Is Laundry Detergent a Common Cause of Allergic Contact Dermatitis?

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PRACTICE **POINTS**

- Although laundry detergent commonly is believed to be a cause of allergic contact dermatitis (ACD), the actual prevalence is quite low (<1%).
- Common allergens present in laundry detergent such as fragrances and isothiazolinone preservatives likely are reduced to clinically irrelevant levels during routine machine washing.
- Other diagnoses to consider when laundry detergent–associated ACD is suspected include textile ACD, atopic dermatitis, and cutaneous T-cell lymphoma.

Both patients and health care providers commonly suspect laundry detergent as the cause of skin problems; however, research suggests that the prevalence of laundry detergent–associated allergic contact dermatitis (ACD) may be quite low. Herein, we provide a summary of the evidence for the potential allergenicity of laundry detergent, including common allergens present in laundry detergent, the role of machine washing, and the differential diagnosis for laundry detergent–associated ACD.

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Laundry detergent, a cleaning agent ubiquitous in the modern household, often is suspected as a cause of allergic contact dermatitis (ACD). In one North American study, 10.7% of 738 patients undergoing patch testing believed that laundry detergent was a contributing factor, whereas their referring physicians had the same concern less often (in 2.3% of cases).[1] Likewise, in a 1992 survey of western US households, more than 20% of 3841 respondents reported skin or health problems attributed to a textile and/or laundry product.[2] The suspicion of laundry detergent as a causative agent of ACD is perpetuated across popular wellness and beauty websites.[3,4] Does the evidence support this degree of suspicion? Or, similar to the well-meaning parent who misguidedly fixates on foods as the cause of their child's atopic dermatitis and believes elimination diets are the solution,[5] could a similar desire for control in the face of the unpredictability of eczema drive consumers and health care providers alike to blame laundry detergent—a familiar and modifiable cause?

We provide a summary of the evidence for the potential allergenicity of laundry detergent, including common allergens present in laundry detergent, the role of machine washing, and the differential diagnosis for laundry detergent–associated ACD.

Allergenic Ingredients in Laundry Detergent

Potential allergens present in laundry detergent include fragrances, preservatives, surfactants, emulsifiers, bleaches, brighteners, enzymes, and dyes.[6-8] In an analysis of allergens present in laundry detergents available in the United States, fragrances and preservatives were most common (eTable).[7,8] Contact allergy to fragrances occurs in approximately 3.5% of the general population[9] and is detected in as many as 9.2% of patients referred for patch testing in North America.[10] Preservatives commonly found in laundry

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The eTable is available in the Appendix online at www.mdedge.com/dermatology.

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detergent include isothiazolinones, such as methylchloroisothiazolinone (MCI)/methylisothiazolinone (MI), MI alone, and benzisothiazolinone (BIT). Methylisothiazolinone has gained attention for causing an ACD epidemic beginning in the early 2000s and peaking in Europe between 2013 and 2014 and decreasing thereafter due to consumer personal care product regulatory changes enacted in the European Union.[11] In contrast, rates of MI allergy in North America have continued to increase (reaching as high as 15% of patch tested patients in 2017-2018) due to a lack of similar regulation.[10,12] More recently, the prevalence of positive patch tests to BIT has been rising, though it often is difficult to ascertain relevant sources of exposure, and some cases could represent cross-reactions to MCI/MI.[10,13]

Other allergens that may be present in laundry detergent include surfactants and propylene glycol. Alkyl glucosides such as decyl glucoside and lauryl glucoside are considered gentle surfactants and often are included in products marketed as safe for sensitive skin,[14] such as "free and gentle" detergents.[8] However, they actually may pose an increased risk for sensitization in patients with atopic dermatitis.[14] In addition to being allergenic, surfactants and emulsifiers are known irritants.[6,15] Although pathologically distinct, ACD and irritant contact dermatitis can be indistinguishable on clinical presentation.

How Commonly Does Laundry Detergent Cause ACD?

The mere presence of a contact allergen in laundry detergent does not necessarily imply that it is likely to cause ACD. To do so, the chemical in question must exceed the exposure thresholds for primary sensitization (ie, induction of contact allergy) and/or elicitation (ie, development of ACD in sensitized individuals). These depend on a complex interplay of product- and patient-specific factors, among them the concentration of the chemical in the detergent, the method of use, and the amount of detergent residue remaining on clothing after washing.

