

Patch test results in patients with scalp dermatitis: analysis of data of the Information Network of Departments of Dermatology*

UWE HILLEN¹, STEPHAN GRABBE¹ AND WOLFGANG UTER²

¹Department of Dermatology, University of Duisburg-Essen, 45122 Essen, Germany and ²Department of Medical Informatics, Biometry and Epidemiology, University of Erlangen-Nürnberg, 91054 Erlangen, Germany

Background: Contact dermatitis of the scalp may develop primarily due to exposure to cosmetic products or secondarily due to application of topical medicaments on affected skin.

Objectives: To illustrate the current spectrum of allergens in scalp dermatitis.

Patients/methods: Data of 1320 patients recorded by the Information Network of Departments of Dermatology (IVDK) between 1993 and 2003, who were patch tested to confirm or rule out (secondary) allergic contact dermatitis of the scalp, were analysed.

Results: Sensitization to *p*-phenylenediamine, toluene-2,5-diamine, *p*-aminophenol, 3-aminophenol, *p*-aminoazobenzene, cocamidopropyl betaine and pyrogallol was significantly more common than in the remaining IVDK patients. In 690 patients, altogether 4070 patients' own products were patch tested. Medical products, hair tints and bleaches (HTB) and hair-cleansing products together caused nearly 2/3 of positive patch test reactions. Among these categories, HTB showed the highest percentage of positive patch test reactions; 24 of 29 HTB-positive patients had no positive reaction to any of the commercially available allergens.

Conclusions: In our subgroup of patients with scalp dermatitis, constituents of hair-colouring products were the most important allergens. As some ingredients of hair dyes are not contained in patch test series, testing of patients' own products is an important part of diagnostic workup, as otherwise sensitizations may be missed.

Key words: contact dermatitis; hair dye; patch test; patients' own products; scalp. © Blackwell Munksgaard 2007.

Accepted for publication 6 September 2006

The scalp is frequently exposed to cosmetic products. It has been estimated that approximately 40% of the US women use hair-colouring agents (1); some hair cosmetics such as shampoos are

used (almost) daily by many people. Contact dermatitis of the scalp may develop primarily after the application of cosmetic products (e.g. hair tints) on healthy skin or secondarily on skin

*Centres contributing data to this analysis (in alphabetical order): Aachen (H. Dickel, S. Erdmann), Augsburg (A. Ludwig), Basel (A. Bircher), Berlin B.-Frank. (B. Tebbe, R. Treudler), Berlin BWK (A. Köhler), Berlin Charité (B. Laubstein, T. Zuberbier, M. Worm), Berlin UKRV (J. Grabbe, T. Zuberbier), Bielefeld (I. Effendy), Bochum (Ch. Szliska, M. Straube), Dortmund (P.J. Frosch, B. Pilz, C. Pirker, R. Herbst), Dresden (G. Richter, R. Aschoff), Duisburg (J. Schaller), Erlangen (K.-P. Peters, T.L. Diepgen, M. Fartasch, M. Hertl, V. Mahler), Essen (J. Schaller, H.-M. Ockenfels, U. Hillen), Freudenberg (Ch. Szliska), Göttingen (Th. Fuchs, J. Geier), Gera (J. Meyer), Graz (W. Aberer, B. Kränke), Halle (G. Gaber, D. Lübke), Hamburg (M. Kiehn, D. Vieluf, R. Weißbecher), Hannover (T. Schaefer, Th. Werfel), Heidelberg (A. Schulze-Dirks, M. Hartmann, U. Jappe), Heidelberg AKS (H. Dickel, T.L. Diepgen, E. Weisshaar), Homburg/Saar (F.A. Bahmer, P. Koch), Jena (M. Gebhardt, A. Bauer, W. Wigger-Alberti, M. Kaatz, S. Schliemann-Willers), Kiel (J. Brasch), Krefeld (M. Lilie, A. Wallerand, S. Wassilew), Lübeck (K.P. Wilhelm, J. Kreusch, J. Grabbe), Mainz (D. Becker), Mannheim (Ch. Bayerl), Marburg (I. Effendy, H. Löffler), München LMU (F. Enders, F. Rueff, B. Przybilla, P. Thomas, T. Oppel), München Schwabing (M. Agathos), München TU (J. Rakoski), Münster (R. Brehler, B. Hellweg), Nürnberg (I. Müller), Osnabrück [W. Uter, S.M. John, H.J. Schwanitz (deceased), N. Schürer, H. Dickel], Rostock (H. Heise), Tübingen (G. Lischka, M. Röcken), Ulm [H. Gall (deceased), P. Gottlöber, G. Staib, H. Pillekamp, R. Hinrichs], Wuppertal (O. Mainusch, J. Raguz) and Würzburg (J. Arnold, A. Trautmann).

