

CLOTHING CONTACT DERMATITIS

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ABSTRACT

Clothing dermatitis from textile fibres, dyes and chemical finishes is not well described in the literature. Clothing dermatitis can be found amongst textile industry workers, textile and garment sales personnel and end users of the products made from textiles. Despite the broad range of people exposed, and thus potentially at risk, textile dermatitis is often unrecognised and misdiagnosed. There are a wide range of substances used in textile manufacture but despite this dyes and resins are the most frequently found cause of clothing dermatitis.

A case is presented to illustrate important aspects of clothing dermatitis in the end user, a factory worker who developed contact dermatitis to a mop cap. It highlights the clinical presentation of clothing dermatitis and how to diagnose, manage and prevent it.

INTRODUCTION

Clothing is a basic requirement both for physical and psychosocial reasons. Clothing includes garments, shoes and accessories such as stockings, gloves, hats and belts. Various materials are used in the manufacture of clothing: fabrics, leather, foam, fur as well as fasteners and decorations made from rubber, plastic, metals and wood.¹ Apart from the raw materials, chemical additives are used in the processing of fabrics. These include dyes, biocides which inhibit mould growth, fire retardants, softeners, anti-static agents, spot removers, chromates, nickel and glues.^{1,2,3,4} Skin disorders can be caused by almost any material used in textile and garment manufacture.

The pattern of clothing dermatitis (clinical presentation and range of allergens implicated) has evolved over the years reflecting changes in textile production technology, fashion and leisure activities. The exact prevalence of clothing-related contact dermatitis is unknown because of a lack of epidemiological studies.^{1,5} There are no prospective epidemiologic studies specific for clothing as opposed to textiles. Most clothing studies are allergen related (dyes and finishes) or are case reports. In a prospective study over 4 years from Tel Aviv, 12.9% of 644 patients referred for evaluation of textile dermatitis had textile allergy with a relevance rate of 81.4%.⁵ In a retrospective study from Melbourne, a textile allergy prevalence of 7.6% with a relevance rate of 77% was reported among 2069 patients referred predominantly with suspected textile allergy.⁶ Relevance was considered to be present if there was a temporal and clinical relationship between the use of clothing and the outbreak of the dermatitis and resolution of the rash when contact with the clothing thought to contain the allergen was discontinued.^{5,6} Reports suggest that its occurrence is underestimated as diagnosis is

largely dependent on the awareness of the practitioner.^{1,5} Without a high index of clinical suspicion, clothing contact dermatitis may be misdiagnosed for months to years as neurodermatitis, lichen simplex chronicus, parapsoriasis, erythema multiforme, mycosis fungoides, drug eruption, post-inflammatory hyperpigmentation, pigmented purpura, scabies and disseminated pruritus with excoriations.^{4,5,7}

Studies have demonstrated that females have a higher prevalence of clothing dermatitis and have suggested that this is due to the fact that they wear more tight-fitting, crease resistant and dark clothes.^{2,5,7,8}

Clothing dermatitis can be both an occupational and a non-occupational disease. Textile and garment manufacturing employees are at high risk, as are garment sales personnel who handle the end product daily.⁹ In the occupational setting garments worn as personal protective equipment (PPE) or as work uniforms may be the cause of dermatitis.¹⁰ Textile dermatitis in workers in the textile industry was previously discussed and will not be addressed here.¹¹ This article will focus on textile dermatitis in those who use the end products of textile manufacture.

CASE REPORT

A 42-year old machine operator presented with a 2-year history of an itchy rash on her forehead and neck. She had been working at a packaging manufacturer for the previous 17 years and because the packaging was destined for the food industry, health precautions were in place that necessitated personal protective equipment including a mop cap and gloves. She first noticed the rash after a change in personal protective clothing provided at work. The company had previously provided washable cotton mop caps to cover employees' hair but had swapped to dispos-



Figure 1: Post-inflammatory hyperpigmentation with some skin thickening and lichenification and red vesico-papules extending along the hairline and onto the ear lobes, matching precisely the area of direct skin contact with the mop cap

able ones for financial and hygienic reasons shortly before her symptoms began. From an initial itch, her rash had progressed to darkening along her hairline and outer ear lobes, sparing the rest of the scalp and face. The rash did not extend to involve the rest of her body. The increased pigmentation was particularly distressing for the patient.