In the 1990s, the North American Contact Dermatitis Group (NACDG) attempted to determine the prevalence of ACD caused by laundry detergent.[1] Among 738 patients patch tested to aqueous dilutions of granular and liquid laundry detergents, only 5 (0.7%) had a possible allergic patch test reaction. It was unclear what the culprit allergens in the detergents may have been; only 1 of the patients also tested positive to fragrance. Two patients underwent further testing to additional detergent dilutions, and the results called into question whether their initial reactions had truly been allergic (positive) or were actually irritant (negative). The investigators concluded that the prevalence of laundry detergent–associated ACD in this large group of patients was at most 0.7%, and possibly lower.[1]

Importantly, patch testing to laundry detergents should not be undertaken in routine clinical practice. Laundry detergents should never be tested "as is" (ie, undiluted) on the skin; they are inherently irritating and have a high likelihood of producing misleading false-positive reactions. Careful dilutions and testing of control subjects are necessary if patch testing with these products is to be appropriately conducted.

Isothiazolinones in Laundry Detergent

The extremely low prevalence of laundry detergent–associated ACD reported by the NACDG was determined prior to the start of the worldwide MI allergy epidemic, raising the possibility that laundry detergents containing isothiazolinones may be associated with ACD. There is no consensus about the minimum level at which isothiazolinones pose no risk to consumers,[16-19] but the US Expert Panel for Cosmetic Ingredient Safety declared that MI is "safe for use in rinse-off cosmetic products at concentrations up to 100 ppm and safe in leave-on cosmetic products when they are formulated to be nonsensitizing."[18,19] Although ingredient lists do not always reveal when isothiazolinones are present, analyses of commercially available laundry detergents have shown MI concentrations ranging from undetectable to 65.7 ppm.[20-23]

Published reports suggest that MCI/MI in laundry detergent can elicit ACD in sensitized individuals. In one case, a 7-year-old girl with chronic truncal dermatitis (atopic history unspecified) was patch tested, revealing a strongly positive reaction to MCI/MI.[24] Her laundry detergent was the only personal product found to contain MI. The dermatitis completely resolved after switching detergents and flared after wearing a jacket that had been washed in the implicated detergent, further supporting the relevance of the positive patch test. The investigators suspected initial sensitization to MI from wet wipes used earlier in childhood.[24] In another case involving occupational exposure, a 39-year-old nonatopic factory worker was responsible for directly adding MI to laundry detergent.[25] Although he wore disposable work gloves, he developed severe hand dermatitis, eczematous pretibial patches, and generalized pruritus. Patch testing revealed positive reactions to MCI/MI and MI, and he experienced improvement when reassigned to different work duties. It was hypothesized that the leg dermatitis and generalized pruritus may have been related to exposure to small concentrations of MI in work clothes washed with an MI-containing detergent.[25] Notably, this patient's level of exposure was much greater than that encountered by individuals in day-to-day life outside of specialized occupational settings.

Regarding other isothiazolinones, a toxicologic study estimated that BIT in laundry detergent would be unlikely to induce sensitization, even at the maximal acceptable concentration, as recommended by preservative manufacturers, and accounting for undiluted detergent spilling directly onto the skin.[26] Nonetheless, a single European center recently reported that almost half of the 38 patients with positive patch tests to BIT had a potentially relevant exposure attributed to household cleaning products, including laundry detergent.[13] This emphasizes the need

for further examination of sources of exposure to this increasingly common positive patch test allergen.

Does Machine Washing Impact Allergen Concentrations?

Two recent investigations have suggested that machine washing reduces concentrations of isothiazolinones to levels that are likely below clinical relevance. In the first study, 3 fabrics—cotton, polyester, cotton-polyester—were machine washed and line dried.[27] A standard detergent was used with MI added at different concentrations: less than 1 ppm, 100 ppm, and 1000 ppm. This process was either performed once or 10 times. Following laundering and line drying, MI was undetectable in all fabrics regardless of MI concentration or number of times washed (detection limit, 0.5 ppm).[27] In the second study, 4 fabrics—cotton, wool, polyester, linen—were washed with standard laundry detergent in 1 of 4 ways: handwashing (positive control), standard machine washing, standard machine washing with fabric softener, and standard machine washing with a double rinse.[28] After laundering and line drying, concentrations of MI, MCI, and BIT were low or undetectable regardless of fabric type or method of laundering. The highest levels detected were in handwashed garments at a maximum of 0.5 ppm of MI. The study authors postulated that chemical concentrations near these maximum residual levels may pose a risk for eliciting ACD in highly sensitized individuals. Therefore, handwashing can be considered a much higher risk activity for isothiazolinone ACD compared with machine washing.[28]

