

SPECIAL ARTICLE

Contact Allergy in Singapore

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Eczema or dermatitis is one of the most common skin conditions that is seen in most dermatological institution. Exogenous or contact dermatitis constitutes an important subset of this large group of patients. Over the years, there had been a plethora of literature that had been published from the Contact & Occupational Dermatoses Clinic of Middle Road Hospital (MRH), National Skin Centre Singapore and interested organizations, like the Division of Industrial Health, Ministry of Manpower (DIH), Singapore and the Department of Community, Occupational & Family Medicine, National University of Singapore.

This is a review article that summarizes important studies and highlight interesting case reports that had been published on the subject of contact allergy in Singapore.

Epidemiology

Trends: contact allergens

Patch testing is the time

SUMMARY Contact allergy, viz. allergic contact dermatitis, photo-allergic contact dermatitis and contact urticaria, is a well-studied sub-specialty of dermatology in Singapore. Over the years, numerous studies and anecdotal reports on the subject have been published in both international and local refereed journals. This article reviews the epidemiological data on patch testing and photo-patch testing in Singapore. It also summarizes published clinical reports on important contact allergens that are found in both non-occupational and occupational setting.

tested and accepted standard method of assessing delayed type hypersensitivity, viz. contact allergy. The methodology and materials adopted in our country are similar to major centers in the world, but trends and epidemiology differ because of our unique racial, social and cultural practices.

Three major epidemiological studies had been published on the trends of contact allergy in Skin Clinics in Singapore. Data were collected from patients that were seen in the Contact Dermatitis Clinic of MRH from 1984 to 1985 and NSC from 1986 to 1990 and 1992 to 1996 respectively.¹⁻³ These patients had been patch tested with the modified International Contact Dermatitis Research

Group (ICDRG) standard series of the dermatological institutions and additional relevant allergens. Patch testing was performed in the standard manner and reactions were recorded according to the ICDRG scoring system.⁴ The frequency of positive reactions to various allergens were then collated and the top ten allergens were determined.

Direct comparison between one study and the other may not be feasible as there had been modification to the patch test series over the years. However there are 8 major contact allergens that have remain relevant to our Singaporean population over the last decade

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Table 1 Prevalence of the top 10 contact allergens over the years (adapted from Kwok *et al.*³)

Allergens	1992 – 1996 N = 5,810 % (Ranking)	1986 – 1990 N = 5,557 % (Ranking)	1984 – 1985 N = 2,471 % (Ranking)
Nickel sulphate	19.4 (1)	17.7 (1)	13.9 (1)
Fragrance mix	6.8 (2)	13.3 (2)	8.4 (2)
Thimerosal	6.8 (3)	-	-
Cobalt chloride	6.6 (4)	4.5 (7)	4.7 (7)
Colophony	4.8 (5)	6.6 (4)	4.9 (5)
Balsam of Peru	4.7 (6)	2.7 (8)	3.1 (9)
Neomycin	4.3 (7)	6.9 (3)	5.7 (4)
Potassium dichromate	3.8 (8)	2.7 (9)	6.3 (3)
Amerchol	3.4 (9)	-	-
Proflavine	3.4 (10)	6.5 (5)	4.8 (6)

(Table 1). These include nickel sulphate, fragrance-mix, cobalt chloride, colophony, balsam of Peru, neomycin, potassium dichromate and proflavine.³ Nickel sulphate and fragrance-mix remain as the most common contact allergens in all three reports.

Nickel is ubiquitous. It is found in costume jewelry and an assortment of metal objects. There is a rising trend in the prevalence of contact allergy to nickel over the last decade. The prevalence has increased from 13.9% between 1984 to 1985, to 17.7% between 1986 to 1990, to 19.4% between 1992 to 1996. Similar trends have been observed all over the world.⁵

Fragrance-mix, together with balsam of Peru are important sentinel markers for contact allergy to fragrance. Apart from perfumes and colognes, fragrance is also present in toiletries, cosmetics and over the counter skin care products. It is thus not surprising that these 2 allergens remain as the two top 10

allergens in the 1980s through 1990s.

