

ALLERGIES IN THE WORKPLACE

CONTACT DERMATITIS IN THE PLASTIC INDUSTRY – A CASE SERIES

Hussein Mwanga, MD

Centre for Occupational and Environmental Health Research and Division of Dermatology, School of Public Health and Family Medicine, University of Cape Town, South Africa

ABSTRACT

Plastics are one of the most widely used materials worldwide, and the plastic industry employs a significant number of workers. Workers in this industry are exposed to plastic monomers and other products used in the production process in order to give the finished products specific characteristics such as heat stability, flame resistance, ultraviolet stability, flexibility or hardness. Workers are therefore at risk of developing occupational contact dermatitis (OCD). This article reports on two workers diagnosed with contact dermatitis. It illustrates how difficult it is to identify the cause of OCD from a consultation room clinic history and evaluation alone.

INTRODUCTION

Occupational skin diseases (OSDs) are among the commonest diseases caused by work.¹ The commonest OSD is contact dermatitis and it has been estimated to account for 90-95% of all OSDs.² Some other OSDs include contact urticaria, skin cancers, skin infections, occupational vitiligo and miscellaneous skin diseases.¹

Occupational contact dermatitis (OCD) has been defined as an inflammatory skin condition caused by skin contact with an exogenous agent or agents in the workplace setting, with or without a concurrent exposure to a contributory physical agent (e.g. ultraviolet light).³

There are two major types of contact dermatitis: irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD). ICD occurs when skin comes into contact with agents that have a direct toxic effect on the skin, e.g. wet work, detergents, solvents and friction.¹ ACD is a delayed (type IV) hypersensitivity reaction as a result of exposure to skin sensitisers such as epoxy resins and preservatives.¹ Estimates indicate that ICD accounts for 80% and ACD for 20% of all contact dermatitis.³ It is thought that ACD is more prevalent than documented, depending on how much effort is made towards identifying the allergens responsible.⁴

A study done at the Occupational Skin Disease Clinic at the National Institute for Occupational Health (NIOH) in South Africa found that 85% of all OSDs were OCD.⁵ The remaining 15% included contact urticaria, tinea pedis, tinea corporis, paronychia, recurrent abscesses and a case of Sézary syndrome.⁵ ICD was the commonest OCD, accounting for 42% of all OSDs; 20% of OSDs were ACD and in 24% of OSDs, ACD coexisted with ICD.⁵

This article highlights the possible skin effects in workers in the plastic industry. It specifically focuses on contact dermatitis as this is the commonest OSD reported.² Several other health effects due to plastics, particularly the monomers used for manufacture of the plastics, have been described, including liver angiosarcoma, acro-osteolysis and asthma-like reactions.⁶

PLASTIC INDUSTRY

Plastics are one of the most widely used materials worldwide and a significant number of workers are employed in the plastic industry. Plastic has been defined as 'a material that contains as an essential ingredient an organic substance of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or in its processing into finished articles, can be shaped by flow'.⁶

There are two main types of plastics: thermoplastics and thermosets. Thermoplastics are those plastics that can be heated to soften and harden when cooled. This forming process can be redone several times repeatedly as these kinds of plastics do not undergo a chemical change during the forming process.⁷ Examples of thermoplastics include: polyethylene, polypropylene, polystyrene, polyvinyl chloride (PVC) and saturated polyester.⁷ Thermosets undergo a chemical reaction upon being heated, pressurised or reacted with a hardening agent and become permanently solid.⁷ Examples of thermosets include epoxy, phenolic, polyurethanes, unsaturated polyester, and urea-formaldehyde.⁷

The plastic industry can broadly be classified into two major categories, namely plastic resin manufacturers and plastic processing industries.⁷ Plastic resin manufacturers are those industries that make plastic resins by chemically combining relatively simple organic molecules (monomers) into much longer molecules (polymers).⁷ These monomers are often very irritant or sensitising. Plastic processing industries use the plastic resins to form manmade fibres and various plastic products such as plastic bottles and plastic sheets.⁷

Plastic fibres are produced mainly for use as raw materials in the textile industries.⁷ There are two main types of fibres: noncellulosic and cellulosic. Noncellulosic (synthetic) fibres are those formed by polymerisation of monomers and include nylons, polyesters, polyolefins (polyethylene and polypropylene) and acrylics. Cellulosics are made from cellulose which is a naturally occurring material.⁷

CASE SERIES

Patient A

A 30-year-old woman presented with a 6-year history of a recurrent itchy, burning skin rash of the hands. The skin rash would normally resolve with the use of topical steroids but would return once they were discontinued.

She had been working in a plastic processing factory for 10 years, making various plastic products. During this time, she had been working as a machine operator on



Fig. 1. Patient A performing her daily routine. Note the way she is holding the newly manufactured plastic hangers in her left hand.

a line producing food containers but had been moved to working with plastic hangers 3 months before the onset of the recent episode of the skin disease. Currently her job involved inspecting and packing the newly manufactured plastic hangers into boxes ready for dispatching (Fig. 1). The newly manufactured hangers are usually warm but protective gloves were not used to protect her skin while working. It was noted that the skin disease was not related to activities outside her workplace.