affected by dermatoses such as seborrheic dermatitis, atopic dermatitis or psoriasis. Contact dermatitis may be due to (i) exposure to cosmetic products and/or (ii) topical medicaments. Regarding the latter, pre-existing scalp dermatitis may be aggravated by allergic contact dermatitis or getting seemingly resistant to the treatment. Various products are applied on hair and scalp, e.g. cleansing products, conditioning products, waving products, hairdressing products and topical drugs. Some of these contain potent allergens, e.g. *p*-phenylenediamine (PPD) in oxidative hair dyes. The active ingredients of hair-care products have been found to be the third most common source of allergic reactions to cosmetic products in the USA (2, 3). To illustrate the current spectrum of allergens in scalp dermatitis, we analysed patch test data of 1320 patients with suspected (secondary) allergic contact dermatitis of the scalp recorded by the Information Network of Departments of Dermatology (IVDK; www.ivdk.org) between 1993 and 2003.

Methods

The IVDK is a multicentre project for the epidemiological surveillance of contact allergy (4, 5). Presently, the IVDK comprises more than 40 departments of dermatology in Austria, Germany and Switzerland. Briefly, results of all patch tests, which are performed according to national (6) and international guidelines (7), and a standardized history of all patients patch tested in the participating centres are recorded. Anamnestic data include the anatomical site of current dermatitis, information on previous or current atopic dermatitis, age and sex. At regular intervals, data are anonymously transferred to the data centre in Göttingen for pooled analysis. Data management and analysis is performed with the statistical program package SAS (version 9.1; SAS Institute, Cary, NC, USA).

Data of patients consulting between 1993 and 2003, with the scalp being the anatomical site of the current dermatosis, were analysed. Patch test readings 3 days after the start of patch test application according to the criteria of the International Contact Dermatitis Research Group (8) were evaluated. Commercially available patch test substances were mostly supplied by Hermal (Reinbek, Germany). In 690 patients, own products were patch tested. For further statistical evaluation, the products tested were manually assigned to 1 of the categories of cosmetic products, listed in the EU classification 'annex I to 76/768/EEC' (Table 3), which was supplemented by 2 further categories 'medical products (MP)' and 'other products'.

The latter category comprised products that could not otherwise be categorized; these products had not been applied to the scalp but were additionally patch tested for other reasons.

The proportion of patients sensitized to commercial allergens was directly standardized for age and sex, following current recommendations (9). Possible differences regarding the sensitization prevalences between the case group and the remaining patch test patients were quantified with odds ratios accompanied by a corresponding 95% confidence interval, as derived from a logistic regression analysis adjusting for age and sex.

Results

Between 1993 and 2003, data of 1320 patients (1030 women and 290 men) who were patch tested because of suspected (secondary) allergic contact dermatitis of the scalp were recorded in the IVDK. Upon presentation, 1290 had eczematous lesions of the scalp, while in 30 patients (2.3%), another inflammatory scalp dermatosis (e.g. psoriasis) was the underlying diagnosis. The MOAHLFA index (10), summarizing important patient characteristics, is shown in Table 1. Compared with the remainder of the IVDK patients, female patients were over-represented, whereas occupational dermatoses were underrepresented in the subgroup analysed.