Cobalt often occurs in association with a positive patch test reaction to nickel, hence there is probably less relevance and importance of cobalt chloride as an isolated major contact allergen rather than a cross-sensitivity with nickel sulphate. Neomycin and proflavine are important topical medicament, that are still in use in Singapore over the years. Colophony is a common resinous material that can be found in sticky plaster and some topical medicament. Chromate is probably one of the most well studied and most common occupational contact allergen for its role in cement allergy among construction workers. The prevalence of chromate allergy appears to be declining over the last decade.

Contact allergy: sex, age and race

Goh⁶ reported the influence of sex, race and age in the prevalence of contact allergy in popula-

tion of a Skin Clinic in Singapore. He reviewed the data collected from 1873 patients that had been patch tested in MRH from January 1984 to June 1985 and found that there was no significant difference in the prevalence of contact allergy among the three major races in the local indigenous population, namely Chinese, Malay and Indian. Contrary to observations that had been made by investigators overseas, he found similar prevalence of contact allergy in both females and males and the prevalence was significantly higher for patients above the age of 40 as opposed to those below 40 years of age (60.9% vs 45.2%).

Occupational dermatoses

Studies looking at the general epidemiological trends in occupational dermatoses in Singapore have also been published. As occupational diseases are notifiable in Singapore under Section 60 of the Factories Act 1973, the Joint Occupational Dermatoses Clinic that is

Table 2 Common occupational contact allergens over the years (adapted from Goh and Soh⁸ and Goh¹⁰)

Allergens	1983 N = 127	1985 N = 100	1986 N = 55	1987 N = 74	1988 N = 48	1989 N = 24
Chromate	66 (52%)	52 (52%)	23 (41.8%)	21 (28.4%)	10 (20.8%)	2 (8.3%)
Rubber chemicals	12 (9.4%)	42 (42%)	10 (18.2%)	16 (21.6%)	9 (18.8%)	0 (0%)
Nickel	N.D.*	4 (4%)	7 (12.7%)	14 (18.9%)	2 (4.2%)	4 (16.7%)
Cobalt	N.D.	8 (8%)	6 (10.9%)	8 (10.8%)	3 (6.3%)	0 (0%)
Epoxy Resin	8 (6.3%)	5 (5%)	11 (20%)	5 (6.8%)	4 (8.3%)	3 (12.5%)
Colophony	1 (0.8%)	3 (3%)	4 (7.3%)	0 (0%)	0 (0%)	1 (4.2%)
Foodstuff	4 (3.1%)	2 (2%)	2 (3.6%)	2 (2.7%)	1 (2.1%)	2 (8.3%)

*N.D. = not documented

jointly run by dermatologists and occupational physicians from DIH, in NSC. The clinic was set up to consolidate the management of patients with skin conditions that satisfy the criteria for the diagnosis of occupational dermatoses based on the American Medical Association's definition. The latter refers to any pathological condition of the skin for which occupational exposure can be shown to be a major causal or contributory factor.⁷

Major occupational contact allergens that have been identified over the years are summarized in Table 2. Chromate was the top occupational allergen from 1983 to 1988.⁸⁻¹⁰ However it was superseded by epoxy resin and nickel that emerged as two most important occupational allergens in 1989. Similar trend could be observed with rubber chemicals. The epidemiology of occupational dermatoses reflects the change in the industrialization of Singapore. Chromate was mainly found as an impurity in cement in the construction industry. It was a predominant industry in Singapore in the early and mid 1980s. Personal protective equipment, like rubber gloves and boots,

was currently used by construction workers which probably accounted for the high prevalence of rubber allergy among construction workers. In the late 1980s, the electronic/electrical and metal/engineering industries became the "sunshine" industries in Singapore. This led to a sharp drop in the number of cases of occupational skin diseases from contact allergy to chromate, but a corresponding rise in contact allergy to epoxy resin and nickel that were widely used in the electronics industry.

Photopatch testing

Photopatch testing is the most important tool to confirm the clinical diagnosis of photo-allergic contact dermatitis. Ultra-violet A is required as an intermediate step to induce a photoallergic patch test reaction. Well-recognized photoallergens that are included as part of the NSC standard photopatch test series, can be broadly classified as antiseptics, fragrance fixatives, medication and sunscreens.

