

# Allergic Contact Dermatitis and Cosmetics

Shannon Watkins, MD; Jonathan Zippin, MD, PhD

*Contact dermatitis is a common dermatologic condition that can result from exposure to allergens at home or at work. Cosmetics represent a large diverse group of products that Americans apply to their skin to treat disease or enhance beauty. With increased use of cosmetics, the rate of sensitization to many allergenic components has increased. We review the more common allergens present in cosmetics as well as the types of cosmetics that are known to contain them. With proper education and patch testing, dermatologists will be able to identify contact allergies to cosmetic ingredients and help patients avoid the offending products.*

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The US cosmetic and cosmeceutical market has been growing steadily over the last decade. It has been projected that the market would reach \$9.4 billion by 2012.<sup>1,2</sup> Many women use multiple cosmetic products on a daily basis. Studies have shown that 6% to 23% of patients report adverse reactions to cosmetic products.<sup>3-5</sup> Although these reactions may result in sensory irritation (ie, irritation of the eyes, nose, and throat), it has been shown that 4% to 10% of patients who underwent patch tests exhibited a contact allergy to a cosmetic product or its constituents.<sup>4</sup> Causative agents include skin care products, nail polishes, hair products, deodorants, perfumes, and makeup. Diagnosis of allergic contact dermatitis should include patch testing of the whole product formulation as well as an open application test of the product's components to ensure the results are relevant.<sup>4</sup> We review some of the major contact allergens that are common ingredients in cosmetic and cosmeceutical products.

## Shellac

Shellac is the purified resinous secretion of the insect *Laccifer lacca* (formerly *Coccus lacca*), which feeds on certain trees in southern Asia.<sup>6,7</sup> Historically, shellac has been used in textiles; sealants; polishes; shoe and floor waxes; coating for medications, fruit, and candies; and dental varnish. Processed shellac has emollient and film-forming properties; therefore, it often is used in cosmetic products such as hair spray; nail polish; lipstick; eyeliner; and mascara, in which it acts as a curling agent.<sup>6,7</sup> When patch tests for shellac are conducted, the physician should test various dilutions to ensure the reaction is not of an irritant etiology, as raw shellac has irritant properties and can form crystalline shards. The ideal patch test is performed with a 20% concentration of shellac in an alcohol vehicle.<sup>7</sup> Patch tests with a 5% aqueous solution of shellac with triethanolamine 5% (as an emulsifier) also has been reported as an effective and possibly less irritating alternative.<sup>6</sup> Shellac in mascara has been reported to cause allergic contact dermatitis of the eyelids,<sup>6,7</sup> and shellac present in lip care products has been reported to cause allergic contact cheilitis of the lips.<sup>8</sup> Shellac nail polishes are becoming more popular, with many salons promising a 14-day wear time. Because shellac is being used more frequently in cosmetics, dermatologists should be aware of its potential allergenic properties.

## Gallates

Gallates (propyl gallate, octyl gallate, dodecyl gallate) have been used since 1947 to prevent the oxidation of unsaturated fats in cosmetic, pharmaceutical, and food products. Chemically, gallates are alkyl esters of trihydroxybenzoic acid and differ from each other in the length of their side chains.<sup>9</sup> In guinea pigs, it was found that increased side chain length was correlated with increased allergenicity<sup>9,10</sup>; in humans, however, a multicenter patch testing study showed that octyl gallate had the greatest sensitizing capacity, followed by dodecyl gallate and propyl gallate.<sup>9,11</sup> Propyl gallate is the most

From Weill Cornell Medical College, Cornell University, New York, New York.

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Correspondence: Jonathan Zippin, MD, PhD, 1305 York Ave, 9th Floor, New York, NY 10021 (jzippin@med.cornell.edu).

commonly used gallate in the industry; therefore, most reported cases of sensitization to gallates are due to propyl gallate.<sup>9</sup> Because propyl gallate is found most often in lipstick and other lip cosmetics, the most common clinical manifestation of an allergy to propyl gallate is cheilitis; thus patch tests for a gallate allergy should be considered in patients presenting with persistent or recurrent cheilitis.<sup>12</sup> Other products that include gallates are lip balms, salves, cosmetic creams, and lotions. A series of patients who received patch tests from 1988 to 2005 showed a statistically significant ( $P < .05$ ) increase in propyl gallate-positive rates on patch tests performed over the last decade, which the authors believed was attributable to an increased use of propyl gallate in the cosmetic industry. However, they could not exclude the possibility that a reduction in the use of propyl gallate as an antioxidant in food products has led to decreased oral tolerance in humans.<sup>13</sup> According to one study, the ideal patch-test concentrations for gallates are propyl gallate at 1%, octyl gallate at 0.25%, and dodecyl gallate at 0.25%, all diluted in a petrolatum or olive oil vehicle.<sup>9,14</sup>