Commercially available patch test preparations

Patch test results with the 30 substances most frequently eliciting a positive reaction are shown in Table 2. The most common allergens were hair-colouring agents, with significantly higher frequencies of sensitization to PPD, toluene-2,5-diamine (PTD), *p*-aminophenol (PAP), 3-aminophenol (AP), *p*-aminoazobenzene and pyrogallol than in the remaining IVDK patients. A higher frequency was also noted for the detergent cocamidopropyl betaine. Interestingly, sensitization frequencies of ammonium persulfate and glyceryl monothioglycolate were lower than in the remainder of the

Table 1. Demographic and clinical characteristics according to the MOAHLFA index (10) of patients with scalp dermatoses in comparison with the remainder of IVDK patients

		Scalp dermatosis, <i>n</i> (%)	IVDK, <i>n</i> (%)
Men	M	290 (22.0)	39 353 (36.5)
Occupational dermatitis	O	24 (1.8)	16 351 (15.1)
Atopic dermatitis	A	221 (16.7)	18 821 (17.4)
Primary site: hand	H	0 (0.0)	30 855 (28.6)
Primary site: leg	L	0 (0.0)	10 304 (9.5)
Primary site: face	F	0 (0.0)	15 727 (14.6)
Age above 40 years	A	829 (62.8)	65 133 (60.3)

IVDK, Information Network of Departments of Dermatology; *n* number of patients.

Table 2. Patch test reactions to commercially available patch test preparations

	Test concentration (%)	<i>n</i> _{tested}	<i>n</i> _{positive}	% _{positive} (crude)	% _{positive} (stand)	OR (95% CI)
Hair dyes						
3-Aminophenol	1.0	626	37	5.9	8.5	3.21 (2.13–4.75)
<i>p</i> -Aminophenol (CI 76550)	1.0	630	52	8.3	10.2	2.93 (2.10–4.04)
<i>p</i> -Aminoazobenzene (CI 11000)	1.0	75	18	24.0	24.3	4.48 (2.55–7.52)
<i>p</i> -Phenylenediamine (Std)	1.0	1222	144	11.8	11.3	2.88 (2.40–3.42)
Tolune-2,5-diamine	1.0	667	106	15.9	16.1	2.29 (1.82–2.86)
Pyrogallol	1.0	628	34	5.4	4.8	1.66 (1.12–2.40)
Products for waving, straightening and fixing hair						
Ammonium persulfate	2.5	634	20	3.2	2.3	0.47 (0.29–0.73)
Glyceryl monothioglycolate	1.0	627	21	3.3	3.5	0.35 (0.22–0.54)
Medicaments						
Neomycin sulfate (Std)	20.0	1237	16	1.3	1.1	0.48 (0.28–0.76)
Benzocaine (Std)	5.0	1225	24	2.0	2.1	1.19 (0.77–1.75)
Preservatives						
Methyldibromo glutaronitrile ^a	0.3	537	16	3.0	3.4	0.71 (0.41–1.13)
Methyldibromo glutaronitrile/phenoxyethanol (Std)	1.0 ^b	1222	32	2.6	3.1	0.82 (0.56–1.14)
(Chlor)-Methylisothiazolinone (Std)	0.01 ^c	1225	23	1.9	2.1	0.77 (0.49–1.14)
Formaldehyde (Std)	1.0	1235	15	1.2	1.3	0.62 (0.36–1.00)
Thimerosal (Std)	0.1	1073	59	5.5	6.4	0.85 (0.64–1.09)
Phenylmercuric acetate	0.05	739	49	6.6	6.2	1.05 (0.77–1.39)
Detergents						
Cocamidopropyl betaine	1.0 ^c	1021	48	4.7	5.0	2.37 (1.74–3.16)
Antioxidants						
Tert-butyl-hydroquinone	1.0	802	16	2.0	1.9	1.02 (0.59–1.62)
Octyl gallate	0.3	735	16	2.2	1.9	0.78 (0.46–1.24)
Vehicles, emulsifiers						
Amerchol L-101	50.0	735	16	2.2	2.2	0.37 (0.22–0.59)
Lanolin alcohol (Std)	30.0	1236	22	1.8	1.8	0.42 (0.27–0.62)
Fragrances						
Fragrance mix (Std)	8.0	1234	117	9.5	8.6	0.80 (0.66–0.97)
Balsam of Peru (<i>Myroxylon pereirae</i> resin) (Std)	25.0	1233	92	7.5	6.9	0.81 (0.65–0.99)
Metals						
Nickel (II)-sulfate 6*H ₂ O (Std)	5.0	1225	190	15.5	15.1	0.87 (0.74–1.02)
Potassium dichromate (Std)	0.5	1236	29	2.3	2.1	0.54 (0.36–0.76)
Cobalt (II)-chloride, 6*H ₂ O (Std)	1.0	1234	69	5.6	6.0	1.00 (0.78–1.27)
Mercury ammonium chloride (Std)	1.0	1224	25	2.0	2.1	0.81 (0.53–1.17)
Miscellaneous						
Colophony (Std)	20.0	1235	30	2.4	2.1	0.57 (0.39–0.80)
Oil of turpentine (Std)	10.0	1224	15	1.2	1.1	0.61 (0.35–0.97)
Thiuram mix (Std)	1.0	1235	16	1.3	1.3	0.47 (0.27–0.74)