The patient used scalp and hair grooming products, but no hair dyes or relaxers, and reported no problems with their use. She did not wear hats or headscarves regularly outside work. She had no past history of eczema or atopy, but had noticed that a rash would develop on her neck if she wore perfumes directly on her skin. She was otherwise well with no chronic medical conditions.

On examination she had prominent post-inflammatory hyperpigmentation with some skin thickening and lichenification on a background of red vesico-papules extending along her hairline and onto her ear lobes (Figure 1). This fitted the area of direct skin contact by the mop cap. The rest of her skin was unremarkable.

The clinical history and distribution of the rash strongly suggested a contact dermatitis to her disposable mop cap. The employee and cap manufacturer provided details of the mop cap which was made from 100% spun bond polypropylene nonwoven fabric with an elastic band (fabric covered) used to hold the cap on the head. The caps were white and contained no additive such as perfume.

A patch test to differentiate contact allergy from irritancy was performed. The Contact Dermatitis International Research Group Guidelines were followed for testing, reading and reaction interpretation.¹² A battery of 45 commercially available allergens, including fragrances, rubber additives, some dyes, formaldehyde and formaldehyde releasing preservatives and resins was used. These commercial patch test allergens were extended to include two pieces of the disposable mop cap provided by the workplace. Pieces from the nonwoven material, (excluding the

elastic) were placed in aluminium Finn chambers under water dampened filter paper. The commercial allergens and one mop cap patch test were left *in situ* for 48 hours and a reading was done after 72 hours. The second piece of mop cap remained in place for 96 hours before being removed and read at 120 hours.

At 72 hours she had 2+ (strong) reactions to formaldehyde (liquid) and fragrance mix 1 and 2 and a ± (doubtful) reaction to the mop cap (Figure 2). After prolonged skin contact of 96 hours, a 1+ (mild) reaction to the piece of mop cap was observed at 120 hours (Figure 3).

Although it could not be proven directly, formaldehyde released from the cap was the most likely cause of the rash. The workplace was requested to provide her with a cotton non-disposable mop cap and the symptoms have settled but the post-inflammatory hyperpigmentation continues to be a problem. The case was reported to the Compensation Commissioner as occupational allergic contact dermatitis to her mop cap, and a decision regarding compensation is awaited. She was given advice regarding garment and textile use and avoidance. In addition, the patient was advised to avoid fragrances as far as possible and to choose personal hygiene products and cosmetics free of formaldehyde releasing preservatives.

DISCUSSION

Textile dermatitis can develop from skin contact with textiles such as clothes, bed sheets, pillowcases, upholstery and chair covers.⁵ Clothing dermatitis specifically is frequently undiagnosed because of the atypical clinical presentations, the limited number of textile allergens in standard patch test series, and the non-declaration on the product label of the chemicals used to dye or finish the garments.⁷

TYPES OF SKIN DISORDERS CAUSED BY CLOTHING

Clothes can cause both allergic (type 1 and 4 hypersensitivity reactions) and irritant contact dermatitis. Irritant dermatitis is more common, is non-immune and can occur in anyone exposed to the clothing.¹ Diffuse body itching may be the only symptom of clothing dermatitis.¹ Most reactions are eczematous but a range of skin diseases have been reported. Contact urticaria caused by natural silk, wool, rubber, formaldehyde and ammonium chloride in textiles and leather has been documented.^{1,4} Less frequent presentations include:^{1,4,5}

- petechial/purpuric dermatitis (from dyes, fibre glass and wash powders);
- hyperpigmentation (from dyes and resins);
- papulo-pustular rashes (fibre glass);
- erythema multiforme-like eruptions (from disperse dyes);
- nummular eczema-like lesions (from disperse dyes);
- lichenification (from disperse dyes);
- erythroderma (from disperse dyes).

Reactions can be generalised or localised to areas where the skin is in close contact with the clothing, e.g. axilla borders (the vault is typically spared), genitals, upper back, ante-cubital or popliteal fossae, waist and hands if occupational.^{1,2} For trousers, dermatitis predominates on the thighs and lower legs, and dorsal hands if the hands are kept in the pockets. Blouses and fitted shirts often cause dermatitis involving the upper back, lateral chest and axillary folds with sparing of the axillary vault.¹³ Men often have increased irritation around the neck, where tight-fitting collared shirts are in contact with the skin.² A similar picture can be seen from other textiles used around the neck such as scarves.¹⁴ Occupational cases often demonstrate involvement of the hands.^{5,7}

