

# Hairdressers with dermatitis should always be patch tested regardless of atopy status

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**Background:** Allergic contact dermatitis is common in hairdressers because of their exposure to chemicals used in hair dyes and permanent wave solutions. Atopic individuals are known to have a higher prevalence of leaving the profession due to morbidity associated with hand eczema.

**Objectives:** To assess which chemicals are responsible for allergic contact dermatitis in hairdressers and whether the prevalence is the same according to atopy status.

**Methods:** A total of 729 hairdressers who had been patch tested were retrospectively identified. Allergic reactions to relevant allergens from the extended European baseline series and hairdressing series were analysed against history of atopic eczema.

**Results:** Of the total, 29.9% of patients had a current or past history of atopic eczema. The most frequent positive allergens from the European baseline series were nickel sulfate (32.1%) and *p*-phenylenediamine (19.0%) and from the hairdressing series were glyceryl monothioglycolate (21.4%) and ammonium persulfate (10.6%). There was no significant difference between people with or without a history of atopic eczema, except for fragrance mix I and nickel sulfate.

**Conclusions:** We present findings from the largest cohort of hairdressers patch tested from a single centre. It is necessary to patch test hairdressers with dermatitis, regardless of a history of atopy. Strategies to reduce prevalence of allergic contact dermatitis are required.

**Key words:** allergic contact dermatitis; atopy; hairdressers; patch test. © John Wiley & Sons A/S, 2010.

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Hand eczema is a common occupational disease of hairdressers and barbers (1, 2). It has a multifactorial aetiology with endogenous, irritant, and allergic components. Wet work, from washing and handling damp hair, results in exposure to surfactants that may lead to skin irritation. The inflamed and damaged skin is then at higher risk of sensitization. Atopic individuals are at higher risk of leaving the hairdressing profession than non-atopics (3), perhaps because atopic patients have a greater susceptibility to irritants (4).

Allergic contact dermatitis in hairdressers was first described at the end of the 19th century, with reports of *p*-phenylenediamine (PPD) as a causative agent (5). More recently, a number of other allergens have been associated with occupational dermatitis

in hairdressers. These include the permanent wave solution ingredients such as ammonium thioglycolate and glyceryl monothioglycolate (6, 7), rubber accelerators, nickel, and formaldehyde (8).

In 2005, hairdressers were identified by the UK's Health and Safety Executive (HSE) as having the highest incidence of occupational skin disease in the United Kingdom with an incidence of 98 per 100 000. As a consequence, this occupational category was selected as a priority area for intervention within the HSE's Skin Disease Project, which in turn forms part of the Disease Reduction Programme (9).

At the Department of Cutaneous Allergy at St John's Institute of Dermatology, London, more than 1000 patients are seen annually for patch testing. The purpose of this communication is to report our

findings from a cohort of 729 hairdressers who have presented to us with dermatitis.

### Materials and Methods

Hairdressers attending the Department of Cutaneous Allergy at St John's Institute of Dermatology from October 1980 to July 2007 were retrospectively identified from our electronic database. Patients had been clinically assessed by a dermatologist and appropriately patch tested. A record was made of age, gender, site of the dermatitis, history of atopic eczema [according to the criteria of Williams et al. (10)], and positive reactions to the tested allergens.

Allergens were obtained from Trolab® (Hermal, Reinbek, Germany or their predecessor), and patch tested in Finn chambers® (Epitest Oy, Tuusula, Finland) mounted on Scanpor® (Norgesplaster, Venesla, Norway). Patches were removed at 2D and readings were taken by a dermatologist at 2/3D and 4/5D, according to International Contact Dermatitis Research Group (ICDRG) criteria (11). Only reactions that were considered to be allergic based on their morphology and time-course, according to ICDRG criteria, were included. All doubtful reactions were excluded from the analysis. Statistical analysis was carried out with two-tailed chi-squared tests using Prism software (Graphpad).

### Results

During a 26-year period, 729 hairdressers were patch tested by us. Of these, 91.1% ( $n = 664$ ) were women and 8.9% ( $n = 65$ ) were men. The mean age of hairdressers was 26.0 years (range 15–71).