OR, odds ratio; CI, confidence interval [estimates derived from logistic regression analyses (1 for each allergen), adjusting for age and sex]; *n*_{tested}, number of patients tested; *n*_{positive}, number of patients with a positive patch test reaction; %_{positive} (crude), proportion of patients with a positive patch test reaction; %_{positive} (stand), standardized for age and sex [according to Uter et al. (9)]; Std, allergens contained in the standard series (remainder in special series) during the study period.

The 30 substances shown are which most frequently caused a positive patch test reaction in the case group. Vehicle of all patch test substances was petrolatum, except where indicated otherwise.

^aTested in the standard series during the period January 1997 to June 1999.

^bUntil January 1997 it was 0.5%.

^cVehicle of the patch test substances was water.

IVDK patients. Moreover, sensitization to formaldehyde was underrepresented in comparison with the IVDK collective, and sensitization to fragrance mix, balsam of Peru, Amerchol L 100 and lanolin alcohol was less frequently observed in the case group.

Patients' own products

A broad spectrum of altogether 4070 patients' own products was patch tested in 690 of the 1320

patients (52.3%), i.e. an average of about 6 products per patient (Table 3). Among these 4070 products, 2989 were intended for the use on the scalp (2177 hair-care products, 590 MP and 222 bath and shower preparations). Within the categories, the average number of products tested per patient was in the range from 1 to 2.7 (Table 3). Moreover, several categories of products were often tested in 1 patient. MP, hair tints and bleaches (HTB) and hair-cleansing products (HCP) together caused nearly 2/3 of all positive patch test reactions.

Table 3. Patch testing of patients' own products categorized based on annex I to 76/768/EEC (slightly extended)

