

allergies in the workplace

CONTACT DERMATITIS CAUSED BY SYNTHETIC GLUE

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ABSTRACT

Glue is an adhesive substance that binds together the surfaces of the material to which it is applied. Glues may be found naturally or are produced synthetically. Glues are common contact allergens because of their widespread use as bonding agents, both in the occupational environment and at home. Exposure to glue can lead to allergic or irritant contact dermatitis, allergic rhinitis and asthma. A thorough history, clinical examination, workplace, home and hobbies evaluation, supported by patch testing where appropriate, using commercial allergens and own allergens including workplace-specific allergens, are of paramount importance in identifying the cause of contact dermatitis.

INTRODUCTION

Contact dermatitis has been defined as an 'acute or chronic immunologic or non-immunologic inflammation of the skin usually caused by contact with chemicals but occasionally by biologic or physical agents.'¹ This response can either be irritant or allergic in nature. Irritant contact dermatitis (ICD) is a result of local toxic effect when the skin comes into contact with irritant chemicals while allergic contact dermatitis (ACD) is an immune-mediated delayed-type hypersensitivity reaction that is elicited when the skin comes into contact with a chemical to which the individual has previously been sensitised. It is of importance to note that the exposure concentration necessary to sensitise an individual is significantly higher than that necessary to elicit ACD in an already sensitised individual. ICD and ACD are among the most common occupational dermatological diseases seen in workplaces and also at home. It is estimated that about 79-95% of all cases of occupational skin diseases (OSD) are due to contact dermatitis.¹ Approximately 85 000 chemicals present in our surroundings can be irritants and more than 4 350 are known contact allergens.² The potential for these substances to cause contact dermatitis varies greatly, and the severity of the dermatitis or eczema, the most common clinical expression, ranges from a mild, short-lived condition to a severe, persistent, job-threatening disease.²

Glue exposure may lead to sensitisation and ACD to a variety of agents as discussed below. Rare case reports of occupational allergic rhinitis and asthma have been described and depend on the glue ingredients to which the worker is exposed.

CASE REPORT

A 56-year-old male presented to the occupational dermatology clinic with an 8-month history of an itchy skin rash involving his hands. He had been working in a factory manufacturing toilet paper for the past 18 years. He was a machine operator in the core winding department, making the cardboard core around which the toilet paper is wound. His task involved placing three long strips of brown paper into rollers. The strips of paper were then pulled through a glue tray and finally into the machine where they were bonded together (Figures 1 and 2). One day while trying to release the paper rollers which had become stuck, he had significant exposure to the glue. He washed his hands as soon as the jam had been released and continued working without any problem. The day after the exposure, he noticed an itchy, red rash on his hands. This progressed to fluid-filled vesicles over the next 24 hours, interfering with his ability to work. He was seen by his occupational medicine practitioner who prescribed a topical steroid with minimal response.



Fig. 1. Strips of brown paper being pulled through the glue tray prior to being wound on the rollers.



Fig. 2. The glue-coated brown paper strips being wound onto the roller to form the toilet roll cardboard core.

On examination at the clinic he had patchy, thickened, lichenified, hyperpigmented, scaly skin of the dorsum and borders of the hands (Figures 3 and 4). The picture was compatible with an ACD. Patch testing using a standard series of 45 commercial allergens commonly found to cause ACD was deemed appropriate as many of the glue allergens were included in the series. After 48 hours of skin contact, the patch test was read at 72 hours. A 2+, strongly positive reaction to the preservatives Kathon CG/CI+Me-isothiazolinone and Euxyl K400 (a mix of dibromodicyanobutane and phenoxyethanol) were noted. Weakly positive, 1+ reactions to dibromodicyanobutane (found as a component of Euxyl 400), fragrance mix and cetystearyl alcohol (component of topical creams and ointments) were also present.



Figs 3 and 4. Patchy, thickened, lichenified, hyperpigmented, scaly skin of the dorsum and borders of the hands, compatible with chronic allergic contact dermatitis.

As none of these allergic reactions was to glue allergens *per se*, it was decided to visit his workplace to identify the relevance of the reactions noted from the commercial allergen patch testing and identify potential exposure to the strongly positive preservatives commonly used in water-based industrial and manufacturing products. Potential hazards to which he was exposed were identified as printing inks, machine oil, glue, 'mark-up' fluid and brown paper. The patient returned for repeat patch testing with the products

identified from work. Undiluted 'mark-up' fluid, glue and printing ink were placed in individual Finn chambers and left to dry. This ensured evaporation of solvents likely to cause an irritant reaction. When dry, the chambers were covered with water-moistened filter paper. The machine oil was applied to filter paper directly. The brown paper was applied under cover of water-moistened filter paper. After 48 hours occlusion the patch test was read at 72 hours. He reacted strongly, 2+, to the glue tested. He did not react to the printing inks, machine oil, paper or 'mark-up' fluid. A final assessment of allergic contact dermatitis secondary to the glue at work was made. This was identified as a polyvinyl acetate (PVA) glue, but details of additives to the glue, such as preservatives, were not available.