64.5% of patients ( $n = 470$ ) presented with dermatitis either on their hands alone, hands and face, or hands and feet; 13.7% ( $n = 100$ ) presented

with involvement only on their face and neck. The remaining presented with dermatitis on other body areas that were not considered occupationally relevant.

99.5% ( $n = 725$ ) of patients were patch tested with an extended European baseline series, which varied slightly over the course of the study. The allergens most frequently testing positive were nickel sulfate (32.1%), PPD (19.0%), cobalt chloride (7.5%), fragrance mix I (6.6%), and formaldehyde (4.6%). Of those positive to PPD, 92.8% were currently relevant, 2.1% were of old relevance, and 5.1% were of unknown relevance. Table 1 summarizes the most relevant allergens for hairdressers from the extended European baseline series.

Patients who underwent patch testing were classified according to their current or past atopic eczema. A total of 29.9% ( $n = 218$ ) patients reported a present or previous history of atopic eczema, 69.3% ( $n = 505$ ) reported no history, status was unknown in 0.8% ( $n = 6$ ) of patients.

A two-tailed chi-squared test with Yates correction confirmed a significant difference in positive patch testing for nickel sulfate ( $P < 0.02$ ) and fragrance mix I ( $P < 0.01$ ). There was no significant difference between the two groups for all other allergens (see Table 2)

In total, 538 hairdressers were tested against a local and long-established hairdressing chemicals series. A total of 33.1% ( $n = 178$ ) patients had a positive patch result to one or more chemicals (see Table 3). Of these, 36.5% ( $n = 65$ ) did and 63.5% ( $n = 113$ ) did not have a current or history of atopic eczema. There was no significant difference between these two groups. The most common sensitizers were glyceryl monothioglycolate (21.4%), ammonium persulfate (10.6%), toluene-2,5-diamine (4.5%), and ammonium thioglycolate (3.9%).

Table 1. Patch test results of 725 patients tested with relevant allergens from an extended European baseline series

| Allergen                                              | Positive (%)       | Negative (%)       | Unknown (%)       |
|-------------------------------------------------------|--------------------|--------------------|-------------------|
| Nickel sulfate (5% pet.)                              | 32.1 ( $n = 233$ ) | 67.7 ( $n = 491$ ) | 0.1 ( $n = 1$ )   |
| <i>p</i> -Phenylenediamine (1% pet.)                  | 19.0 ( $n = 138$ ) | 80.7 ( $n = 585$ ) | 0.3 ( $n = 2$ )   |
| Cobalt chloride (1% pet.)                             | 7.5 ( $n = 54$ )   | 92.3 ( $n = 669$ ) | 0.3 ( $n = 2$ )   |
| Fragrance mix I (8% pet.)                             | 6.6 ( $n = 48$ )   | 93.4 ( $n = 677$ ) | 0.0 ( $n = 0$ )   |
| Formaldehyde (1% aq.)                                 | 4.6 ( $n = 33$ )   | 95.3 ( $n = 691$ ) | 0.1 ( $n = 1$ )   |
| Thiuram mix (1% pet.)                                 | 3.5 ( $n = 25$ )   | 96.4 ( $n = 699$ ) | 0.1 ( $n = 1$ )   |
| Quaternium-15 (1% pet.)                               | 3.0 ( $n = 22$ )   | 96.4 ( $n = 699$ ) | 0.6 ( $n = 4$ )   |
| MCI/MI (0.01% aq.)                                    | 2.8 ( $n = 20$ )   | 87.6 ( $n = 635$ ) | 9.7 ( $n = 70$ )  |
| Colophonium (20% pet.)                                | 2.5 ( $n = 18$ )   | 97.4 ( $n = 706$ ) | 0.1 ( $n = 1$ )   |
| <i>Myroxylon pereirae</i> (balsam of Peru) (25% pet.) | 1.2 ( $n = 9$ )    | 85.2 ( $n = 618$ ) | 13.5 ( $n = 98$ ) |
| Potassium dichromate (0.5% pet.)                      | 0.6 ( $n = 4$ )    | 99.5 ( $n = 721$ ) | 0.0 ( $n = 0$ )   |
| Lanolin alcohol (30% pet.)                            | 0.6 ( $n = 4$ )    | 99.5 ( $n = 721$ ) | 0.0 ( $n = 0$ )   |
| Mercaptobenzothiazole (2% pet.)                       | 0.4 ( $n = 3$ )    | 99.6 ( $n = 722$ ) | 0.0 ( $n = 0$ )   |
| Mercapto mix (2% pet.)                                | 0.4 ( $n = 3$ )    | 99.6 ( $n = 722$ ) | 0.0 ( $n = 0$ )   |
| Paraben mix (12% pet.)                                | 0.3 ( $n = 2$ )    | 99.7 ( $n = 723$ ) | 0.0 ( $n = 0$ )   |