Leow *et al.*¹¹ reviewed all patients that had been photo-patch tested at the Contact & Occupation-

al Dermatoses clinic of NSC between April 1991 and March 1993. Sixty-two (22.6%) of the patients tested had 27 positive photopatch test reactions to, musk ambrette, chlorpromazine, promethazine, sulphapyridine, quinine, tetrachlorosalicylanilide, hexachlorophene, fenticlor and trichlorocarbanilide. However, they were not able to find direct clinical relevance to the above reactions, except for positive photopatch test reactions to sunscreens, namely p-aminobenzoic acid, 2 ethylhexyl-p-methoxycinnamate and 2-hydroxy-4-methoxy-4-methyl-benzophenone that were found in 2 patients.

Contact allergy: atopics versus non-atopics

Goh¹² looked at the epidemiological data of 864 atopic and 2283 non-atopic patients that were attending the Contact & Occupational Dermatoses Clinic of NSC from 1991 to 1993. He found the prevalence of contact allergy among atopics and non-atopics to be similar. There was no statistical difference in the frequency of patients with positive patch test reactions, as well as the proportion of patients

with allergic and irritant contact dermatitis in both groups.

Contact allergy in the elderly

Goh and Ling¹³ examined the epidemiology of contact eczema in 201 patients who were older than 49 years old who attended the Contact & Occupational Dermatoses Clinic of NSC from 1990 to 1993. They found that the proportion of patients with allergic contact dermatitis was slightly higher in the older age group (70-79 years), but the difference was not statistically significant. They found that the important allergens in the elderly included nickel, clioquinol-mix, balsam of Peru, fragrance-mix and para-phenylenediamine.

Important contact allergens

Medication

There had been publications on contact allergy to both topical and oral medication from Singapore. In special circumstances, medications can be a bane instead of a cure.

a. Topical medication

Topical antimicrobials

Goh¹⁴ found that 18% of the 3,145 patients who were attending the Contact Dermatitis Clinic at NSC in Singapore had contact sensitivity to one or more topical antimicrobials. There was also significant difference in the rate for patients above and below the age of 50 years, with a higher prevalence rate of 30% compared with 16% in the respective group. He attributed his finding to the fact that older patients usually require long-term topical medication for the treatment of chronic skin conditions. He also found that the most

common sensitizers were *proflavine, neomycin and clioquinol*.

In a later study, he studied the sensitizing potentials of topical antimicrobials using a modified Beuhler's technique on guinea pigs.¹⁵ He found that among the over the counter antimicrobials, proflavine was the most potent sensitizer, followed by parachlorometaxylenol, benzalkonium chloride and propamidine isetionate as moderate sensitizers. Iodine was a weak sensitizer and chlorhexidine and cetrimide were very weak sensitizers. Among prescribed topical antibiotics, neomycin was found to be a moderate sensitizer, gentamicin and chloramphenicol as weak sensitizers. Kanamycin, clioquinol, polymyxin B, bacitracin, tetracycline, sodium fusidate and fusidic acid were very weak sensitizers. He found good correlation between sensitizing potentials in animal studies and clinical experience of contact allergy.

Proflavine

Proflavine is a potent sensitizer and can be found as a common over the counter medicament in Singapore. Lim *et al.*¹⁶ reported a 53-year-old Malay man who developed perioral and mucosal edema from proflavine, that was used as an antiseptic following a dental extraction.

Goh¹⁷ reported two Chinese men who developed erythema multiforme-like and pupuric eruption following the use of proflavine for the treatment of minor abrasions. He coined the term, urticarial papular and plaque eruption to describe this atypical non-eczematous eruption (erythema multiforme-like eruption) that he observed in 4 male patients following the use of proflavine.¹⁸

Topical traditional Chinese medicament (TCM)