PREDISPOSING FACTORS FOR CLOTHING DERMATITIS

Factors which promote release of chemicals in clothing and predispose to contact dermatitis include specific handling of clothes (washing, dry cleaning or ironing) sweating and heat. Factors which lead to damage to the skin barrier (e.g. friction, maceration and tight clothes, and underlying conditions such as atopic eczema), make the skin more vulnerable to penetration of external agents and hence sensitisation and allergic reactions.^{1,2,3,4,5,7} Formaldehyde may be released from clothing and other textiles during extended storage.⁶ The physical or occlusive effect of clothing can result in non-allergic irritant occlusive dermatitis.^{2,3}

Our case is typical of an eczematous reaction that started with pruritus in the area of direct close, occlusive contact with the mop cap. It also illustrates the lack of awareness and recognition of clothing dermatitis, as it took 2 years before a definitive diagnosis was made and the worker could be appropriately managed.

ALLERGENS CAUSING CLOTHING CONTACT DERMATITIS

FIBRES

Fibres forming the basis of textiles can be natural or man-made and include those used in nonwoven fabric production. Fibres may be natural cellulose based, like cotton, flax, sisal and linen, or natural protein based, like silk and wool. They may be synthetic, like nylon, rayon and polyester.

- Natural fibres are obtained from¹¹:
 - vegetables (cotton, flax, ramie, manilla, sisal, kapok and coir);
 - animals (sheep wool, camel wool, goat mohair or cashmere, angora and silk);
 - minerals (asbestos).
- The man-made fibres are¹¹:
 - vegetable (latex or regenerated cellulose);
 - synthetic (polyamide, polyester, polyacrylic, polyethylene, polypropylene, modacrylic, elastane);
 - inorganic (glass and metal).

Natural and synthetic textiles that are undyed and unfinished do not commonly cause textile dermatitis.^{1,2,4} Most problems are as a result of fibre chemical processing.

Nonwoven fabrics are of the oldest and simplest fabrics. Felt is a classic example and the earliest well documented records of its use date back to before 3000 BC.¹⁵ Since the 1960s the term nonwoven fabrics applies to new techniques and principles of fibre production other than weaving or knitting. New products are being developed to meet many diverse needs in the automotive, civil engineering (geo-textiles), packaging, home furnishing, building, water purification, sanitary, cleansing, food and medical industries. Nonwoven fabrics are broadly defined as sheets or web structures of fibres or extruded filaments bonded together by entangling the fibre or filaments mechanically, thermally or chemically.

The mop cap was made of fabric manufactured from polypropylene using the spun bonding technique. Polypropylene has the advantages of being inert, easy to process and low cost to produce.¹⁶

DYES

The incidence of textile dye dermatitis in those with suspected textile dermatitis and allergic contact dermatitis was found to range from 0.05% to 15.9% depending on the country, patient sample, and number of dyes in the patch test series.¹⁷ The notion of low incidence is most likely because dye contact allergy is not suspected and therefore not tested and standard screening patch test series lack the allergen that might reliably indicate the possibility of textile dye contact allergy.¹⁷

Dyes are organic compounds that contain a chromophore (the coloured portion), and an auxochrome. The auxochrome renders the dye soluble, is a site for bonding of the dye to the textile fibre and it also slightly alters the colour of the dye.¹⁸ Dyes can be classified by the method of application or by their chemical composition. There are

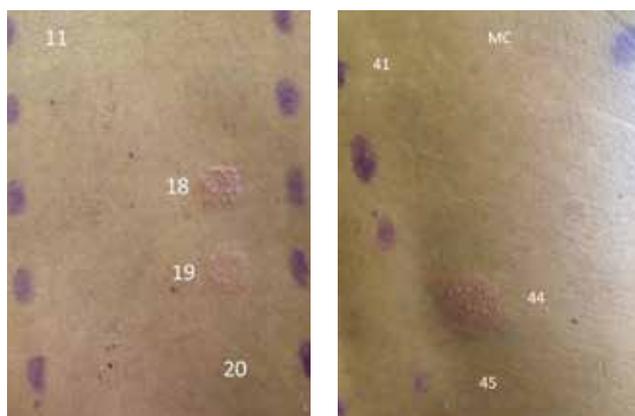


Figure 2: Patch test result at 72 hours showing 2+ reaction to formaldehyde (18), fragrance mix 1 (19) and fragrance mix 2 (44). An equivocal reaction to the mop cap (MC) material is present

