

Common allergens present in personal care products: identification, diagnosis, and management

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■ Abstract

The incidence of allergic contact dermatitis (ACD) reactions to personal care products has progressively increased, affecting women more so than men. Fragrances and preservatives are the major sensitizers behind cosmetic-induced ACD, due to their ubiquitous presence in these products, though emulsifiers, ultraviolet filters, and botanical allergens have been implicated as well. While patch testing is the standard for diagnosing ACD, many cosmetic-specific antigens are not currently included within the commercially available kits. Therefore, patch testing for potential cosmetic-induced ACD should be supplemented with additional compounds commonly found in personal use products. Effective treatment of ACD must involve accurate identification and removal of the offending agent.

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Introduction

Along with the increasing ubiquity of cosmetics in modern society, adverse reactions to personal care products rose from 5% in 1983 to 9.8% in 2011.^{1,2} Women have higher lifetime rates of adverse reactions to personal care products than men do, at 51.4% and 38.2%, respectively.³ Considering that women use, on average, 12 personal care products and 168 ingredients per day,⁴⁻⁷ European studies have shown a concomitant increase in the incidence of cosmetic contact sensitization in women between the ages of 20 and 55, rising from 2.4% to 5.8% within 8 years.² Allergic contact dermatitis (ACD) reactions are generally seen more frequently in women and in patients aged 20 to 60 years.⁸⁻¹¹ Furthermore, the incidence of adverse reactions and ACD may be underestimated because many patients do not present to their medical practitioners with mild reactions.^{12,13}

The term “cosmetics” has a variety of definitions depending on the country and agency. The federal Food, Drug, and Cosmetic Act (Food and Drug Administration [FDA]) of the United States defines cosmetics as “articles intended to be applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance without affecting the body’s structure or function.”¹⁴ The purpose of this article is to review the main ingredients that are the cause of sensitization to these products, the categories

of cosmetics most associated with ACD, and the diagnosis and management of ACD in those with cosmetic allergies.¹⁵

Diagnosis

An ACD diagnosis involves first obtaining a patient history and physical examination before being confirmed by patch testing.¹⁶ Patch testing is the standard for isolating and identifying instrumental allergens in ACD due to its sensitivity and specificity of around 70% to 80%.¹⁷ An established patch testing kit is the 36-antigen, 3-panel, Thin-layer Rapid Use Epicutaneous test, while extensive patch testing panels created by the American Contact Dermatitis Society (ACDS) and the North American Contact Dermatitis Group (NACDG) each contain 80 and 70 screening allergens, respectively (Table 1).

Many commercial kits do not include the allergens found in personal consumer products, such as those found in cosmetics, and should be augmented with diluted antigens for customized patch testing.¹⁸ Up to 10% of ACD patients have a positive patch test (PPT) for cosmetic products or their ingredients, justifying the inclusion of products possibly elucidated from patient history.¹⁴ Furthermore, hypersensitivity to cosmetics and personal care products frequently presents on areas such as the face, eyelids, neck, hands, scalp, and anogenital region, depending on the offending agent.¹⁵

Common allergens in personal care products

Numerous studies have examined the most common allergens within cosmetics and personal care products. Though the specific organization and ranking of the allergens may not be precisely the same, the general causative agents remain consistent: fragrances, preservatives, emulsifiers, ultraviolet (UV) light absorbers, and botanicals.^{7,14,15,29} Fragrances and preservatives are largely considered the stronger causes of cosmetic-induced ACD, while emulsifiers and antioxidants are weaker sensitizers.³⁰

Fragrances

Fragrances—found ubiquitously in almost every personal care product ranging from deodorants to facial moisturizers, are frequent causes of ACD—with 16% of the population estimated to have a fragrance sensitivity.³⁰ Following studies in the 1970s and a subsequent study from 2005, patch testing for fragrances is done mainly through fragrance mixes I and II, as well as with Balsam of Peru.³¹⁻³⁴ Up to 85% of fragrance-allergic patients may be detected using fragrance mix I; 32% of patients undetected by mix I are positive to mix II, indicating the need for both mixes.²⁰ Fragrance mix I contains 8 substances: amylcinnamaldehyde, cinnamyl alcohol, cinnamic aldehyde, hydroxycitronellal, geraniol, eugenol, isoeugenol, and oakmoss absolute, all diluted to 1% in petrolatum and emulsified with sorbitan sesquiolate.⁷ The second mix contains lylal, citral, farnesol, citronellol, hexylcinnamic aldehyde, and coumarin. Out of the sen-

