamethylenethiuram disulphide	1 (1)	1 (1)	100
Dibenzothiazyl disulfide 1	1 (1)	1 (1)	100
N-Cyclohexyl-2-benzothiazyl sulphenamide	1 (1)	1 (1)	100
2-(4-Morpholinylmercapto)benzothiazol	1 (1)	1 (1)	100
Cetearyl alcohol	1 (1)	1 (1)	100
Hydroperoxides of linalool	1 (1)	1 (1)	100
Dibutyl thiourea	1 (1)	1 (1)	100
N,N-Diphenylguanidine	1 (1)	1 (1)	100
Carba mix	1 (1)	1 (1)	100
4-Phenylenediamine base	1 (1)	0 (0)	0

Colophonium	1 (1)	0 (0)	0
Tixocortol-21-pivalate	1 (1)	0 (0)	0
Hydroxycitronellal	1 (1)	0 (0)	0
Ammoniated Mercury	1 (1)	0 (0)	0
Diallyl disulfide	1 (1)	0 (0)	0
Propolis	1 (1)	0 (0)	0
Sodium metabisulfite	1 (1)	0 (0)	0
N-(Cyclohexylthio) phthalimide	1 (1)	0 (0)	0
Potassium dichromate	1 (1)	0 (0)	0

Table	Gender	Occupation	Site	Relevant positive reactions	Occupational exposure	Non-occupational exposure
S2.						

Summary of health care workers with occupational allergic contact dermatitis XAge (years)						
31	F	Nurse	Hands	MI/MCI, fragrance mix II, hydroxyisohexyl 3-cyclohexene carboxaldehyde, MI, patients own shampoo	Hand sanitiser (fragrance)	Shampoo
49	F	Nurse	Hands	Thiuram mix, fragrance mix I, fragrance mix II, hydroxyisohexyl 3-cyclohexene carboxaldehyde, clobetasol ointment and cream, zinc diethyldithiocarbamate, zinc dibenzylthiocarbamate, tetramethylthiuram disulfide, tetraethylthiuram disulfide, tetramethylthiurammonosulfide dipentamethylenethiuramdisulphide, own substances	Gloves, antibacterial foam hand cleanser (fragrance)	Topical corticosteroid, deodorant
36	F	Nurse	Generalised	Formaldehyde, quaternium-15, imidazolidinyl urea, diazolidinyl urea, own substances	Disinfectant used in operating theatre	Moisturisers
22	F	Laboratory worker	Hands and feet	Mercapto mix, benzothiazole N-(Cyclohexylthio) phthalimide	Gloves	Shoe inner soles

58	F	Nurse	Hands	MI/MCI, MI	Hospital antiseptic wipes	
36	F	Nurse	Hands	Cetearyl alcohol, amerchol L 101, patient's own gloves, moisturiser and hand cleansers	Gloves, moisturisers and hand cleansers used at work	
50	F	Nurse	Hands and face	Hydroxyisohexyl 3-cyclohexene carboxaldehyde, N,N-Diphenylguanidine, Zinc dibenzylthiocarbamate	Gloves	Shampoo
30	F	Respiratory physiologist	Face	MI	Paint from renovations in working place	
60	M	Doctor	Hands	Carba mix, N, N-diphenylguanidine, dibutyl thiourea	Gloves	

F = female; M = male; MI/MCI = methylisothiazolinone/methylchlorisothiazolinone; MI=methylisothiazolinone

Table S3: Suggested allergens for testing healthcare workers in New Zealand.

Allergen (concentration and vehicle)	Comment/potential occupational exposures for HCW
Rubber chemicals*	
Thiuram mix 1% pet [†]	Most common rubber allergen in gloves
Mercapto mix 2% pet [†]	Rubber accelerator in gloves
2-Mercaptobenzothiazole (MBT) 2% pet [†]	Rubber accelerator in gloves, testing with mercapto mix alone may miss allergy
Carba mix 3% pet	Rubber allergen with increasing incidence
1,3-Diphenylguanidine (DPG) 1% pet	Prominent carba allergen, testing with carba mix alone may miss allergy
Fragrances	
Fragrance mix I 8% pet [†]	Fragrance added to sanitisers, cleaning products, skin cleansers and creams
Fragrance mix II 14% pet [†]	Fragrance added to sanitisers, cleaning products, skin cleansers and creams
<i>Myroxylon pereirae</i> 25% pet [†]	Fragrance added to sanitisers, cleaning products, skin cleansers and creams
Hydroxyisohexyl 3-cyclohexene carboxaldehyde (Lyrar) 5% pet [†]	Fragrance added to sanitisers, cleaning products, skin cleansers and creams, in Dermasoft® Alcohol-free Hand Sanitiser commonly used by HCW with irritant hand dermatitis in Auckland, NZ
Preservatives and antimicrobials	