It is intriguing that machine washing appears to reduce isothiazolinones to low concentrations that may have limited likelihood of causing ACD. Similar findings have been reported regarding fragrances. A quantitative risk assessment performed on 24 of 26 fragrance allergens regulated by the European Union determined that the amount of fragrance deposited on the skin from laundered garments would be less than the threshold for causing sensitization.[29] Although this risk assessment was unable to address the threshold of elicitation, another study conducted in Europe investigated whether fragrance residues present on fabric, such as those deposited from laundry detergent, are present at high enough concentrations to elicit ACD in previously sensitized individuals.[30] When 36 individuals were patch tested with increasing concentrations of a fragrance to which they were already sensitized, only 2 (5.6%) had a weakly positive reaction and then only to the highest concentration, which was estimated to be 20-fold higher than the level of skin exposure after normal laundering. No patient reacted at lower concentrations.[30]

Although machine washing may decrease isothiazolinone and/or fragrance concentrations in laundry detergent to below clinically relevant levels, these findings should not necessarily be extrapolated to all chemicals in laundry detergent. Indeed, a prior study observed that after washing cotton cloths in a detergent solution for 10 minutes, detergent residue was present at concentrations ranging from 139 to 2820 ppm and required a subsequent 20 to 22 washes in water to become undetectable.[31] Another study produced a mathematical model of the residual concentration of sodium dodecyl sulphate (SDS), a surfactant and known irritant, in laundered clothing.[32] It was estimated that after machine washing, the residual concentration of SDS on clothes would be too low to cause irritation; however, as the clothes dry (ie, as moisture evaporates but solutes remain), the concentration of SDS on the fabric's surface would increase to potentially irritating levels. The extensive drying that is possible with electric dryers may further enhance this solute-concentrating effect.

Differential Diagnosis of Laundry Detergent ACD

The propensity for laundry detergent to cause ACD is a question that is nowhere near settled, but the prevalence of allergy likely is far less common than is generally suspected. In our experience, many patients presenting for patch testing have already made the change to "free and clear" detergents without noticeable improvement in their dermatitis, which could possibly relate to the ongoing presence of contact allergens in these "gentle" formulations.[7] However, to avoid anchoring bias, more frequent causes of dermatitis should be included in the differential diagnosis. Textile ACD presents beneath clothing with accentuation at areas of closest contact with the skin, classically involving the axillary rim but sparing the vault. The most frequently implicated allergens in textile ACD are disperse dyes and less commonly textile resins.[33,34] Between 2017 and 2018, 2.3% of 4882 patients patch tested by the NACDG reacted positively to disperse dye mix.[10] There is evidence to suggest that the actual prevalence of disperse dye allergy might be higher due to inadequacy of screening allergens on baseline patch test series.[35] Additional diagnoses that should be distinguished from presumed detergent contact dermatitis include atopic dermatitis and cutaneous T-cell lymphoma.

Final Interpretation

Although many patients and physicians consider laundry detergent to be a major cause of ACD, there is limited high-quality evidence to support this belief. Contact allergy to laundry detergent is probably much less common than is widely supposed. Although laundry detergents can contain common allergens such as fragrances and preservatives, evidence suggests that they are likely reduced to below clinically relevant levels during routine machine washing; however, we cannot assume that we are in the "free and clear," as uncertainty remains about the impact of these low concentrations on individuals with strong contact allergy, and large studies of patch testing to modern detergents have yet to be carried out.

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APPENDIX

Investigations of Potential Allergens Present in Laundry Detergents

Reference (year)/ country	No. of participants	Fragrance	Potential allergens, n (%)[a]								
			Preservative				Surfactant			Emulsifier	Other
			BIT	MCI/ MI	MI	Phenoxyethanol	CAPB	Decyl glucoside	Lauryl glucoside	PG	Benzyl benzoate
Magnano et al[7] (2009)/ Italy	63	45 (71.4)	15 (23.8)	22 (34.9)	20 (31.7)	NI	0 (0)	NI	NI	20 (31.7)	NI
Bai et al[8] (2020)/ United States	30	20 (66.7)	11 (36.7)	0 (0)	12 (40.0)	0 (0)	0 (0))	2 (6.7)	5 (16.7)	10 (33.3)	1 (3.3)

Abbreviations: BIT, benzisothiazolinone; CAPB, cocamidopropyl betaine; MCI, methlychloroisothiazolinone; MI, methylisothiazolinone; NI, not investigated; PG, propylene glycol.

[a]The prevalence of laundry detergents with the potential allergen listed as an ingredient.