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TABLE 1. Common allergens found in common personal care products^{18,19}

Chemical Name	Class	Core Series
Colophony (rosin)	Adhesive	NACDG, ACDS
Acrylates (hydroxyethyl methacrylate, MMA, ethyl acrylate)	Adhesive	NACDG, ACDS
α -tocopherol/vitamin E 100%	Antioxidants	NACDG, ACDS
Propolis	Botanical	NACDG, ACDS
Compositae mix	Botanical	NACDG, ACDS
PG	Emollient/humectant	NACDG, ACDS
Lanolin alcohol (Amerchol L101)	Emollient/humectant	NACDG, ACDS
Cocamidopropyl betaine	Emollient/humectant	NACDG, ACDS
Cocamide DEA	Emollient/humectant	NACDG, ACDS
Fragrance mix I	Fragrance	NACDG, ACDS
Fragrance mix II	Fragrance	NACDG, ACDS
<i>Myroxylon pereirae</i> (Balsam of Peru)	Fragrance	NACDG, ACDS
Hydroperoxides of limonene	Fragrance	NACDG
Hydroperoxides of linalool	Fragrance	NACDG
Cinnamic aldehyde	Fragrance	NACDG, ACDS
Benzyl alcohol	Fragrance	ACDS
Lavender absolute	Fragrance/botanical	ACDS
SL mix	Fragrance/botanical	NACDG, ACDS
<i>Mentha piperita</i> (peppermint) oil	Fragrance/botanical	NACDG
TTO, oxidized (<i>Melaleuca alternifolia</i>)	Fragrance/botanical	NACDG, ACDS
<i>Cananga odorata</i> (ylang ylang) oil	Fragrance/botanical	NACDG, ACDS
Carvone	Fragrance/botanical	NACDG
Ammonium Persulfate	Hair bleaching	NACDG
PPD	Hair dye	NACDG, ACDS
Nickel sulfate	Metals	NACDG, ACDS
Tosylamide formaldehyde resin	Nail cosmetic	NACDG, ACDS
Epoxy resin	Nail cosmetic	ACDS
Formaldehyde	Preservative	NACDG, ACDS
Q-15	Preservative	NACDG, ACDS
Diazolidinyl urea	Preservative	NACDG, ACDS
Imidazolidinyl urea	Preservative	NACDG, ACDS
DMDM hydantoin	Preservative	NACDG, ACDS
MCI/MI	Preservative	NACDG, ACDS
Paraben mix	Preservative	NACDG, ACDS
Iodopropynyl butyl carbamate	Preservative	NACDG, ACDS
Methyl dibromoglutaronitrile/phenoxethanol	Preservative	NACDG, ACDS
Ethyl hexylglycerin	Preservative	NACDG, ACDS
Sodium metabisulfite	Preservative	NACDG
Hydroquinone	Skin whitener	NACDG
Benzophenone 3	UV filter	NACDG, ACDS
Benzophenone 4	UV filter	ACDS

Abbreviations: ACDS, American Contact Dermatitis Society; MCI, methylchloroisothiazolinone; MI, methylisothiazolinone; MMA, methyl methacrylate; NACDG, North American Contact Dermatitis Group; PG, propylene glycol; PPD, positive patch test; Q-15, quaternium-15; SL, sesquiterpene lactone; TTO, tea tree oil; UV, ultraviolet.

TABLE 2. Fragrance mix I

Chemical Name	Notes
Amylcinnamaldehyde	Notes of jasmine, weakly allergenic. Found in perfumes and cosmetic products. ²⁰
Cinnamyl alcohol	An ester found in Balsam of Peru, jasmine oil, and propolis. It is highly allergenic and found in cosmetic, household, and food products. Cross-reacts with cinnamyl aldehyde, smells like cinnamon. IFRA recommends use at concentrations no higher than 4%. ^{20,21}
Cinnamic aldehyde	Is also highly allergenic and has a maximum recommended concentration of 0.5% in commercial products. Its uses are comparable to that of cinnamyl alcohol, due to its similar flavor and aroma. ^{20,22}
Hydroxycitronellal	Fully synthetic chemical, produces a floral aroma, is modestly allergenic, and cross-reacts with geraniol and eugenol. ^{20,23} It is also commonly used as an insecticide and an antiseptic.
Geraniol	A rose-inducing fragrance; has been proposed as the primary cause of fragrance sensitivity in Spain despite its low allergenic rate. ^{20,24}
Eugenol	A strong allergen and derived from essential oils, it is used as a fragrance and antiseptic.
Isoeugenol	A component of the highly allergenic ylang ylang oil; is a common component of deodorants, leading to axillary dermatitis. ²⁰
Oakmoss absolute	A natural fragrance mainly used in aftershave products. It contains highly allergenic substances such as atranol and chloroatranol. ²⁰

Abbreviation: IFRA, International Fragrance Association.