TABLE I: KEY DIAGNOSTIC CRITERIA FOR ALLERGIC CONTACT DERMATITIS FROM FORMALDEHYDE TEXTILE RESINS² (Adapted from Hovding G; Marcussen PV; Berrens L et al modified by Reich HC and Warshaw EM²)

1. Characteristic location of the eruption, corresponding to contact with clothing.
2. Positive patch-test reaction to formaldehyde or formaldehyde resin.
3. Patch test positive to suspected fabric.
4. Demonstration of free formaldehyde in the suspected fabric.
5. Negative reaction to other potential clothing allergens (e.g. rubber, nickel, dyes).

several classes of dyes but only two, azo and disperse dyes, are of clinical interest as they have the potential to cause allergic contact dermatitis and possibly cancer.¹⁸ The latter concern has meant that the use of the azo and disperse dyes is regulated in many countries.¹⁸

Disperse dyes (DDs) are the principle cause of textile-related allergic contact dermatitis.^{1,7,19} They are slightly water soluble and their particle size and uniformity, together with the dispersant used, determine their fixation to textile fibres, although some materials like polyester also require carriers for fixation. They are used for dyeing synthetic fabrics, not natural fibres.¹⁷ Disperse dyes do not chemically bind to the fibres, and their small, lipophilic molecules can therefore easily migrate onto the skin of the person who is wearing the garment, especially if the textile colour fastness is poor. The migration is aided by friction, tight clothes and moisture.^{1,2,3,4,5,7,19}

Azo dyes are water soluble, simple to produce, and offer a very wide variety of shades and colour fastness. It is felt that sensitisation to azo dyes rarely, if ever, occurs through wearing clothes. Sensitisation is thought to occur through exposure in other settings to paraphenylenediamine (PPD) (black henna, temporary tattoos, permanent hair dyes, black rubber etc.) which is closely related to the azo dyes.¹⁸

Basic dyes may also cause contact dermatitis.¹⁸

Reactive dyes are used for natural fibres. They are not readily available for transfer from fabric to skin, as they are covalently bonded to the cellulose polymers of fibers.^{1,4,8} They rarely cause contact dermatitis.

Dyes are dissolved or dispersed in a carrier to allow penetration of the textile fibres. Some molecules remain on the surface of the fibres or remain unfixed within the fibres where they can bleed and are subject to surface abrasion. The dye would thus be transferable from the fabric to the skin to cause a skin reaction.⁸ It is often the dark coloured disperse dyes, (black, blue and green) that cause reactions.^{6,16,19}

Reactions to dyes are often acute and severe.² One should

suspect textile dye contact eczema in patients with sudden onset of eczematous dermatitis especially if dark blue, black or green clothes have been used.^{2,9} Dyes have also been reported to cause purpuric contact dermatitis, contact urticaria, erythroderma and erythema multiform like lesions.^{1,5,16}

FINISHES

FORMALDEHYDE RESIN FINISHES

Formaldehyde resin treatments are applied to fibres to increase their strength, prevent shrinking, and make them wrinkle resistant. Formaldehyde may be found both in free or bound form in treated fabrics.²

The prevalence of contact dermatitis due to formaldehyde is unknown, but may be reducing due to use of newer formaldehyde resins. Several countries like Japan have regulations limiting the amount of formaldehyde in clothes.^{2,18} Sensitisation to substances requires exposure to higher concentrations of the substance than is required to elicit an immune response in an already sensitised person. Further exposures often require a smaller amount of allergens to elicit a hypersensitivity reaction. In those with a contact dermatitis to formaldehyde, the initial sensitisation may have resulted from formaldehyde preservatives in consumer products such as antiperspirants, cosmetics, or toiletries.² Reactions may thus occur even to formaldehyde concentrations at acceptable levels. There are nine formaldehyde resins in current use in the United States and most do not release a significant amount of formaldehyde as compared to older formulations used before the 1960s.¹⁸ An allergic reaction may actually be due to the resin *per se* and not the released formaldehyde.³

OLDER FORMALDEHYDE TEXTILE RESINS

These include urea and melamine formaldehyde resin which polymerise within the interstices of the fibres. They contain high amounts of free formaldehyde.² Another disadvantage to the use of the older resins is their ability to absorb chlorine when exposed to bleaching agents, leading to discoloration and fabric weakening.²

From the 1950s, cyclic ethylene and propylene derivatives were used in place of the earlier resins, as they released less formaldehyde, washed better and were less likely to cause discolouration. These resins bond to cellulose and include dimethylol dihydroxyethyleneurea (DMDHEU).²

TABLE II: AVOIDANCE ADVICE FOR PATIENTS WITH DISPERSE DYE ALLERGY⁴ (Adapted from Fishers Contact Dermatitis⁴)

1. Wear cellulose based and natural fibres; cotton, rayon, silk, and wool. Wool may cause a non-allergic irritation in those with atopic dermatitis.
2. Wear loose fitting garments.
3. Wear cotton and silk undergarments.
4. Wash new clothes once or twice before wearing them.
5. Avoid synthetic dark clothes, especially blue, green and black.