She had hyperkeratosis of the palms (Fig. 2a), with cracks and fissures especially on the tips of the fingers

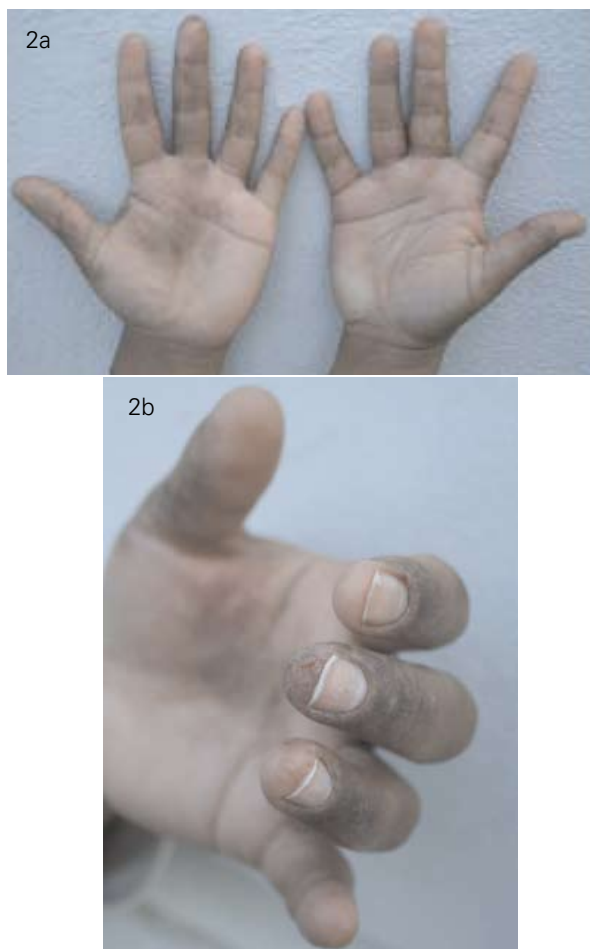


Fig. 2a. Patient A's palms. Note the hyperkeratosis especially of the left palm which corresponds to areas of contact with the hangers.

Fig. 2b. Cracks and fissures, especially on the tips of the fingers of patient A.

(Fig. 2b) and mild paronychia of the finger nails. The findings were consistent with chronic eczema and were more severe and accentuated at the points of contact with the manufactured plastic materials, especially on the left palm.

A patch test using a standard series of 45 commercial allergens most often implicated in allergic skin reactions was done. A positive (2+) reaction was identified to nickel sulphate and Kathon CG/CI + Me-isothiazolone. Nickel is a ubiquitous allergen and was not thought to be the cause of the worker's occupational hand problem. Kathon CG is a broad-spectrum preservative active against bacteria, fungi, yeast and algae. It is widely used to prevent microbiological contamination especially of water-based products in both industry and cosmetics.

Patient B

A 33-year-old man presented with an 8-month history of an itchy, burning skin rash. His hobbies and home activities were found not to be related to his skin disease. He has been working as a machine operator in a factory that makes polyester fibres for duvet filling and carpets for about 10 years. During this time he has been working as an operator on the stretchline where lengths of premanufactured plastic fibres are mechanically drawn through a bath of warm soapy solution and then between heated rollers to align the polymer molecules and stretch the fibres to four times their original length.

The warm soapy solution contains spin finishers which are fatty acid polyglycols (ph 7.2 -7.6) used to prevent damage to the fibres during the stretching process and when the fibres rub against each other. This solution is variously contaminated by the plastic resin monomers and other chemicals that have been used in the manufacture of the fibres.

Once the machine is running, most of the worker's time is spent observing the process to ensure fibres do not break. If one of the fibres breaks, he has to pick up the loose end and reconnect it. It has been noticed by colleagues that he often plays with a short length of fibre while observing the working of the machine.

When the first episode happened, the dermatitis only occurred in the web spaces of his left hand. This responded to treatment with topical steroids. He subsequently had further episodes which responded in the same way. He reported that the rash would resolve when doing other duties and with the use of topical steroids, but would recur when he went back to work on the stretchline.

When we saw him in our clinic, he had lichenification and cracks on the dorsum of the middle phalanx of the right fifth finger and lichenification on the dorsum of the third and fourth fingers of the left hand.

A patch test using a standard series of 45 commercial allergens most often implicated in allergic skin reactions was negative.

Comment

Our current working diagnosis for both these patients is ICD with probable ACD superimposed in view of the eczema being localised to points of contact with the skin. The referring doctor sent pictures of patient A at work and of her hands when badly affected. These made our understanding of the job and problem easier, but do not replace a workplace assessment. It is only with observation of the work in progress and an analysis of the tasks and agents used at each stage of the process that one can identify potential risks and allergens and assess the relevance of commercial patch test results.