TABLE 3. Fragrance mix II

Chemical Name	Notes
Lyral (hydroxyisohexyl 3-cyclohexene carboxaldehyde)	Associated with ACD reactions in 2%-3% of eczema patients. ⁹ With a fragrance reminiscent of lilies, it is used widely in cosmetics, antiperspirants, lotions, deodorants, shampoos, and soaps. ²⁵
Citral	A principal constituent of lemongrass. A possible cause of ACD as well as ICD.
Farnesol	Another floral fragrance; is also derived from essential oils and has antibacterial qualities. ^{20,26}
Citronellol	Found in both rose and citronella oil, it is commonly used in insect repellants and perfumes. ²⁰
Hexylcinnamic aldehyde	A component of chamomile oil and, like citral, can cause both ACD and ICD. ²⁰
Coumarin	Found frequently in cosmetics and is a component of essential oils. ²⁰

Abbreviations: ACD, allergic contact dermatitis; ICD, irritant contact dermatitis.

sensitizing ingredients found in mix I, oakmoss induced the most reactions, followed by isoeugenol, cinnamic aldehyde, cinnamic alcohol, eugenol, hydroxycitronellal, geraniol, and amyl cinnamaldehyde.^{35,36} Brief characteristics and notes about each fragrance are found in Table 2 and 3.

In addition to the fragrance mixes, common fragrance allergens include Balsam of Peru, limonene, linalool, linal, benzyl salicylate, and sesquiterpene lactones (SLs)/ α -bisabolol. Balsam of Peru, a natural fragrance derived from fir trees, can detect up to 50% of fragrance allergies alone.²⁵ When used in conjunction with fragrance mix I, over 90% of fragrance allergy cases would be detected.²⁵ Fragrance terpenes limonene and linalool, though weak allergens in their pure forms, may be strongly sensitizing once oxidized. A 2011 study showed a 1.3% PPT rate to linalool, while a 2014 study showed a 5.0% and 5.9% positive rate to hydroperoxides of limonene and linalool.^{37,38} Reports of allergies to the synthetic and ubiquitous fragrance linal have also been reported.^{32,39} Benzyl salicylate, a compound used both as a fragrance and UV

light absorber, is a common ingredient found in cosmetics. However, it may have a low allergenic potential because few reports have been made on benzyl salicylate and ACD.⁴⁰ SLs are indicators of plant sensitization, with α -bisabolol cross-reacting with SLs. It should be noted that many personal products contain additional antigens and substances not present with the mixes, therefore patch testing for fragrances should be supplemented with additional sensitizers to increase sensitivity.²⁷

Preservatives

Preservatives have been identified as the most common cosmetic contact allergen, found in virtually every personal care product due to their antimicrobial properties.^{41,42} General categories of preservatives include formaldehyde, formaldehyde releasers, and nonformaldehyde releasers. Previous studies identified parabens, isothiazolinones, thiomersal, formaldehyde, imidazolidinyl urea, and quaternium-15 (Q-15) as the most frequently used preservatives.^{14,43}

Nonformaldehyde releasers

Parabens. Parabens have been found in 99% of leave-on products and 77% of rinse-off products in European studies due to their odorless and colorless properties, as well as low sensitizing capabilities (0.1%-0.3%)^{14,44} However, despite their relatively safe allergenic capabilities, they have been questionably associated with breast cancer and hormonal dysregulation.⁴⁵⁻⁴⁷