He received potent topical corticosteroids, emollients and aqueous cream for washing his hands, and was advised to wear fabric gloves when working and to avoid glue contact as much as possible. Despite these measures, the patient's skin symptoms continued and he elected to stop working. At a visit to the clinic 2 months after he resigned (and was therefore no longer exposed to the glue) his hand dermatitis was much improved.

DISCUSSION

Glues are widely used in various occupations, leisure and household activities. They are commonly used in leather goods and shoe making, furniture manufacture, the paper-making industries, cosmetics products and adhesives in clothing, disposable nappies and sanitary pads, toys, and in medical practice.

Historically, glues were made from natural sources such as plant matter, starch or animals (from hides or casein) and rubber was also used in glues and adhesives. While natural adhesives are still used for certain processes (e.g. starch-based wallpaper adhesive), they have largely been replaced by synthetic glues in industry.

Synthetic glues may be made from various different chemicals, many of which are well-known skin sensitizers. The most common ingredients of glues that have been reported as causes of contact dermatitis include rubber, acrylates, epoxy resins, colophony and formaldehyde resins (Table 1).³ Preservatives may be included in the glues which are water-based and cases of ACD to isothiazolinones,⁴ 2,4,6-trichlorophenol and Euxyl K400⁵ have been reported. Other additives such as benzoyl peroxide⁶ have also been reported as causes of contact dermatitis when used in glues.

Formaldehyde resins, such as para-tertiary butylphenol formaldehyde resin (PTBP-FR), are well recognised contact allergens.³ Contact dermatitis due to PTBP-FR can occur in both occupational and non-occupational settings. PTBP-FR is a glue used as an alternative to rubber-based glues in the leather industry. It is commonly used in belts, bags, hats, shoes and watchbands. An Italian study reported cases of vitiligo-like leukoderma on the hands of shoe-manufacturing workers exposed to PTBP-FR.⁷ Foot dermatitis caused by

Table I. Common contact allergens found in synthetic glue*

Formaldehyde resins	Phenol-formaldehyde resin, toluene-sulfonamide-formaldehyde resin, p-tert-butylphenol-formaldehyde resin, resorcinol-formaldehyde resin, para-tertiary butylphenol, 2-monomethylol phenol
Epoxies	Triethylenetetramine, triethylenediamine, 4-4'-diaminodiphenyl methane, diethylenetetramine, isophoronediamine, hexamethylenetetramine, epichlorohydrin, triglycidylisocyanurate
Acrylates	(2-hydroxyethyl) methacrylate (2-HEMA), (2-hydroxypropyl) methacrylate, 2-hydroxyethylacrylate, methyl methacrylate, butyl acrylate, ethyl acrylate, ethyl methacrylate
Colophony	Abitol, abietic acid, dehydroabietic acid

*Modified from Gebhardt and Elsner.³

PTBP-FR contained in shoe glue has also been reported.³ Toluene-sulphonamide-formaldehyde resins (TS-FR) are very common ingredients of nail lacquers and hardeners and hence an important occupational contact allergen for manicurists and beauticians. Contact dermatitis due to TS-FR can also occur in those who personally use nail products such as nail polish and nail hardeners.⁸

Epoxy resins are found in adhesives and glues, laminates, surface coatings, paints and inks, product finishes, vinyl gloves, dental bonding agents, floor coverings and microscopy immersion oil. Apart from ACD and ICD, exposure to epoxy resins may also lead to leukoderma⁹ and urticaria.¹⁰ In a large series of 3 731 patients investigated between 1974 and 1990, 1 844 (49.4%) had an occupational skin disease. Contact dermatitis due to epoxy resins was found in 142 of the 1 844 patients with occupational disease. Epoxy paints and their raw materials (31%, 41 cases), epoxy resin compounds used in electrical insulation (29%, 38 cases) and epoxy glues (18%, 24 cases) were responsible for the dermatitis.^{11,12}

Acrylates are widely used in different settings such as in the construction, paper-making and food-processing industries. They are also commonly used in the manufacturing of adhesive tapes and glues, paint, contact lenses, hearing aids, dental prostheses and orthopaedic cement.⁹ Many of the acrylates are contact allergens and are responsible for contact dermatitis.^{13,14} Although rare, there have been case reports of occupational contact dermatitis to cyanoacrylates (super glue components),¹⁵ and they have also been reported to cause occupational allergic rhinitis¹⁶ and occupational asthma.^{16,17} Like formaldehyde resins, acrylates are found in artificial nails, nail glues and nail varnishes and may lead to fingertip dermatitis, periungual dermatitis, onychodystrophy,¹⁸ onycholysis, paronychia, and ectopic ACD (dermatitis at a site distant to the nails).¹⁹ (Meth)acrylates are used in dentistry and orthopaedic surgery as bone cement. (Meth)acrylates readily penetrate latex surgical gloves leading to skin exposure. Studies have shown that contact may lead to pulpitis of the fingertips,²⁰ and also allergic contact hand eczema in dentists and dental

technicians. Orthopaedic surgeons/personnel in contact with bone cement develop contact dermatitis limited to the volar surface of the hands and fingertips.²¹ Acrylates may also cause ectopic contact dermatitis, and cases of airborne occupational dermatitis in dentists and beauticians have been reported.²²