TABLE III: AVOIDANCE ADVICE FOR PATIENTS WITH FORM-ALDEHYDE RESIN ALLERGY⁴ (Adapted from Fishers Contact Dermatitis⁴)

1. Avoidance of permanent press, wrinkle resistant and easy care clothing and bed linen. If worn they should be cool, loose-fitting items for short periods of time. Perspiration and heat make the problem worse.
2. All new clothes should be washed at least twice before being worn. Levels of free formalin may however rise again as the resin degrades.¹⁸
3. Soft and easily wrinkled fabrics are the safest to wear. Heavy stiff clothes should be avoided.
4. Most blended fabrics, e.g. polyester and cotton, are usually treated with resins and should be avoided.
5. Silk, linen, wool, denim and nylon are usually not treated and almost always safe.
6. Rayon, corduroy and shrink proof wool should be avoided.

NEWER FORMALDEHYDE TEXTILE RESINS

There has been a reduction in the percentage of urea formaldehyde used in durable press finishes because of concerns regarding the high release of formaldehyde. DMDHEU may be modified by the addition of methyl groups, which replace the N-methylol (formaldehyde) groups, the main source of formaldehyde release. When DMDHEU is blended or reacted with diethylene glycol, an ultra-low formaldehyde product is produced.² The formaldehyde groups in the resin form stable bonds and thus release a much lower amount of formalin.^{2,18}

FORMALDEHYDE FREE RESIN FINISHES

Dimethyl dihydroxyethyleneurea (DMdDHEU) is a textile resin that does not contain formaldehyde.² It cross-links with cellulose in a similar manner to DMDHEU, but requires stronger catalysts because it is a less reactive compound. As it is more expensive than older resins, DMdDHEU is still less commonly used.² Other non-formaldehyde resins include butanetetra-carboxylic acid (BTCA) and similar polycarboxylic acids. Many of these non-formaldehyde resins are used in the infant and children's clothing industry.²

Cutaneous reactions to formaldehyde can include irritant and allergic contact dermatitis, exacerbation of atopic dermatitis, urticaria, and phototoxic eruptions. Erythroderma, petechial eruptions, generalised pruritis, and lichen amyloidosis have also been reported.² Presentations are sub-acute and chronic unlike the acute reactions seen with reactions to dyes.²

OTHER ALLERGEN CAUSES OF CLOTHING DERMATITIS^{1,4,11,12,13,20}

- Flame retardants;
- Chromium used to fix dye in textiles may cause allergic dermatitis;
- Nickel in fasteners and decorations may also be a cause of clothing dermatitis;^{1,4,12}
- Colophony from glues;
- Rubber allergens in elastic parts of garments, and rubber glues;
- Spot removers which may be made of acetic acid, carbolic acid and hydralazine;

- Epoxy resin in some glues and in the print of textile labels;
- Biocides, such as quaternary ammonium, are commonly added to military and canvas materials used for outdoor recreational use;⁴
- Foam in mattresses and bra padding has also been found to cause clothing dermatitis;²⁰
- Anti-statics;
- Water repellents;
- UV-absorbers and polymer stabilisers;
- Lubricants;
- Soil release chemicals;
- Optical brighteners;
- Perfumes released on touching the fabric or added as detergents and softeners.

Despite using novel technology for fibre production and textile manufacture, nonwoven fabrics are finished in much the same way as woven fabrics to obtain specific properties in the end product.

The nonwoven disposable mop caps used by the worker were made of polypropylene, which is melted in the early stages of the production of the nonwoven textile and extruded to form filaments which are then laid down in a sheet and bonded together by heat. A by-product of polypropylene degradation is formaldehyde. Usually, there is an off-gassing of formaldehyde during the manufacturing, but it is not 100% efficient. Trace amounts of free formaldehyde may remain in the textile.¹⁰

As there were no additives to the fabric processing according to the manufacturer and no reactions to the commercial rubber allergens, this worker's dermatitis was felt to be due to formaldehyde in the cap nonwoven fabric. The amount of formaldehyde in the mop caps was perhaps too low for sensitisation of the worker, there she could have become sensitised to formaldehyde in personal use products or cosmetics.