Methylchloroisothiazolinone/methylisothiazolinone. Perhaps the most well-known nonformaldehyde releasers, named as the 2013 Contact Allergen of the Year by the ACDS, methylisothiazolinone (MI) and its related compound methylchloroisothiazolinone (MCI) are used as preservatives in personal care products due to their robust antimicrobial effects, even at low concentrations.⁴⁸ MI is considered a weaker sensitizer than MCI at the same concentrations; however, because it is also a weaker preservative than MCI, higher concentrations are permitted and used (up to 100 ppm).²⁹ MCI/MI is commonly found in common consumer products such as shampoos, toiletries, skin creams, and lotions, as well as in industrial products such as water-cooling systems, paints, glues, latex emulsions, household cleaning products, and detergents.⁴⁹ Due to its high allergenic potential, the European Commission banned the use of MI in leave-on products in 2016, with no current bans in the United States.⁵⁰ This has led to an increasing PPT rate to MCI/MI in the United States, from 2.5% to 6.8% from 2012 to 2014.^{48,50} Sensitization to MI is more prevalent in women and also in individuals with hand and facial dermatitis.⁵¹

Thiomersal. Thiomersal, an organic mercury compound of thio-salicylic acid, is used as a preservative due to its strong antifungal and antibacterial properties. Incidence of PPT results with thiomersal is high at 11.8%, though often times, no clinical relevance can be found.⁴³ It may be found in eye shadows, mascaras, lotions, contact lens solutions, and vaccines, at a maximum concentration of 0.007%; however, its use in skin care products has diminished.^{30,52}

Formaldehyde

A frequent sensitizer, the ACDS identified formaldehyde as the Contact Allergen of the Year in 2015. It is now less commonly found in cosmetics as a preservative, other than in nail cosmetics and hair-straightening products.^{27,53} Free formaldehyde, as well as its related compounds formalin and methylene glycol, are all common active ingredients in nail-strengthening formulations.^{27,54,55} Tosylamide/formaldehyde resin, or toluene sulfonamide-formaldehyde resin (TSFR), is the seventh most common ACD-related cosmetic allergen and is responsible for most ACD cases related to nail polish.⁸ According to data from the NACDG, 4% of all PPTs resulted from TSFR sensitivity. Many nail polish brands now use tosylamide epoxy resin instead of TSFR; however, this alternative agent is also sensitizing.⁵⁶

Formaldehyde releasers

Formaldehyde-releasing preservatives, such as diazolidinyl urea, Q-15, DMDM hydantoin, and imidazolidinyl urea, are likewise

used in many personal care products due to their potent antimicrobial and antifungal properties.⁵⁷ Formaldehyde-releasing preservatives have largely replaced formaldehyde, as a result of its robust allergenic potential as described previously, in order to reduce sensitization and decrease the concentration of formaldehyde in product formulations. In fact, according to data from the FDA, 19.5% of cosmetic products contain a formaldehyde releaser.⁵⁸ However, formaldehyde releasers are still able to cause allergic reactions, due to their free formaldehyde degradation products.^{29,59} Their allergenic potential is further exacerbated in patients with injured skin, such as patients with atopic dermatitis (AD).^{14,60} A 2017 study determined that 9.5% of their patch-tested patients were found to be allergic to formaldehyde-releasing preservatives.⁶¹ Imidazolidinyl urea was found to be the second most prevalent preservative, behind parabens; however, it is considered a weak formaldehyde-releasing sensitizer.¹⁴ PPT rates range from 0.7% in Europe to 3.1% in the United States.¹⁴ In contrast, Q-15 is an allergen that is 8 times as potent as imidazolidinyl urea and is the most common preservative allergen.^{14,15}

Emulsifiers and emollients

Emulsifier and emollients, which help with mixing hydrophilic and hydrophobic materials, are important causes of ACD. The most common of these vehicles are lanolin and propylene glycol (PG).⁷

Lanolin, an emollient with origins from sheep sebum, is a debated and variable allergen due to inconsistencies in the development of the product by differing manufacturers.⁵⁷ Although lanolin is not considered to be a strong or common sensitizer, false-negative reactions are frequent in those allergic to lanolin.⁶² Amerchol L101 (lanolin alcohol) is the strongest allergenic element found in lanolin.⁵⁷ Due to inconsistencies surrounding lanolin in regards to patch testing, lanolin is largely considered an important substance to patch test.⁶³

PG is an excipient used as a solvent, humectant, emulsifier, and vehicle for numerous products, including topical cosmetics and medications. According to the NACDG, personal care products, such as moisturizers, are the most common exposure source (53.8%), followed by topical steroids (18.35%).⁶⁴ Even though PG is considered to be a weak allergen, PPT result rates have been increasing.^{57,65} The rate of ACD to PG is estimated to be around 3.5%.⁶⁴ Furthermore, the ubiquitous presence of PG in topical products may lead to its increased prevalence as a cause of ACD, due to an increased likelihood of prior sensitization.