Categories of products	Products			Patients			
	n_{prod}	$n_{\text{prod pos}}$	% $_{\text{prod pos}}$	n_{pat}	$n_{\text{pat pos}}$	% $_{\text{pat pos}}$	$n_{\text{prod/pat}}$
Medical products	590	46	7.8	220	28	12.7	2.7
Creams, emulsions, lotions, gels and oils for the skin (hands, face, feet, etc.)	367	8	2.2	182	5	2.7	2.1
Face masks (with the exception of peeling products)	6	0	–	5	0	–	1.2
Tinted bases (liquids, pastes, powders)	45	4	8.8	30	3	10.0	1.5
Make-up powders, after-bath powders, hygienic powders, etc.	17	1	5.9	13	1	7.7	1.3
Toilet soaps, deodorant soaps, etc.	64	0	–	47	0	–	1.4
Perfumes, toilet waters and eau de Cologne	58	3	5.2	43	3	7.0	1.3
Bath and shower preparations (salts, foams, oils, gels, etc.)	222	9	4.1	123	8	6.5	1.8
Deodorants and anti-perspirants	56	3	5.4	49	3	6.1	1.1
Hair tints and bleaches	297	42	14.1	141	29	20.6	2.1
Products for waving, straightening and fixing hair	68	1	1.5	25	1	4.0	2.7
Hair-setting products	249	7	2.8	176	7	3.9	1.6
Hair-cleansing products (lotions, powders, shampoos)	971	53	5.5	394	42	10.6	2.5
Hair-conditioning products (lotions, creams, oils)	307	13	4.2	170	13	7.6	1.8
Hairdressing products (lotions, lacquers, brilliantine)	285	4	1.4	197	4	2.0	1.4
Shaving products (creams, foams, lotions)	19	0	–	15	0	–	1.3
Products for making up and removing make-up from the face and the eyes	85	1	1.2	40	1	2.5	2.1
Products intended for application to the lips	12	0	–	8	0	–	1.5
Products for care of the teeth and the mouth	13	0	–	11	0	–	1.2
Products for nail care and make-up	12	1	9.3	7	1	14.2	1.7
Products for external intimate hygiene	2	0	–	2	0	–	1
Sunbathing products	20	2	10.0	14	1	7.1	1.4
Products for tanning without sun	2	0	–	1	0	–	2
Anti-wrinkle products	23	0	–	15	0	–	1.5
Other products	280	21	7.5	115	10	8.6	2.4

n_{prod} number of patients' own products tested, $n_{\text{prod pos}}$ number of patients' own products tested positive, n_{pat} number of patients tested with patients' own products, $n_{\text{pat pos}}$ number of patients tested positive with patients' own products, $n_{\text{prod/pat}}$ number of patients' own products/patient tested in each product category.

Within these categories, HTB showed the highest percentage of positive patch test reactions. Out of 29 patients in whom patient's own hair tints were positive, 24 (83%) did not show a positive reaction to an allergen of the patch test series (Table 4). Not surprisingly, irritant and questionable patch test reactions in contrast were more frequent in HCP and bath and shower preparations than in HTP and MP. Nevertheless, clearly positive (++, +++) reactions were also observed within these categories of rinse-off products (Table 5).

Discussion

In the subgroup of patients with scalp dermatitis, patch tested to confirm or rule out (secondary) allergic contact dermatitis, constituents of hair-colouring products were the most important aller-

gens. As the use of pyrogallol has been prohibited for many years, sensitization to this substance may be only 'historically' relevant. Hair dyeing is popular, 100 and 80 tons of PTD and PPD, 50 and 30 tons of PAP and AP, respectively, were used in hair-colouring products in 2002 (11). It is estimated that the proportion of women who use hair-colouring agents has increased from 16% in 1987 to more than 50% in the industrial world (12, 13). An interview-based study performed in the Danish adult population showed that 18.4% of the male and even 74.9% of the female respondents had at some point dyed their hair (14). At the same time, hair-colouring agents are often potent allergens. Using a quantitative structure–activity relationship, 75% of 229 hair dye substances assessed were predicted to be strong/moderate sensitizers, including PPD,

Table 4. Reactions to standardised patch test preparations in patients tested with own hair-colouring products (number of patients)

Own products	Standardized patch test preparations		
	Negative	Positive	Total
Negative	100	12	112
Positive	24	5	29
Total	124	17	141

PTD, PAP and AP (11). Thus, it is not surprising to find components of hair dyes as the most common cause of allergic scalp dermatitis in our analysis. Within the IVDK, a significant increase of sensitizations to PPD, PTD and PAP between 1995 and 2002 in 'clients' was observed (15). In Finland, an increasing frequency of sensitizations to toluene-2,5-diamine, toluene-2,5-diamine sulfate and 4-aminophenol was found when comparing patch test results collected between 1995–1997 and 2000–2002 (16). Allergic contact dermatitis to hair dyes may even be more frequent at the population level than patch test data suggest. In the interview-based study performed by Søstved et al. (14), 5.3% of individuals who ever had used hair dye reported skin reactions compatible with an allergic reaction. Of these, only 15.6% had been in contact with healthcare services after the hair dye reaction (14).