TCM is very much a part of the cultural heritage of the East and they contend with western-based medication as cheap alternative over the counter medication in Singapore. Leow *et al.*¹⁹ interviewed 116 patients who attended the Contact & Occupational Dermatoses clinic at NSC on the use of TCM. They identified the most common ten TCM that were used by their study population. These can be broadly classified as herbal oils (Axe brand medicated oil, Green grass oil, Eagle brand medicated oil, Tiger Balm, Tiger oil, White Flower embrocation and Wong Cheung Wah U 1 oil), bone setters' herbal oils (Zheng Gu Shiu and Tjin Koo Lin) and anti-fungal medication (Saw Hong Choon skin ointment). The ideal concentration for patch testing the above TCM without inducing a false positive or false negative reaction was recommended in the report. There were four patients who developed allergic contact dermatitis to different TCM, namely Wong Cheung Wah U 1 oil, Tiger balm, Tjin Koo Lin and Green Grass oil.

Topical corticosteroid

Goh²⁰ reported a 56-year-old Chinese man whose leg dermatitis failed to improve despite various topical corticosteroid. The patient also developed a generalized maculopapular eruption 2 days after ingestion of oral prednisolone. He was patch tested positive to Betnovate cream, Synalar cream and hydrocortisone cream, showing cross-sensitivity to different types of corticosteroid.

Khoo *et al.*²¹ reviewed the results of 3,603 patients who were

patch tested to various corticosteroid, namely betamethasone 17-valerate (1% petrolatum), fluocinolone acetonide (0.25% petrolatum) and tixocortol pivalate (1% petrolatum) in the Contact Dermatitis Clinic of NSC between 1994 to 1996. Three patients reacted positively to betamethasone 17-valerate, 17 to tixocortol pivalate and none to fluocinolone acetonide. However relevance could only be demonstrated in 5 patients. The prevalence of positive patch test reaction to corticosteroid in NSC of 0.55% was low compared to most reports published overseas.

Miscellaneous

Ng and Goh²² reported a 47-year-old man who developed subacute perianal eczema following surgery. He was found to be allergic to flavine and *sodium hypochlorite* that was found in Eusol. They were both used as cleansing agents for post-operative dressing.

Wong *et al.*²³ reported a 37-year-old Chinese patient who developed generalized urticaria and breathlessness following the insertion of a copper IUCD. *Chlorhexidine* was used as the cleansing solution during the procedure. She was prick tested positive to chlorhexidine diacetate and digluconate.

Goh and Ng²⁴ reported a 50-year-old man who developed allergic contact dermatitis to *iodoform and bismuth subnitrate*. Both items were incorporated as a bismuth et iodoform paste that was used as a post-operative dressing for right radical mastoidectomy in this patient.

Goh²⁵ reported two women who developed acute dermatitis following the use of Spectraban[®] 15

lotion (sunblock) and Zovirax[®] cream, respectively. Both patients were patch tested positive to the incriminating lotion and cream, but patch tested negative to all individual constituents of both items, respectively. He concluded that both patients had compound allergy to their items.

Goh and Ng²⁶ performed a small study on 11 patients to establish the sensitizing potential of salicylic acid, a constituent in numerous rubefacients. They concluded that salicylic acid was a weak skin sensitizer and was probably a skin irritant in most clinical situations.

b. Oral medication

Goh and Kwok²⁷ reported 3 Chinese female patients who developed photosensitivity after ingesting *Carprofen* (Imadyl[®]). It is a non-steroidal anti-inflammatory drug that is a derivative of phenylpropionic acid. All three patients showed reduced minimal erythema dose to ultraviolet B (UVB) and photopatch testing to the medication dispersed at 5% in petrolatum was negative. They concluded that carprofen exerted its photosensitivity effect through a phototoxic mechanism in the UVB range.

Metals

Nickel

Nickel is the most well-known and best studied metal in the field of contact allergy. Interesting anecdotal clinical reports of contact allergy to nickel have been published from Singapore.

Goh and Ng²⁸ reported a 30-year-old Indian man who developed recurrent itchy papular eruption

over his beard area for 3 years. He was initially diagnosed and treated as suffering from sycosis barbae. He was patch tested positive to nickel and was finally diagnosed to have an allergic contact dermatitis to nickel that was found in the shaving foil of his electric razor and metallic bracket of the blade shaver. The skin eruption cleared following replacement with disposable plastic shavers with stainless steel blades.