MCI, methylchloroisothiazolinone; MI, methylisothiazolinone.

Table 2. Comparison of patch testing with the European baseline series for atopic and non-atopic individuals ( $n = 720$ )

| Allergen                                              | Current or past history of atopic eczema | No current/past history of atopic eczema |
|-------------------------------------------------------|------------------------------------------|------------------------------------------|
|                                                       | Total 217 (%)                            | Total 503 (%)                            |
| Nickel sulfate (5% pet.)                              | 25.8 ( $n = 56$ )                        | 35.2 ( $n = 117$ )                       |
| <i>p</i> -Phenylenediamine (1% pet.)                  | 23.5 ( $n = 51$ )                        | 17.3 ( $n = 87$ )                        |
| Cobalt chloride (1% pet.)                             | 6.5 ( $n = 14$ )                         | 8.0 ( $n = 40$ )                         |
| Fragrance mix I (8% pet.)                             | 2.8 ( $n = 6$ )                          | 8.3 ( $n = 42$ )                         |
| Formaldehyde I (% aq.)                                | 2.3 ( $n = 5$ )                          | 5.6 ( $n = 28$ )                         |
| Thiuram mix (1% pet.)                                 | 2.8 ( $n = 6$ )                          | 3.8 ( $n = 19$ )                         |
| Quaternium-15 (1% pet.)                               | 2.3 ( $n = 5$ )                          | 3.4 ( $n = 17$ )                         |
| MCI/MI (0.01% aq.)                                    | 1.8 ( $n = 4$ )                          | 3.2 ( $n = 16$ )                         |
| Colophonium (20% pet.)                                | 1.4 ( $n = 3$ )                          | 3.0 ( $n = 15$ )                         |
| <i>Myroxylon pereirae</i> (balsam of Peru) (25% pet.) | 0.9 ( $n = 2$ )                          | 1.4 ( $n = 7$ )                          |
| Potassium dichromate (0.5% pet.)                      | 0.9 ( $n = 2$ )                          | 0.4 ( $n = 2$ )                          |
| Lanolin alcohol (30% pet.)                            | 0.5 ( $n = 1$ )                          | 0.6 ( $n = 3$ )                          |
| Mercaptobenzothiazole (2% pet.)                       | 0.0 ( $n = 0$ )                          | 0.6 ( $n = 3$ )                          |
| Mercapto mix (2% pet.)                                | 0.5 ( $n = 1$ )                          | 0.4 ( $n = 2$ )                          |
| Paraben mix (12% pet.)                                | 0.0 ( $n = 0$ )                          | 0.4 ( $n = 2$ )                          |

MCI, methylchloroisothiazolinone; MI, methylisothiazolinone.