In contrast to the findings regarding hair dyes, the hair-bleaching agent ammonium persulfate and the permanent waving agent glyceryl monothioglycolate were underrepresented in our collective in comparison with the remainder of the IVDK collective. This is in good accordance to a similar finding regarding 'clients', compared with hairdressers, in the study mentioned (15). These 2 allergens are apparently often responsible for occupational hand dermatitis of hairdressers (who are included in the comparison group in our

present analysis) but not so often for allergic contact dermatitis of the scalp of (female) clients.

Other important cosmetic allergens include fragrances (fragrance mix), balsam of Peru (*Myroxylon pereirae* resin) and preservatives [e.g. methylidibromo glutaronitrile (MDBGN)] (3, 16, 17). In our subgroup, the frequency of sensitization to none of these allergens was higher than in the remainder of the IVDK patients. Sensitizations to the fragrance mix and balsam of Peru were even slightly, but significantly, underrepresented. MDBGN has increasingly been used in the last decade in many cosmetics, not only in products intended for use on the scalp (17). As its use in leave-on products – applied to sites other than the scalp – was banned by the European Union regulatory institutions only in March 2005 (Commission directive 2003/833/EC), it is not surprising that the sensitization frequency found in our collective did not differ from the remainder of the IVDK collective. However, MDBGN has been shown to elicit an allergic response during experimental and non-experimental exposure to rinse-off products as well (18, 19). Data collected from Danish dermatologists showed liquid soaps as most important rinse-off products in cases with currently relevant MDBGN sensitization; nevertheless, exposure to MDBGN in shampoos and hair wax/gel was also relevant in some patients (20). Therefore, MDBGN should be considered as a possible trigger of an allergic contact dermatitis of the scalp. Other preservatives used in shampoos comprise organic acids (e.g. benzoic acid, sorbic acid), methyl paraben and other parabens, 2-bromo-2-nitropropane-1,3-diol, and formaldehyde-releasing agents (e.g. DMDM hydantoin, imidazolidinyl urea and diazolidinyl urea) (21). However, sensitizations to formaldehyde/formaldehyde-releasing agents and

Table 5. Patch test results of patients' own products used on the scalp

Categories of products	Patch test reactions				
	<i>n</i> _{prod}	IR, <i>n</i> (%)	?, <i>n</i> (%)	+, <i>n</i> (%)	++/+++, <i>n</i> (%)
Medical products	590	16 (2.7)	34 (5.8)	22 (3.7)	24 (4.1)
Bath and shower preparations (salts, foams, oils, gels, etc.)	222	15 (6.8)	22 (9.9)	6 (2.7)	3 (1.4)
Hair tints and bleaches	297	2 (0.7)	15 (5.1)	25 (8.4)	17 (5.7)
Products for waving, straightening and fixing hair	68	0	4 (5.9)	1 (1.5)	0
Hair-setting products	249	4 (1.6)	8 (3.2)	6 (2.4)	1 (0.4)
Hair-cleansing products (lotions, powders, shampoos)	971	35 (3.6)	92 (9.5)	40 (4.1)	13 (1.3)
Hair-conditioning products (lotions, creams, oils)	307	0	8 (2.7)	7 (2.3)	6 (1.9)
Hairdressing products (lotions, lacquers, brilliantine)	285	0	10 (3.5)	3 (1.1)	1 (0.3)

*n*_{prod}, number of patients' own products tested.

Shown are the irritant (IR), questionable (?) and positive patch test reactions (+, ++, +++).

2-bromo-2-nitropropane-1,3-diol were not frequent in our cases. In contrast, positive test reactions to cocamidopropyl betaine were frequent in our sample, compared with the remainder of the IVDK. Cocamidopropyl betaine is a common detergent in shampoos. It is difficult to patch test but relevant positive patch tests do occur (22).