## Fragrances

Fragrances are the most frequent cause of cosmetic allergies.<sup>4,15</sup> There are more than 2500 fragrance ingredients that are used in cosmetic products.<sup>16</sup> In addition to colognes and perfumes, they also are used in the majority of skin care products. Clinical manifestations of fragrance allergies include localized dermatitis at the site of application or a discoloration caused by the allergen. Dermatitis can be photodistributed or exhibit an airborne pattern (ie, skin exposed to air and not covered by clothes).<sup>4</sup> A large retrospective study conducted in Denmark (N=17,716) found that deodorants (25%) were the most common cause of allergic contact dermatitis from fragrances, followed by scented lotions (24.4%).<sup>17</sup>

When testing for a fragrance allergy, there are different allergens or mixtures of allergens that can be used. Larsen et al's<sup>18</sup> European standard fragrance mix contains 1% of each of the following: cinnamic aldehyde, cinnamic alcohol, geraniol, eugenol, isoeugenol, oakmoss absolute, hydroxycitronellal, and alpha-amyl cinnamic alcohol. This mixture is estimated to identify fragrance allergies in 70% to 80% of affected patients but also may miss 15% of relevant reactions.<sup>4,19</sup> Larsen et al<sup>18</sup> reported that including 3 additional ingredients in the mixture—10% ylang-ylang oil, 10% sandalwood oil, and 2% narcissus absolute—may help to identify up to 96% of fragrance-allergic patients.

Balsam of Peru (*Myroxylon pereirae*) is another agent used in screenings for fragrance allergies, as it is

estimated to detect 50% of patients who are sensitive to fragrances.<sup>4,15</sup> This mix contains multiple commonly used fragrance chemicals. A contact allergy to balsam of Peru may be more common in patients who also have an allergy to citrus fruit peels.<sup>4,20</sup>

## Formaldehyde and Formaldehyde-Releasing Preservatives

Formaldehyde is a frequent sensitizer and thus is rarely used as a cosmetic preservative.<sup>4</sup> In European formulations, the maximum amount of formaldehyde should not exceed 0.2%,<sup>4</sup> except in nail hardeners in which a maximum 5% concentration is allowed.<sup>3</sup> Additionally, in the European Union, products containing formaldehyde in concentrations greater than 0.05% must include a warning label.<sup>3</sup> Although formaldehyde itself rarely is listed as an ingredient in cosmetic products, one Swedish study reported that it was present in 10% of tested moisturizers (N=100), possibly due to formaldehyde-releasing preservatives.<sup>21</sup>

Formaldehyde-releasing agents commonly are used in cosmetics as antimicrobial and antifungal preservatives<sup>22</sup> and typically are found in body cleansers and sun and skin care products.<sup>3</sup> Imidazole urea is one of the most commonly used preservatives and is thought to release formaldehyde as it decomposes.<sup>22</sup> Other formaldehyde-releasing preservatives include diazolidinyl urea, quaternium-15, dimethylodimethyl hydantoin, methylisothiazolinone/methylchloroisothiazolinone (MI/MCI), and under extreme pH conditions 2-bromo-2-nitropropane-1,3-diol.<sup>4</sup> These agents are thought to have an easily detached formaldehyde moiety, which explains their formaldehyde-releasing quality. The presence of formaldehyde in products also may be due to its use as a transport detergent; some experts hypothesize that in the transportation process, formaldehyde may inadvertently become incorporated into the products.<sup>4</sup>

In cases of contact dermatitis from exposure to diazolidinyl urea, which often is found in sun protection and skin care products,<sup>3</sup> cosensitization to formaldehyde and other formaldehyde releasers also may be present.<sup>4,23</sup> Additionally, patients who are sensitive to formaldehyde often experience sensitivity reactions from leave-on cosmetics that contain quaternium-15. Hair care and personal hygiene products as well as facial cleansers frequently contain MI/MCI.<sup>3</sup> Studies have suggested that rinse-off products that contain MI/MCI concentrations of 15 ppm and leave-on products with concentrations of 7.5 ppm are unlikely to result in allergic contact dermatitis.<sup>4,24</sup> Even in patients who are sensitive to MI/MCI, rinse-off products that contain MI/MCI concentrations of 15 ppm are unlikely to cause a

reaction.<sup>4,25</sup> The European standard series of patch test allergens utilizes higher concentrations of MI/MCI (100 ppm) diluted in water.<sup>4</sup> In patients with suspected reactions to MI/MCI, avoidance of this potential allergen is advised.