MANAGEMENT

- It is important to consider clothing dermatitis in the differential diagnosis of all skin rashes;



Figure 3: Patch test result at 120 hours showing 1+ reaction to the mop cap material after 96 hours of occlusion

- Evaluate exposures and relevance to pattern and type of clinical presentation;
- Perform a patch test to confirm a diagnosis of allergic clothing dermatitis using commercial allergens;
- To accurately assess positive reactions to textile dyes, late readings after 7 and 10 days must be performed in order to avoid false negative reactions;⁵
- Extended patch testing using samples taken from the suspected clothes is advisable. All textiles, under occlusion or in semi-open settings, need to be in contact with the skin for 4 days;
- Patient education is important and advice on what to avoid, or use as alternatives, is essential;
- The standard treatment of contact dermatitis induced by clothing is with topical or systemic steroids according to the condition and strict avoidance of the offending allergen source.^{2,5}

OTHER ADVICE FOR PATIENTS WITH CLOTHING DERMATITIS

- Recommend the avoidance of formaldehyde releasing products in personal hygiene products;²
- Synthetic spandex or lycra exercise clothing, 100% acetate and polyester liners and dark nylon stockings should be avoided by those with disperse dye dermatitis.⁵ These are likely to contain disperse dyes.

If pure white or natural fibre products can be found, they can be considered for use.

Our patient was treated with potent topical steroids and the nonwoven mop cap was replaced by the cotton reusable one. She was advised about formaldehyde sensitisation and instructed on how to limit exposure by avoiding permanent press garments and personal care products and cosmetics with formaldehyde releasing antimicrobial preservatives.

Despite relief of symptoms and eczema resolution, the significant post-inflammatory hyperpigmentation persists

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and is more distressing to her than the contact dermatitis.

CONCLUSION

Clothing dermatitis is not always thought of as the cause of dermatitis, which leads to delay in diagnosis and prolonged patient discomfort. Dyes, especially dark dyes, and resin are the predominant cause of the dermatitis. Multiple allergens are used in textile manufacture and if clothing dermatitis is suspected then every effort should be made to identify the cause and appropriately advise the patient on what to avoid and what to use.

Our case illustrates that clothing dermatitis can be caused by PPE provided to a worker. It is often misdiagnosed especially when presenting atypically (and not on the hands) as illustrated by our case, which took over 2 years before it was correctly diagnosed and managed. Patch tests with textile materials should be left on for longer than the standard duration of time to avoid false negative results as illustrated with our patient, who showed a positive reaction after 96 hours of skin contact.

This case introduces one to the newer fabrics made by nonwoven technology and highlights their potential role in contact dermatitis. Textile dermatitis caused by clothing, the end product of textile manufacture, should always be considered in persistent non-responsive dermatitis.

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DECLARATION OF CONFLICTS OF INTEREST

The author has no conflict of interest to declare.

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CONGRESS WELCOME AND OVERVIEW

A very warm invitation is extended to you by the 2015 ALLSA Congress organisers, Di Hawarden and Claudia Gray. This year's congress promises to be full of the essentials of allergology, coupled with an overview of the latest trends in allergy and clinical immunology. It will be held in friendly Port Elizabeth at the world-class Boardwalk Hotel from the 3rd-6th September 2015.

The programme will kick off with 4 workshop-style sessions covering both the essential theory as well as the practical skills required to run an allergy service. These workshops include an anaphylaxis workshop, an asthma workshop, an allergic rhinitis workshop and a skin workshop, and will be suitable for general practitioners, specialists as well as the allied-professions. Later in the programme there is also a food allergy workshop, open to all, and of particular benefit also to our dietetics colleagues.

Our 2 plenary sessions on Friday the 4th and Saturday the 5th September cover some cutting edge topics in allergology including the concept of the biofilm in respiratory allergy, the skin barrier in allergy causation, and several ethics topics. We will have some expert international speakers as well as the local stalwarts of allergology presenting.

Parallel to the allergy workshops, we have sessions on immunology/primary immunodeficiency disease, making up the 6th African School for Primary Immunodeficiencies.