CAUSES OF CONTACT DERMATITIS IN THE PLASTIC INDUSTRY

The plastic industry uses a number of chemicals and sensitisers that can cause both ACD and ICD. The chemicals range from the monomers used to manufacture the plastic resins themselves to chemicals (additives) that are necessary to impart certain characteristics to the final plastic product.⁸ Some of these additives include: **lubricants** (stearic acid, waxes, fatty acid esters, and fatty acid amines); **antioxidants** (alkylated phenols, amines, organic phosphites and phosphates, and esters); **antistatics** (quaternary ammonium compounds, anionics, and amines); **blowing/foaming agents** (azodicarbonamide, modified azos and 4,4'-oxybis (benzenesulfonyl hydrazide)); **colourants** (titanium dioxide, iron oxides, anthraquinones, and carbon black); **flame retardants** (antimony trioxide, chlorinated paraffins, and bromophenols); **heat stabilisers** (lead, barium-cadmium, tin, and calcium-zinc); **organic peroxides** (methyl ethyl ketone peroxide, benzoyl peroxide, alkyl peroxide, and peresters); **plasticisers** (adipates, azelates, trimellitates, and phthalates) and **ultra-violet stabilisers** (benzophenones, benzotriazole and salicylates).⁸

Workers can be exposed to these chemicals at one or more of the several stages of plastic production. Chemicals can spill and cause ACD while being weighed, mixed, etc. Chemicals may leak from the containers or moulding machines and come into incidental contact with workers' skin. Airborne exposure from volatile products and emission fumes can lead to exposure contact dermatitis or urticaria.

Water is used for several activities in the plastic industry, namely: cooling or heating plastic products; cleaning the surfaces of the plastic products and the moulding equipment; and also for different activities such as lubrication.⁸ Waste water from these processes has usually been contaminated with a variety of the above chemicals. Workers exposed to the contaminated water can develop skin disease, making identification of the causative agent difficult.

Handling finished products may result in skin problems because of the presence of monomers or agents used in production or to colour the plastics, preserve them or to give the finished products specific characteristics such as heat stability, flame resistance, ultraviolet stability, flexibility or hardness.

The possible causes of hand dermatitis in our patients have not, as yet, been identified.

Patient A had a positive patch test to nickel and Kathon CG. Although there are many potential nickel exposures in the factory, it was felt that the relevance of the positive reaction needed evaluation – a dimethylglyoxime spot test for nickel release from metal surfaces will be done during the planned work visit. The preservative

Kathon CG could be in the colouring agent or other water products used for plastic moulding.

No potential allergens were identified from commercial allergen testing in Patient B, making a work visit mandatory for identifying risks and exposures before a diagnosis and advice on management can be offered. Potential irritants and allergens that need evaluation include all chemicals and substances used in the production of the fibres, including the spin finishers and the monomers *per se*.

CONCLUSION

The approach to diagnosing and treating OCD remains a challenge for the astute health care worker. One needs to recognise the features of eczema. Only then can one evaluate the work environment in an attempt to identify possible irritant and allergen exposures. Once they have been identified, appropriate patch testing can be done and advice given to prevent ongoing exposures.

This article seeks to emphasise the problem of OCD in the plastic industry. It also illustrates how difficult it is to identify the cause of OCD from a consultation room clinic history and evaluation alone.

The plastic industry employs a great number of workers and it is important to appreciate the challenges in diagnosing, treating and preventing these illnesses.

Declaration of conflict of interest

The author declares no conflict of interest.

Acknowledgements

I acknowledge with thanks the assistance of Prof Gail Todd, Dr Terry Berelowitz and CPN Jane Alt.

REFERENCES

1. Nicholson P, Llewellyn D, English J. Evidence-based guidelines for the prevention, identification and management of occupational contact dermatitis and urticaria. *Contact Dermatitis* 2010; 63: 177-186.
2. Keegel T, Moyle M, Dharmage S, Frowen K, Nixon R. The epidemiology of occupational contact dermatitis (1990–2007): a systematic review. *Int J Dermatol* 2009; 48: 571-578.
3. Lushniak B. Occupational contact dermatitis. *Dermatologic Therapy* 2004; 17:272–277.
4. Kucenic MJ, Belsito DV. Occupational allergic contact dermatitis is more prevalent than irritant contact dermatitis: a 5-year study. *J Am Acad Dermatol* 2002; 46: 695-699.
5. Fourie A, Carman H. The Occupational Skin Disease Clinic at the NIOH, NHLS: five years' experience. *Occupational Health Southern Africa* 2010, 16 (5): 6-11.
6. Eckardt R. Occupational and environmental health hazards in the plastics industry. *Environmental Health Perspectives* 1976; 17: 103-106.
7. U.S. Environmental Protection Agency. Office of Compliance Sector Notebook Project: *Profile of the Plastic Resin and Manmade Fiber Industries* 1997. Washington, DC: EPA, 1997.
8. U.S. Environmental Protection Agency. Office of Compliance Sector Notebook Project: *Profile of Rubber and Plastic Industry* 2005. Washington, DC: EPA, 2005.