Goh *et al.*²⁹ reported a 23-year-old Chinese woman who presented with allergic contact eczema of her eyelids following the use of a new blue eyeshadow. She was patch tested positive to nickel. Analysis of the patient's and 3 other brands of eyeshadow by atomic absorption spectrophotometry confirmed the presence of high nickel content.

Gold

Gold as a contact allergen is previously thought to be uncommon. However, recent overseas publications on sensitization to gold sodium thiosulfate seem to suggest otherwise.

Gold sodium thiosulfate 0.5% in petrolatum was included as part of the standard patch test series of NSC in late 1996. Leow *et al.*³⁰ reviewed the data of 345 patients who were patch tested to the putative allergen over a 6-month period from October 1996 to March 1997. They found a high sensitization rate of 6.4% to gold, that seemed to concur with figures quoted overseas. However, only 3 out of 22 patients (0.86%) who were patch tested positive had clinically relevant reactions that could be traced to gold jewelry.

Rubber chemicals

Rubber chemicals are found in personal protective equipment for workers in the occupational setting and in gloves used by housewives during domestic chores. They have been reported to cause allergic contact dermatitis.

Goh³¹ reported a 24-year-old Chinese motorcyclist who developed chronic eczema on his palms and fingers from the rubber handles of his motorcycle. The patient was patch tested positive to shavings from the black rubber motorcycle handle and PPD mix (black rubber mix). Hand eczema cleared six months after replacement with plastic handles.

Goh³² also reported two patients who developed allergic contact dermatitis following gynecological procedure and dental treatment respectively. They developed allergic contact dermatitis to the rubber gloves that were used by their respective medical practitioners. Both patients were patch tested positive to the rubber gloves and thiuram mix, a common rubber chemical allergen found in rubber gloves.

Kumkum and bindi

Singapore is a multicultural society. Kumkum or bindi are commonly applied over the foreheads of Indian Hindi women for cultural and religious reasons. Interesting reports of contact allergy to kumkum and bindi had been published from our part of the world.

Goh and Kozuka³³ reported 3 Indian women who developed pigmented allergic contact dermatitis to red kumkum. Through meticulous patch testing, they con-

firmed that the patients were allergic to the red kumkum. Brilliant Lake Red R, Sudan I, aminoazobenzene and canaga oil were the suspected contact allergens found in red kumkum. Kozuka *et al.*³⁴ further analyzed 7 brands of red kumkums by gas chromatography-mass spectrophotometry. They demonstrated that they all contained *Sudan I* in significant concentration and that it was the cause of pigmented allergic contact dermatitis in red kumkums.

Koh *et al.*³⁵ chemically analyzed 30 different types of Bindi that were used by Indian women in Singapore. They demonstrated the presence of abietic and dihydroabietic acid that were oxidation products of colophony in almost all stick-on bindi bought in Singapore. Hence bindi may cause contact allergy in those who were allergic to *colophony*.

Grass

All healthy Singaporean males above the age of 18 years were required to undergo military training as part of national service. Training entails field training and thus inevitable contact with grass and the unique problem of suspected contact allergen to the latter.

Wong *et al.*³⁶ investigated 23 patients with suspected grass allergy from 1989 to 1990. They were patch and prick tested to axonopus compressus (cow grass). They found great difficulty in interpreting the results and felt that most reactions to grass were due to irritation and that atopic individuals were more susceptible.

In a recent study, Koh *et al.*³⁷ expanded on the study of allergic contact dermatitis from grass

in our Singaporean population. They patch tested 20 controls and 46 patients with history of suspected grass intolerance to 6 common grass species from lawns and military training areas. Five (11%) out of 46 patients had positive patch test reactions to 5 of the grass species. They concluded that contact reaction to grass were not only irritating but can also be allergic.

Sunscreen

Ang *et al.*³⁸ reviewed the data of 61 patients with suspected allergy to sunscreen that underwent patch and/or photopatch testing in NSC from 1992 to 1996. Five were found to be allergic to sunscreens, 2 were photoallergic and 3 were allergic to the active ingredients in the sunscreens. The main causative allergens were 2-ethylhexyl-4-methoxycinnamate (Parsol MCX) and 2-hydroxy-4-methoxybenzophenone (oxybenzone).