UV absorbers

Many personal care products, such as cosmetics, facial moisturizers, and hair care products incorporate UV light filters to protect both the skin and the products from UV damage.^{29,66}

The 2 UV filter allergens that will be discussed include benzophenone 3 and 4. Though benzophenone 3 is widely used in sunscreen and was the most common UVA filter photoallergen in the 1990s, benzophenone 4 has been increasingly prevalent due to its ability to filter UVB rays in addition to UVA.⁶⁶ A 2005 study demonstrated that the 2 filters had similar PPT rates, at 9% each.⁶⁶ It should be noted that benzophenone 3 and 4 are not cross-reactive.⁶⁶

TABLE 4. Allergens found in nail cosmetics²⁷

Component of Product	Allergen	Location of Allergy
Base, color, top coat	(Meth)acrylates, benzophenone, formaldehyde, tosylamide epoxy resin, TSFR, dibutyl phthalate	Nail folds, lips, neck, eyelids
Nail hardener/strengthener	Formaldehyde	
Nail cleanser	Isopropyl alcohol	
Acrylic nails	(Meth)acrylates, isopropyl alcohol, ethyl acetate, cyanoacrylate, benzophenone, camphor, dibutyl phthalate, formaldehyde, tosylamide epoxy resin, TSFR, toluene, monomethyl ether of hydroquinone, and benzoyl peroxide	
Adhesives	Cyanoacrylate	
Nail polish remover	Acetone, ethyl acetate	
Gel manicure	(Meth)acrylates, camphor, dibutyl phthalate, photoinitiators, isopropyl alcohol, ethyl acetate, methacrylic acid	

Abbreviation: TSFR, toluene sulfonamide-formaldehyde resin.

Botanicals

Botanicals have become increasingly prevalent in cosmetics due to their medicinal and fragrant properties, with propolis, Compositae extracts, and tea tree oil (TTO; *Melaleuca alternifolia*) as the most common of these allergens.^{14,67} A 2013 study of over 2,500 patients found that 11% of those who used topical botanical products, such as body lotions, face creams, hair care products, cleaners, and perfumes, experienced an adverse cutaneous reaction.⁶⁵ Furthermore, a higher percentage of women reported side effects than men. In this section, the botanicals propolis, TTO, and members of the Compositae family (*Anthemis nobilis*, *Chamomilla officinalis*, *Matricaria chamomilla*, *Echinacea angustifolia*, *Echinacea purpurea*, and *Arnica montana*) will be discussed. It should be noted that although *Aloe vera* is the most widely used botanical, it is a rare allergen.⁶⁸

Propolis, made by *Apis mellifera* (honeybees) has a low sensitization frequency ranging from 0.5% to 3.5%. However, it has significant cross-reactivity with another allergenic botanical, *Myroxylon pereirae* (Balsam of Peru). Though the PPT rates vary, the median cross-reactivity rate is about 55%.⁶⁹ TTO has been reported to have antimicrobial and anti-inflammatory properties, thus it has been used as a therapy for several skin diseases, including acne and eczema.⁷⁰ However, although fresh TTO is considered a weak allergen, oxidation leads to an increase in its sensitizing potential.⁷¹ Routine testing places PPT reactions for TTO at around 0.1% to 3.5%.⁷⁰ Chamomile (including *Anthemis nobilis*, *Chamomilla officinalis*, and *Matricaria chamomilla*) has many uses due to its calming properties on the skin and for those with AD.⁷² However, as part of the sensitizing Compositae family, they are the most common flowering plant to cause ACD as a result of SL, a main active ingredient in chamomile, and α -bisabolol, an essential oil with cross-reactivity to SL.⁷³ Furthermore, Linalool, a top fragrance allergen, is found at a 0.3% concentration in chamomile.⁷⁴ It should be noted that sensitization to chamomile and its related allergens is low (1.7% to chamomile and 0.9% to SL).⁷⁵ Echinacea species (including *Echinacea angustifolia* and *Echinacea purpurea*), like

chamomile, is part of the Compositae family. Contact dermatitis to *E. purpurea* has been observed in atopic patients, especially those with known sensitivity to Compositae.⁷⁶ Lastly, another member of the Compositae family, *Arnica montana*, is commonly found in topical remedies for bruises and muscle strains, cosmetics, soaps, and massage oils due to its anti-inflammatory and wound-healing effects.⁷⁶ The main sensitizing ingredients in *A. montana* include both the plant itself and its tincture, which contains SLs such as helenalin, xanthalongin, and carabron.⁷⁷ Due to its varied usages, contact allergy to *A. montana* is quite common, with more than 100 cases reported between 1844 and 1977.⁷⁷ A 2001 study showed a 1.13% sensitivity to *A. montana* in patch-tested patients.⁷⁸ Of note, 4.06% of patch-tested patients tested positive to the Compositae mix within the same study.