### Thimerosal

Thimerosal is a mercuric derivative of thiosalicylic acid, a common preservative used in cosmetic, ophthalmologic, and otic preparations, as well as contact lens solutions, vaccines, and intradermal tests.<sup>26,27</sup> Thimerosal sensitivity often presents as periorbital or eyelid dermatitis, typically secondary to sensitization from eyedrops and contact lens solutions.<sup>28</sup>

Although the use of thimerosal in cosmetic products and topical medications has declined,<sup>27</sup> it is thought that sensitization to thimerosal is increasing.<sup>26</sup> Various patch test studies have reported a high positivity rate to thimerosal, ranging from 1.6% to 37.6%.<sup>26,29-31</sup> It is hypothesized that the discrepancy is due to the use of thimerosal as a preservative in vaccines, as the hepatitis B, diphtheria and tetanus toxoids and pertussis, Japanese encephalitis, and influenza virus vaccines all are preserved with thimerosal.<sup>26</sup>

A study of Polish children and adolescents with chronic recurrent eczema reported that thimerosal sensitivity was found in 11.7% (12/103) of children and 37.6% (35/93) of adolescents who were evaluated.<sup>31</sup> It was hypothesized that the different rates of reactivity among children and adolescents could be explained by different exposure patterns to thimerosal. Adolescents in this study had received 6 thimerosal-preserved vaccinations (2–3 years since last vaccination at time of study), while children had received only 4 thimerosal-preserved vaccinations (5 years since last vaccination at time of study).<sup>31</sup> In Denmark, thimerosal is not routinely used in vaccines and the incidence of thimerosal allergy has decreased, which further supports the theory.<sup>26,32</sup>

### Formaldehyde Resins

It is estimated that 1% to 3% of the population is allergic to nail polish. Allergic contact dermatitis from nail polish typically manifests on the face, lips, and/or neck because of physical transfer of the allergen. It is estimated that half of all cases of nail polish allergies manifest as eyelid dermatitis.<sup>33</sup> Nail polish sensitivity rarely manifests on the fingers. Toluenesulfonamide formaldehyde resins (TSFRs) most commonly cause nail polish dermatitis. A study of 42 nail polish samples from 20 different brands found that each product contained TSFR in concentrations from 0.08% to 11%.<sup>34</sup> Different forms of TSFR have different allergenic potential<sup>33</sup>; for instance, TSFR monomers and dimers are considered to be major

allergens, whereas TSFR trimers are not considered to be allergenic.

Nail polishes with higher concentrations of TSFR also have higher concentrations of formaldehyde; therefore, patients who are sensitive to either TSFR or formaldehyde can develop contact dermatitis from nail polish use.<sup>34</sup> Although the incidence is less frequent, other nail polish ingredients have been reported to cause allergic contact dermatitis, such as polyester resin, ethylene dichloride, pigments, amyl acetate, phthalates, guanine, methacrylates, and nitrocellulose.

### Comment

Contact allergy to cosmetic products is common and should be considered as a possible etiology for recurrent dermatitis. It is important to keep in mind that allergies to cosmetic products can take on various clinical manifestations, including periorbital dermatitis, allergic cheilitis, and dermatitis of the face and neck. When a cosmetic allergy is suspected, patch tests should be performed using suspected allergens to which the patient has been exposed as well as any raw cosmetic products. Initial testing should be followed by a confirmatory test with the suspected allergenic components of the reactive product. Once an allergen is identified, the patient should be counseled as to which products commonly contain that particular allergen and safe products that can be used as alternatives. The Contact Allergen Replacement Database (CARD) sponsored by the American Contact Dermatitis Society is a good resource for physicians, as it generates a list of safe cosmetic products that are free of offending allergens. Manufacturers of cosmetic products also can be contacted directly to inquire about allergenic ingredients when necessary.

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