Colophony is a complex of resin acids that comes from the sap of pine and spruce trees. It is a ubiquitous allergen as it is used in a range of products from cosmetics and toiletries through to adhesives, medicines and chewing gum. Occupational exposures include paints and lacquers, printing inks, cements and soldering flux. Abietic acid and dehydroabietic acid are the main components of colophony and have a low allergenic potential; however, their oxidation products are strong contact allergens. Colophony exposure can cause ACD and may also lead to occupational leukoderma in exposed workers.⁹

Polyvinyl acetate (PVA) glue, often known as 'wood glue' is a thermoplastic polymer, and a water-based glue. PVA itself is believed to have very low sensitisation potential, but the adhesive often contains sensitising additives, such as preservatives or stabilisers.²³ For instance, cases of ACD due to wallpaper glue containing methylisothiazolinone(MI)²⁴ and airborne ACD due to carpet glue, most likely the preservative MI,^{4,25} have been described. Euxyl K400 is also used as a preservative in paints, glues, metal-working fluids, lubricants, polyvinyl chloride adhesives, wood preservatives, and the paper industry.⁵

Rubber glues may either be natural, synthetic or a combination of the two. Historically, natural rubbers were used as materials for adhesives but with the increasing global demand for natural rubbers, various types of synthetic rubber have been manufactured from petroleum derivatives. Some of the common synthetic rubbers used in adhesives include polyurethane (such as isocyanates and polyesters), nitrile (such as acrylonitrile and butadiene) and polysulfide (such as polysulfide and organic dichlorides). Allergic reactions to synthetic monomers or polymers such as isocyanates and

polyesters are rare; however, ACD caused by rubber additives such as accelerators (thiurams, thiazoles, dithiocarbamates and thioureas) and anti-oxidants (phenylenediamines) are common.²⁶

We report the case of a worker who developed ACD due to the glue used in the manufacture of the toilet paper cardboard core. Our patient had been working on the same manufacturing line for 18 years with no skin problems, and then developed eczema apparently after a single significant exposure. The sudden onset of ACD could be due to the exposure to a high concentration of glue which led to sensitisation and subsequent precipitation of dermatitis on minimal repeat exposures. Alternatively, a new glue or glue supplier using a different preservative could have been introduced to the factory line.

We were able to make the diagnosis on the basis of a thorough history from work and at home, including hobbies, clinical examination, work visit and patch testing. Unfortunately, we were not able to identify the specific allergen in the glue in this case, but optimally this would be done. Identification of specific allergens is an important initial step in the management of patients with contact dermatitis. This is particularly necessary in the case of ubiquitous exposures such as colophony or preservatives, as patients will need to be educated about what non-occupational exposures to avoid in order to prevent a recurrence of their dermatitis.

Where a specific allergen has been identified in the workplace, exposure avoidance and alternative placement are vital for the patient. Long-term occupational solutions, such as substitution of chemicals with less allergenic or irritant chemicals, or engineering solutions to minimise personal exposure, should be considered in order to protect other workers. In the case of our patient, only minimal changes were made to his work, such as providing him with cotton gloves. This measure was clearly insufficient to prevent ongoing exposure as evidenced by his non-resolving eczema.

In several aspects this case illustrates the problems of skin disease caused by workplace exposures. Occupational health and safety legislation in South Africa puts the onus on the employer to accommodate workers who develop diseases at work. However, in this workplace, as in many others, the worker's job was not changed significantly, and he ultimately stopped work. This has negative consequences both for the company, which loses a skilled and loyal employee, and for the individual who loses his livelihood, health and pension benefits. Workers are often unaware of their right to be accommodated and in an era of increasing labour costs and falling profits, it is often easier for the employer to dismiss someone who cannot fulfill the requirements of his job, or allow the worker to resign, rather than to retrain or accommodate him.

CONCLUSION

Glues are commonly used in a variety of settings including both the occupational environment and at home. Some of the common glue ingredients are known contact allergens and hence glues pose a substantial risk of allergen exposure in a large proportion of the population.

Declaration of conflict of interest

The author declares no conflict of interest.

Acknowledgement

I acknowledge with thanks the assistance of Prof Gail Todd and Dr Amy Burdzik in the preparation of this article. I would also like to thank Sister Japhta who assisted us on our workplace visit.

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