Specific products associated with ACD Nail cosmetics

Nail cosmetics contain numerous possible allergens, though the major offenders are TSFR and acrylates.²⁷ Table 4 explores some of the common allergens found in nail cosmetics, as well as where they present on the body. As stated previously, while free formaldehyde is the main active ingredient in nail-hardening products and is associated with ACD, TSFR accounts for most ACD cases related to nail polish.^{27,54-56}

Acrylates are plastic substances that are formed by the polymerization of monomers derived from acrylic or methacrylic acid.²⁷ First used in plexiglass, these compounds have a wide range of applications, including paints, adhesives, dental composite resins, printing inks, artificial nails, contact lenses, hearing aids, and bone cement for orthopedic endoprostheses. Though reactions to acrylate polymers are rare, monomers that remain unhardened can remain on the surface of the nail, leading to ectopic ACD on areas of the face, eyelids, and neck.⁷⁹ Furthermore, patients are often allergic to multiple methacrylate monomers, due to cross-reactivity between these substances.⁸⁰

Methyl methacrylate (MMA) monomers were originally the

TABLE 5. Allergens found in hair products^{7,15,28}

Component of Product	Allergen	Location of Allergy
Hair bleach	Ammonium persulfate	Eyelids
Hair dye	PPD, toluene 2,5-diamine, p-aminophenol, 3-aminophenol, and p-aminoazobenzene	Eyelids, scalp, hands, face, upper trunk
Shampoos	MI/MCI, triethanolamine, rosin, benzophenone, decyl glucoside, sorbic acid, diazolidinyl urea, benzoic acid, cinnamates, oxybenzone lanolin, propolis, imidazolidinyl urea, Q-15, avobenzene, BHT, fragrance, cetylstearyl alcohol, cocamidopropyl betaine, sorbitan sesquioleate, PG	Eyelids, scalp, face, neck, upper back
Shampoos that treat dandruff and scalp psoriasis	Zinc pyrithione	Scalp
Conditioners	Vitamin E, chlorhexidine digluconate, MI/MCI, lanolin, triethanolamine, benzophenone, avobenzene, rosin, cinnamates, oxybenzone, propolis, benzoic acid, sodium benzoate, cocamide DEA, PABA, 2-Bromo-2-nitropropane-1/3-diol, BHT, fragrance, PG, cetylstearyl alcohol, sorbitan sesquioleate, benzoic acid, triethanolamine	Eyelids, scalp, face, neck, upper back
Styling products	Oxybenzoate, MI/MCI, cocamidopropyl betaine, avobenzene, propolis, sodium benzoate, PABA, BHT, chlorhexidine digluconate, Q-15, benzalkonium chloride, fragrance	Eyelids, scalp, face, neck, upper back
Acid permanent wave solutions	GMT	Hands, forearms, face, neck, scalp

Abbreviations: GMT, glyceryl monothioglycolate; MCI, methylchlorisothiazolinone; MI, methylisothiazolinone; PG, propylene glycol; PPD, p-phenylenediamine; Q-15, quaternium-15.

main active ingredient in liquid acrylics; however, after extensive reporting of allergic sensitization to MMA, the FDA banned its use in cosmetics in 1974.³⁸ Now, most products contain ethyl, isobutyl, and tetrahydrofurfuryl methacrylate, which are likewise implicated in ACD.^{81,82}

Lastly, benzophenone is a common additive to regular and gel nail polish that protects these products by absorbing UV light. It has been associated with cases of ectopic allergic contact and photocontact dermatitis of the eyelid and neck.^{29,83}