A broad spectrum of altogether 4070 patients' own products was patch tested in more than the half of the patients. Patch testing of patients' own products may be difficult to interpret because (i) the products mostly contain several ingredients (among them, potentially 1 or more allergens and/or irritants) in different concentrations and (ii) ingredients which are not irritating under normal use may cause irritant reactions under patch test conditions which could be misinterpreted as positive reactions (23). Thus, it is not surprising that irritant and questionable patch test reactions were observed quite frequently in HCP and bath and shower preparations. Nevertheless, clearly positive reactions were also observed with these categories of rinse-off products. Positive allergic reactions may therefore be a valuable adjunct to the routine diagnostic procedures, especially if the patch testing of standardized allergens remains negative. This is probably of particular relevance in diagnosing hair dye allergy. Besides PTD, PPD and PPD-like substances, other ingredients of hair dyes not contained in commercially available patch test series have been identified as allergens (24–27). In particular, non-oxidative 'semi-permanent' dye components are not well represented in the existing patch test series. Thus, patch testing of patients' own products may be important as otherwise relevant sensitizations may be missed. This is supported by our data; 24 of 29 patients in whom own hair tints were positive did not show a positive reaction to an allergen of the patch test series.

In summary, in our subgroup of patients with scalp dermatitis, constituents of hair-colouring products were the most important allergens. As some ingredients of hair dyes which are potential allergens are not contained in patch test series, testing of patients' own products is an important part of diagnostic workup, as otherwise sensitizations may be missed. Additionally, patch testing with preservatives and cocamidopropyl betaine is recommended in patients with scalp dermatitis.