Table 3. Positive patch testing to the hairdressing series ( $n = 538$ )

| Allergen                             | Positive (%)       | Negative (%)       |
|--------------------------------------|--------------------|--------------------|
| Glyceryl monothioglycolate (1% pet.) | 21.4 ( $n = 115$ ) | 78.6 ( $n = 423$ ) |
| Ammonium persulfate (2.5% pet.)      | 10.6 ( $n = 57$ )  | 89.4 ( $n = 481$ ) |
| Toluene-2,5-diamine (1% pet.)        | 4.5 ( $n = 23$ )   | 95.7 ( $n = 515$ ) |
| Ammonium thioglycolate (2.5% aq.)    | 3.9 ( $n = 21$ )   | 96.1 ( $n = 517$ ) |
| Hydroquinone (1% pet.)               | 0.2 ( $n = 1$ )    | 99.8 ( $n = 537$ ) |
| Resorcinol (1% pet.)                 | 0 ( $n = 0$ )      | 100 ( $n = 538$ )  |

The incidence of allergy to glyceryl monothioglycolate was divided into 5-year groups and showed a reduction in positive reactions in recent years (see Table 4). A two-tailed chi-squared test for trend was performed showing a significant difference ( $P = 0.00001$ ).

There was no significant difference in positive patch testing to hairdressing chemicals when comparing the presence or absence of atopic eczema history (see Table 5).

## Discussion

It is widely accepted that hairdressers are at risk of dermatitis as a result of occupational exposure to variety of chemicals. This can result in hairdressers prematurely leaving their profession due to the morbidity associated with the condition. It is possible to determine relevant allergens with patch testing.

The demographics of our data are broadly comparable to other studies (12). The proportion of women in our data is similar to other studies, reflecting female predominance in the hairdressing industry (13). Furthermore, it has been shown that women are more likely to seek health care than men (14). Patch test populations are commonly over-represented with women compared with the background population (15).

The commonest positive patch test reaction was to nickel sulfate in hairdressers tested to an extended European baseline series followed by PPD, which mirrors other studies from Greece (16) and Spain (13) (although in the Spanish study PPD was more common than nickel). It is also recognized that PPD is a common cause of dermatitis reactions in hairdressers' clients (17). Nickel contact allergy in our study was higher (32.1%) than a previous UK study, which combined patients presenting with dermatitis from a range of professions (18.2%) (18). This could be related to the release of nickel ions when nickel-containing hairdressing implements are exposed to thioglycolic acid in permanent wave solutions (19). Other reasons for increased nickel sensitivity potentially include increased ear/body piercing or increased use of costume jewellery (13); controlling for these variables was beyond the scope of this study. A recent study from Copenhagen showed that one fifth of purchased items released nickel in concentrations that may lead to nickel allergy (20). Although PPD may not be the actual sensitizer in all cases of hair dye allergy, it is a marker for other diaminobenzenes used in hair dyes (21). Of the 23 patients positive for toluene-2,5-diamine, 83% ( $n = 19$ ) also tested positive for PPD. Some of these cases may therefore represent crossreactivity.

The most common patch test positive allergen from the hairdressing series was glyceryl monothioglycolate (21.4%), followed by ammonium persulfate (10.6%) and toluene-2,5-diamine (4.5%). These results reflect those of a previous large multicentred European study (22). Glyceryl monothioglycolate, which is mainly used in acid permanent wave solution, is retained in hair for up to 3 months. This may explain some cases of chronic dermatitis seen in hairdressers' clients (23) as well as the high prevalence in hairdressers themselves, who often change their hair style and use these chemicals in the process. Hairstyling of the hairdressers' own hair is an important confounder in studies of allergic contact dermatitis, as hairdressers have ready access to frequent hair styling and may be under some social pressure to have unusual or fashionable hairstyles themselves. Our data showed that there has been a reduction in positive reactions to glyceryl monothioglycolate in recent years; this

Table 4. The incidence of allergy to glyceryl monothioglycolate was divided into 5-year groups

| Allergen                      | Positive between<br>1985 and 1989<br>(%) | Positive between<br>1990 and 1994<br>(%) | Positive between<br>1995 and 1999<br>(%) | Positive between<br>2000 and 2004<br>(%) | Positive between<br>2005 and 2007<br>(%) | Chi-squared<br>value | P value |
|-------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|----------------------|---------|
| Glyceryl<br>monothioglycolate | 20.7 (n = 46)                            | 30.0 (n = 42)                            | 14.9 (n = 14)                            | 4.8 (n = 4)                              | 2.8 (n = 1)                              | 30.43                | 0.0001  |