Musk ambrette

Goh and Ng³⁹ reported a patient who developed photoallergic contact dermatitis to musk ambrette that was found in the cologne used by his barber. Analysis of the cologne by gas chromatography/mass spectrophotometry confirmed the presence of the fragrance fixative.

With the use of thin layer chromatography and gas chromatography/mass spectrophotometry, Goh and Kwok⁴⁰ further chemically analyzed 32 men's colognes for the presence of musk ambrette. They demonstrated that 14 of the 32 colognes contained musk ambrette, at a concentration varying from 0.02 to 0.39%.

Personal skincare products

Goh and Lim⁴¹ reported a 60-year-old Chinese man who developed allergic contact dermatitis on his scalp and face from a medicated shampoo that contained zinc pyrithione. The patient was patch tested positive to *zinc pyrithione* at diluted concentration and also to medicated Brylcreem[®] that also contained the incriminating allergen.

Goh⁴² reported an Indian woman who developed allergic contact dermatitis at her axillae following the use of a roll-on deodorant. She was found to be allergic to *chlorphenesin* that was incorporated into her deodorant as an antifungal agent to prevent dermatophytosis.

Arterio-venous shunt dermatitis (A-V shunt dermatitis)

Goh and Phay⁴³ studied 88 patients who had A-V shunt dermatitis following hemodialysis. They found that 8% of the patients had cumulative insult irritant contact dermatitis from soaps, disinfectants and alcohol. Five patients who were patch tested had negative or positive reactions that were not of clinical relevance. However, Ng *et al.*⁴⁴ recently reported a 49-year-old man who developed allergic contact dermatitis over the A-V fistulae on his forearms from *epoxy resin in the haemodialysis cannula*. The resin was used to fix the joint between the plastic cannula and the dialysis needle.

Contact cheilitis

Lim *et al.*⁴⁵ studied 27 patients with cheilitis who were patch tested at the Contact & Occupational Dermatoses Clinic at NSC

from July 1989 to December 1991. After extensive investigation, they found that 9 (33.3%) of the patients had allergic contact cheilitis. Five were allergic to their *toothpastes*. The other 4 were allergic to their own *lipsticks*, of which 2 were allergic to nickel in the lipstick casing, 1 to ricinoleic acid and 1 to lanolin.

Thimerosal

Thimerosal is a common preservative that can be found in eye-drops, contact lens solution, ear-drops and vaccines. Thimerosal at 0.1% petrolatum was included as part of the standard patch test series of NSC in April 1990. Wong *et al.*⁴⁶ reviewed all patients who were patch tested to the putative allergen from April to December 1990. They found a positive patch test prevalence rate of 6.2% (55/886) to thimerosal. They postulated that the relatively high sensitization rate could be attributed to the compulsory childhood vaccination or subsequent to the hepatitis B vaccination program in Singapore.

Tussock moth (tussockosis)

Ooi *et al.*⁴⁷ investigated an outbreak of acute pruritic urticarial eruption among 141 residents of a high-rise public housing estate in Bukit Panjang, Singapore in March 1990. The cause of the dermatitis could be traced to histamine-like substances found in the setae (hairs) of tussock moths. The suspected etiology was confirmed by patch testing adult volunteers to extract of the crude moth material.

Contact allergens in the industries

Construction Industry

Until 1986, construction

workers were the most common source of occupational dermatoses in Singapore.⁸ Cement is the main substance used in the construction industry and hexavalent chromate that is found in cement, is the most allergenic form that pose the highest threat to the workers at large.

Goh⁴⁸ reviewed 6,730 patients who attended the Contact Dermatitis Clinic of MRH from 1981 to 1983. He found that the incidence of chromate sensitivity was 3.22%. The source of *chromate* sensitivity in men could be traced to cement in 58.7% of cases.