References

- Mehta S S, Reddy B S N. Cosmetic dermatitis – current perspectives. *Int J Dermatol* 2003; 42: 533–542.
- Marks J G Jr, Belsito D V, De Leo V A, Fowler J F Jr, Fransway A F, Maibach H I, Mathias C G, Pratt M D et al. North American contact dermatitis group patch-test results, 1998–2000. *Am J Contact Dermat* 2003; 14: 59–62.
- Ortiz K J, Yiannias J A. Contact dermatitis to cosmetics, fragrances, and botanicals. *Dermatol Ther* 2004; 17: 264–271.
- Uter W, Diepgen T L, Arnold R, Hillebrand O, Pietrzyk P M, Stüben O, Schnuch A. The information network of departments of dermatology – a multicenter project for computer-assisted monitoring of contact allergy – electronic data processing aspects. *Derm Beruf Umwelt* 1992; 40: 142–149.
- Uter W, Schnuch A, Geier J, Frosch P. The epidemiology of contact dermatitis. The information network of departments of dermatology (IVDK) in Germany. *Eur J Dermatol* 1998; 8: 36–40.
- Schnuch A, Aberer W, Agathos M, Brasch J, Frosch P J, Fuchs T, Richter G. Leitlinien der Deutschen Dermatologischen Gesellschaft (DDG) zur Durchführung des Epikutantests mit Kontaktallergenen. *Hautarzt* 2001; 52: 864–866.
- Wahlberg J E. Patch testing. In: *Textbook of Contact Dermatitis*, 3rd edition, Rycroft R J G, Menné T, Frosch P J, Leppoittevin J-P (eds): Berlin, Springer, 2001: pp. 435–468.
- Wilkinson D S, Fregert S, Magnusson B et al. Terminology of contact dermatitis. *Acta Derm Venereol* 1970; 50: 287–292.
- Uter W, Schnuch A, Gefeller O. Guidelines for the descriptive presentation and statistical analysis of contact allergy data. *Contact Dermatitis* 2004; 51: 47–56.
- Schnuch A, Geier J, Uter W et al. National rates and regional differences in sensitization to allergens of the standard series. Population-adjusted frequencies of sensitization (PAFS) in 40,000 patients from a multicenter study (IVDK). *Contact Dermatitis* 1997; 37: 200–209.
- Søsted H, Basketter D A, Estrada E, Johansen J D, Patlewicz G Y. Ranking of hair dye substances according to predicted sensitization potency: quantitative structure-activity relationships. *Contact Dermatitis* 2004; 51: 241–254.
- Schnuch A, Becker D. Die routinemässige Vortestung von Produkten mit oxidativen Haarfarben ist problematisch und wird abgelehnt. *JDDG* 2005; 3: 700–701.
- Søsted H, Rastogi S C, Andersen K E, Johansen J D, Menné T. Hair dye contact allergy: quantitative exposure assessments of selected products and clinical cases. *Contact Dermatitis* 2004; 50: 344–348.
- Søsted H, Hesse U, Menné T, Andersen K E, Johansen J D. Contact dermatitis to hair dyes in a Danish adult population: an interview based study. *Br J Dermatol* 2005; 153: 132–135.
- Uter W, Geier J, Lessmann H, Schnuch A. Contact allergy to ingredients of hair cosmetics in female hairdressers and clients – an 8-year analysis of IVDK data. *Contact Dermatitis* 2003; 49: 236–240.
- Hasan T, Rantanen T, Alanko K, Harvima R J et al. Patch test reaction to cosmetic allergens in 1995–1997 and 2000–2002 in Finland – a multicentre study. *Contact Dermatitis* 2005; 53: 40–45.
- Uter W, Johansen J D, Orton D, Frosch P F, Schnuch A. Clinical update on contact allergy. *Curr Opin Allergy Clin Immunol* 2005; 5: 429–436.
- Jensen C D, Johansen J D, Menné T, Andersen K E. Methyl-dibromo glutaronitrile in rinse-off products causes allergic contact dermatitis: an experimental study. *Br J Dermatol* 2004; 150: 90–95.
- Zachariae C, Johansen J D, Rastogi S C, Menné T. Allergic contact dermatitis from methyl-dibromo glutaronitrile – clinical cases from 2003. *Contact Dermatitis* 2005; 52: 6–8.
- Johansen J D, Veien N K, Laurberg G, Kaaber K, Thormann J, Lauritzen, Avnstorp C; on behalf of the Danish Contact Dermatitis Group. Contact allergy to methyl-dibromo glutaronitrile – data from a “front line” network. *Contact Dermatitis* 2005; 52: 138–141.
- Trüeb R M. Haarwasmittel (Shampoos): Zusammensetzung und klinische Anwendungen. *Hautarzt* 1998; 49: 895–901.
- DeGroot A C. Cocamidopropyl betaine: a “new” important cosmetic allergen. *Derm Beruf Umwelt* 1997; 45: 60–63.

23. Uter W, Balzer C, Geier J, Frosch P J, Schnuch A. Patch testing with patient's own cosmetics and toiletries – results of the IVDK, 1998–2002. *Contact Dermatitis* 2005; 53: 226–233.
24. Dejobert Y, Piette F, Thomas P. Contact dermatitis to 2-hydroxyethylamino-5-nitroanisole and 3-nitro-p-hydroxyethyl aminophenol in a hair dye. *Contact Dermatitis* 2006; 54: 217–218.
25. Katugampola R P, Statham B N. A review of allergens found in current hair-care products. *Contact Dermatitis* 2005; 53: 234–244.
26. Wedi B, Hoting E, Koerner M, Kapp A. Allergic contact dermatitis due to monovalent sensitization to the oxidation hair dye intermediate oxamitol (2-aminomethyl-p-aminophenol-2HCl) without cross-sensitivity to haptens of the para-group. *Contact Dermatitis* 2000; 42: 104–105.
27. Søsted H, Menné T. Allergy to 3-nitro-p-hydroxyethylaminophenol and 4-amino-3-nitrophenol in a hair dye. *Contact Dermatitis* 2005; 52: 317–319.

Address:

Uwe Hillen, MD

Department of Dermatology

University of Duisburg-Essen

Hufelandstr. 55

45122 Essen

Germany

Phone: +49 201 723 3644

e-mail: uwe.hillen@uni-essen.de