Table 5. Comparison of patch testing with the hairdressing series for atopic and non-atopic individuals (n = 538)

| Allergen                                | Current or past<br>history of atopic<br>eczema | No current/past<br>history of atopic<br>eczema |
|-----------------------------------------|------------------------------------------------|------------------------------------------------|
|                                         | Total 169 (%)                                  | Total 369 (%)                                  |
| Glyceryl monothioglycolate<br>(1% pet.) | 20.7 (n = 35)                                  | 21.7 (n = 80)                                  |
| Ammonium persulfate<br>(2.5% pet.)      | 13.0 (n = 22)                                  | 9.5 (n = 35)                                   |
| Toluene-2,5-diamine<br>(1% pet.)        | 5.9 (n = 10)                                   | 3.5 (n = 13)                                   |
| Ammonium thioglycolate<br>(2.5% pet.)   | 2.4 (n = 4)                                    | 4.6 (n = 17)                                   |
| Hydroquinone (1% pet.)                  | 0.0 (n = 0)                                    | 0.3 (n = 1)                                    |
| Resorcinol (1% pet.)                    | 0.0 (n = 0)                                    | 0.0 (n = 0)                                    |

is probably because of increasing use of ammonium thiolactate. A reduction has also been observed in large German study, where a reduction from 11% to 7.5% was seen between 2003/2004 and 2005/2006 (24).

When comparing patients with atopic eczema to those without atopic eczema, there was no significant difference between the groups except for nickel and fragrance mix I, where there was decreased sensitization in those with atopic eczema (current or history). Atopy is characterized by a tendency to develop immunoglobulin E (IgE) type I antibodies and may be associated with decreased ability to produce the type IV delayed immune response (25); in theory this should render them tolerant to contact allergens. In the 1980s and early 1990s, studies reported that atopic patients with dermatitis were less frequently sensitized than non-atopic patients (26). More recently, some studies have challenged this view and concluded that atopic patients are as capable as non-atopics of being sensitized to contact allergens if similarly exposed (27); our study reflects these findings for the majority of allergens considered here. In addition, reports have suggested a key role of the protein filaggrin in maintaining an effective skin barrier against the environment (28). Mutations in the profilaggrin gene resulting in loss of function are common. A recent systematic review and meta-analysis found that filaggrin gene defects increase the risk of developing sensitization, thereby supporting evidence that in those with allergic conditions the defect could be a fundamental predisposing factor (29). Further research into the mechanistic actions of this protein may lead to a

better understanding in its role in allergic contact dermatitis.

Primary prevention of allergic contact dermatitis is critical in hairdressers. This must include educating hairdressers at an early stage in their careers to the potential morbidity associated with the use of hairdressing chemicals and encouraging appropriate use of gloves. Recent studies advocate cutting hair before dyeing it to reduce unnecessary contact with chemicals in newly coloured hair (30, 31). There is no standardized health and safety training required for UK trainee hairdressers. Because many hairdressers undertake apprenticeships in small, independent businesses it may be difficult to implement effective training and disseminate up-to-date evidence on disease reduction, although employers have a duty to provide a safe working environment without risk to health. Current European Union legislation allows PPD to comprise up to 4% (until recently 6%) of the constituents of hair dyes before mixing with the oxidizing component (2% in the mixed dye). There have been calls to reduce further or prohibit its use, but no satisfactory or widely accepted alternatives to these agents are available for use in permanent hair dye.

## Conclusion

This is a significant study because of its size and because it is from a single centre using rigorous internal audit of patch test interpretation, thereby reducing interobserver variability. Hairdressers are constantly exposed to a variety of potential allergens during their careers. Our study shows that in hairdressers nickel and PPD from an extended European baseline series are the most common causes of allergic contact dermatitis with glyceryl monothioglycolate and ammonium persulfate being the most common allergens from our long-established hairdressing series. These results are similar to several European studies. Apart from nickel and fragrance mix I, there is no difference in sensitization to allergens depending on atopic eczema status. We encourage increased education of hairdresser trainees to help prevent allergic contact dermatitis.

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