To facilitate efficient completion of large scale construction projects, many construction projects adopted the prefabrication construction method, whereby the components of building was built in a factory remote from the construction site, transported and later reassembled on site.⁴⁹ In a field study of occupational dermatoses in one of these prefabrication construction factory, Goh *et al.*⁵⁰ studied 272 workers and found that 39.5% had allergic contact dermatitis from cement, 2.5% were allergic to *rubber chemical* in gloves. The overall prevalence of chromate sensitivity was 8.5% with the highest rate from those working in the concreting bays of the factory. In another publication, Goh *et al.*⁵¹ also reported that 8 of 83 workers (9.6%) who used rubber gloves and/or boots were sensitive to one or more rubber mixes of the patch test series. Four workers had clinically relevant positive patch test reactions to rubber chemical mixes, namely PPD (black rubber mix) and carba mix, that were more commonly found in heavy-duty industrial rubber apparel.

In a recent report, Wong *et al.*⁵² updated the epidemiology of occupational chromate allergy among workers seen at the Contact & Occupational Dermatoses Clinic in NSC from 1990 to 1995. Eighty-seven of the 450 workers had positive patch test reaction to chromate. Cement (61%) was the most common source of chromate allergy, but chromate from sources other than cement (39%) accounted for the rest. They reckoned that chromate allergy from cement was declining, but sources other than cement were rising in recent years.

Electronic industry

The electronics industry is one of the sunshine industries that contribute towards the development of Singapore into a high-skill, high-technology regional hub. Tan *et al.*⁵³ reviewed 149 workers from the electronics industry with occupational dermatoses who attended the Joint Occupational Dermatoses clinic at NSC. They found that 40.9% (61) had allergic contact dermatitis. The most common allergens were *nickel*, resins, followed by *rubber chemicals* and the constituents of *flux*. Amongst the resins, *epoxy resin* was the most common contact allergen.

Phoon *et al.*⁵⁴ reported 5 electronic factory workers who developed Stevens-Johnson syndrome following occupational exposure to trichloroethylene. *Trichloroethylene* was an industrial solvent and degreaser. Apart from severe cutaneous involvement, all 5 patients also had abnormal liver function.

Goh⁵⁵ also reported 5 workers who were allergic to *aminoethylethanolamine* that was present in the soldering fluxes. Fluxes were required to facilitate proper sol-

dering of printed circuit board. They presented with periungual and finger eczema.

Goh and Ng⁵⁶ reported a 29-year-old wave soldering machine operator who developed airborne allergic contact dermatitis to *colophony* that was found in the soldering flux used in an electronic factory.

Electroplating industry

Lee and Goh⁵⁷ reported 38% (14/37) of the chrome platers working in 17 chrome electroplating factories in Singapore had occupational dermatoses. However, only two workers were found to be allergic to *chromate* and one to *nickel*.

Goh⁵⁸ reported a 36-year-old Chinese electroplater with subacute hand and forearm eczema. The patient was sensitized to *gold chloride* in the course of gold plating.

Color developing

Goh *et al.*⁵⁹ reported 4 workers who were working in different photographic developing companies who presented with suspected occupational dermatoses on their upper extremities. Three presented with lichen planus-like eruption while 1 presented with an eczematous reaction. All patients reacted positively when patch tested to different Kodak *color developer (CD) chemicals* (CD2 and CD4), while two of them also reacted to CD3.

Goh⁶⁰ also reported a technician with chronic hand eczema and finger nail onycholysis, 5 months after working in a factory that manufactured color photograph processing chemicals. He was

found to be allergic to the color-print 101 ER Developer Replenisher that contained *hydroxylamine sulphate*.

Furniture industry

Goh⁶¹ reported a 34-year-old carpenter working in a furniture factory with subacute dermatitis on his forearms, cubital fossae, abdomen and ankles. Rash appeared 2 weeks after working on a new batch of *Rengas wood*. He was later found to be allergic to Rengas wood dust. Rengas wood belonged to the Anacardiaceae family and the trees produce a toxic resinous sap.

Interestingly, in a study of sanders employed in the furniture making industry in Singapore, Gan *et al.*⁶² were not able to identify any clinical case of contact allergy to wood dust.