Hair care

Most contact allergies from hair products result from substances found in hair dyes, specifically p-phenylenediamine (PPD), as well as resorcinol and m-aminophenol.^{7,84,85} PPD functions as the primary coloring agents in both permanent and semipermanent hair dyes, as well as in henna skin dyes and other color cosmetics.⁷ PPD may lead to potentially severe clinical reactions, therefore “spot testing” is recommended before using the product.⁷ Hypersensitivity reactions to PPD are as high as 9.1% in the general population and 50% among hairdressers, who come in contact with PPD often, allergic to the substance.^{86,87} Resorcinol, used as a topical antiseptic and as a “coupler” of PPD in dye synthesis, has also been implicated in contact allergies to acne medications and in henna tattoos.^{88,89}

Other hair care-related substances that include potential allergens include bleaching compounds, such as persulfate, and those found in shampoos, such as cocamidopropyl betaine, MCI/MI, formaldehyde-releasing preservatives, PG, vitamin E, parabens, benzophenones, and fragrances.⁹⁰ Cocamidopropyl betaine, a surfactant derived from coconut oil, has been associated with ACD of the head and neck and is found in additional products

such as liquid soap, cleansers, shower gels, and deodorants.^{15,91} Vitamin E, also known as α-tocopherol and tocopheryl acetate, has wound-healing, antioxidant, and anti-aging properties. ACD to tocopherol remains infrequent (0.66%), with no appreciable increase in PPT rate over 20 years.⁹² It should be noted that rinse-off cosmetics, encompassing most hair care products, are less common causes of ACD due to their brief contact with the skin.⁹³

Lip cosmetics

Allergies to lip cosmetics mainly stem from sensitization to shellac and lanolin, resulting in allergic cheilitis.^{7,14} Shellac, a resin secreted by *Coccus lacca*, has emollient characteristics. It is commonly found in hair sprays, nail polishes, lipsticks, eyeliners, and mascaras, producing rare sensitizing and irritant reactions in those using these products.⁹⁴

Eye cosmetics

Due to the thin skin of the eyelid, the eye remains particularly sensitive to both allergens and irritants.^{95,96} Eyelid ACD has been reported following exposure to heavy metals, such as nickel, cobalt, and chromium, in eyeshadow and mascara.^{7,97} ACD has also been reported with eye cosmetic removers, as well as colophony/rosin and shellac found in eye cosmetics.^{94,98-100} Patch testing may also be performed with patient's own products, following drying of any liquid cosmetics.¹⁰¹

Treatment and interventions

For patients experiencing ACD, the offending substance should first be identified through patch testing if a patch test is available, then removed and avoided.

Barrier creams and moisturizers

Barrier creams, such as dimethicone, petrolatum, and paraffin, can prevent repeated contact to allergens by providing another protective layer above the stratum corneum, especially those with occupational contact dermatitis.¹⁰² Furthermore, these balms often contain ingredients that reduce inflammation of the skin and replenish the intracellular lipids of the stratum corneum.^{27,103} Ceramide can lessen transepidermal water loss, while colloidal oatmeal, which contains anti-inflammatory compounds such as polyphenol, may placate acute lesions.¹⁰⁴ Lastly, linoleic and hyaluronic acids can enhance intracellular lipid production.^{27,103} A disadvantage of barrier creams involves its effectiveness at adhering to the skin after prolonged periods of time. Frequent use of certain parts of the body, such as the hands, can dissipate the cream, leading to a reduced efficacy.

Steroids

Potent and midpotent topical steroids (class I to V), are useful in cases of acute ACD of the hand.³⁸ However, on areas of the body with sensitive skin, such as the eyelids or the face, lower-potency steroids can be used to avoid skin atrophy, striae, and dyspigmentation.³⁸ Steroid ointments are preferred because they allow for prolonged contact between the steroid medication and the affected skin.¹⁶

Other topical agents and methods

Calamine lotion, as well as cool compresses, can ease acute symptoms of ACD. Burow's solution or thin saline dressings can desiccate oozy lesions of the skin prior to application of a topical corticosteroid.¹⁰⁵

Conclusion

Personal care products and cosmetics have been an increasing source of ACD, presenting on areas such as the face, eyelids, neck, hands, scalp, and anogenital region. Fragrances and preservatives are considered the leading causes of cosmetic-induced ACD. Botanicals have become increasingly prevalent in cosmetics due to their medicinal and fragrant properties. Patch testing remains the gold standard in diagnosing ACD. Referring to a dermatologist specializing in patch testing is recommended because many commercially available patch testing "easy use" kits are not comprehensive. Proper identification of the allergen, as well as adequate treatment, is necessary to improve the quality of life of individuals affected by ACD.

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