Formaldehyde 2% aq [†]	Antibacterial and antifungal in disinfectants, preserving solution for tissue sections in histopathology
Quaternium 15 1% pet [†]	Preservative in liquid soap, surgical or home-made masks and personal products
Methylchloroisothiazolinone/ methylisothiazolinone 0.02% aq [†]	Preservative in antiseptic wipes, liquid soaps, lotions and shampoos
Methylisothiazolinone 0.2% aq [†]	Preservative in antiseptic wipes, liquid soaps, lotions and shampoos
Diazolidinyl urea 2% pet	Preservative in creams and lotions, in MICROSHIELD [®] hand sanitisers and lotion (commonly used in NZ hospitals)
Imidazolidinyl urea 2% pet	Preservative in creams and lotions
Phenoxyethanol 1% pet	Topical antiseptic, preservative in cosmetics and pharmaceuticals, in MICROSHIELD [®] hand sanitisers (commonly used in NZ hospitals)
Propylene glycol 30.0% aq	Preservative in antiseptic wipes, hand sanitiser and in MICROSHIELD [®] moisturising lotion (commonly used in NZ hospitals)
Chloroacetamide 0.2% pet	Preservative in cosmetics and pharmaceutical creams, hospital hand sanitisers/lotions, common allergen among HCW
Iodopropynyl butylcarbamate 0.2% pet	Preservative in cleansers, creams and lotions, in MICROSHIELD [®] hand sanitisers and lotion (commonly used in NZ hospitals)
p-Chloro-m-cresol 1% pet	Preservative in cream and ointment bases, antiseptic dressings, lubricant for catheters and surgical instruments, hand cleansers, electrocardiogram pastes
Chloroxylenol 1% pet	Preservative in creams and ointments, alcohol-based hand sanitisers, antibacterial used for wound disinfection, electrocardiogram paste
Triclosan 2% pet	Preservative in cosmetic products, present in antiseptic solutions/cleaning products and hand sanitisers
Chlorhexidine diacetate 0.5% aq	Disinfectant in cleansers, surgical scrubs and surgical/antiseptic prep solutions
Chlorhexidine digluconate 0.5% aq	Disinfectant in cleansers, surgical scrubs and surgical/antiseptic prep solutions
Benzalkonium chloride 0.1% aq	Antiseptic in cosmetics, ophthalmic solutions, cleaning solutions, sanitisers
Thimerosal 0.1% pet	Preservative in antiseptic wipes, hand rubs, ophthalmic solutions and biological products such as vaccines
Glutaral 0.5% pet	Disinfectant, used as cold steriliser for medical instruments such as endoscopes, anaesthetic and renal dialysis equipment, present in embalming fluid, HCW >8 times more likely to develop sensitisation compared with non-HCW
<i>Emulsifiers and surfactants</i>	
Lanolin alcohol 30% pet [†]	Emollient and emulsifier in cosmetic and pharmaceutical bases, MICROSHIELD [®] hand cleanser (commonly used in NZ hospitals)
Cetearyl alcohol 20% pet	Emulsifier in creams and ointments
Cocamidopropyl betaine 1% aq	Foaming agent in soaps/hand cleansers

Cocamide diethanolamide (DEA) 0.5% pet	Foaming agent in soaps/hand cleansers
<i>Speciality-specific exposures</i>	
Caine mix III 10% pet [†]	Mix of benzocaine, dibucaine hydrochloride and tetracaine hydrochloride used as local or topical anaesthetic agents and in dentistry
Methyl methacrylate 2% pet	Present in bone cement for orthopaedic surgery, medicinal spray adhesives dental products, hearing aids, intraocular lenses

Pet = petrolatum; aq = aqueous; HCW = healthcare worker; NZ = New Zealand

*A comprehensive rubber series should also be tested in those with hand dermatitis

[†]Allergens in European baseline series