Ammunition factory

Goh and Rajan⁶³ reported a 36-year-old Indian ammunition factory machine-operator who developed erythematous papular rash on her neck, forearms and forehead. She was later found to be allergic to *trinitrotoluene* (TNT) powder that was used in explosives. Goh⁶⁴ reported another operator in an ammunition factory who developed erythema multiforme-like eruption from capping mine that contained TNT.

In another publication, Goh⁶⁵ reported a 37-year-old Chinese detonator packer who developed swelling of her lips, finger, hands and rash on her neck. She was later diagnosed to have an allergic contact dermatitis to TNT and also to *tetryl*.

Epoxy resin

Leow *et al.*⁶⁶ reviewed 23 cases with allergic contact dermatitis to epoxy resin that were seen and patch tested at the Occupational Dermatoses clinic of NSC from 1991 to 1994. They found that 19 of the patients had positive reactions to epoxy resin in the standard patch test series. Three of them also had positive reaction to their own epoxy resin and another patient only reacted to his own epoxy resin and hardener. Sources of epoxy resin could be traced to epoxy-based adhesives that accounted for the largest number of cases, epoxy-grouting agent used in the construction industry and miscellaneous sources.

Paramedical workers

Goh & Ng⁶⁷ reported a 22-year-old technician working in a factory manufacturing ranitidine HCl granules, who developed an allergic contact dermatitis to the H₂ antagonist. He developed eczema on the extremities when he was transferred to work in the packing department where there was direct contact with *ranitidine* base powder.

They also reported a 28-year-old Indian pharmaceutical laboratory dispenser who developed photoallergic contact dermatitis to *carbimazole*.⁶⁸ He was inadvertently exposed to the powder that was used in the tablet making room through contamination in the work area.

The same authors also reported a 45-year-old dental nurse who developed chronic eczema on her left thumb and index finger from direct contact with amalgam that was used for dental fillings.⁶⁹

She was found to be allergic to the *metallic mercury* in the amalgam and eczema cleared when she adopted a non-touch technique when handling the amalgam.

Miscellaneous

Goh *et al.*⁷⁰ reported a 33-year-old prison warder who developed allergic contact dermatitis to a tear gas. The patient had an accidental exposure on his abdomen and chest from a leaked canister of *tear gas* called Mace that contained methylchloroform and chloracetophenone.

Goh *et al.*⁷¹ reported a 46-year-old soft drink factory operator who developed allergic contact dermatitis on his forearms and hands from handling a Chinese herb called *Mesonia chinensis*. The dried leaf of the herb was used to prepare a traditional Chinese herbal tea. The patient was patch tested positive to the crushed leaf.

Goh⁷² also reported a 49-year-old gardener who noticed recurrent dermatitis on his face and hands whenever he trimmed a particular weed, called *Wedelia trilobata*. He was patch tested positive to the leaf and flower of *Wedelia trilobata*, which is a garden weed belonging to the Compositae family.

Goh and Ng⁷³ reported a 64-year-old Indian man with eczema on his hands, forearms and dorsa of the feet. He was exposed to numerous spice powder as he worked as a miller in a spice shop. He was patch tested positive to the curry powder that he handled and *Curcuma longa rhizome (turmeric) powder*.

Goh⁷⁴ reported a 58-year-

old aquarium keeper in a fishery research station with recurrent pruritus on his hands and forearms. He was later found to be allergic to *proflavine* that was added into the fish tanks for the treatment of *Ichthyophthirius* infection. He was also treating his own rash with acriflavine.

Goh and Ng⁷⁵ reported a 29-year-old man who developed recurrent erythematous and xerotic plaques on his arms and trunk from exposure to trichloroethylene. He was using *trichloroethylene* as an industrial solvent and degreaser for cleaning barrels that contained industrial oils.

Conclusion

Contact allergy is an important subset of dermatology that encompasses disorders that include immuno-bullous and connective tissue diseases. As alluded to in the multitude of publications, investigators in Singapore adopt a clear logarithmic approach to the diagnosis, investigation and management of patients with suspected allergic contact dermatitis. The use of chemical analysis as a supplementary tool further consolidates the scientific investigative process. It is particularly gratifying to the patients and physicians when the final diagnosis is made as the clinical problem can be resolved completely if the suspected putative allergen is identified and removed in most instances.

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