

Diagnosis and Treatment of Dermatitis Due to Formaldehyde Resins in Clothing

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An increasing number of cases of allergic contact dermatitis secondary to formaldehyde resins used for textile finishes have been seen in our office over the last several years. Although previously reported to be more common in women, we have seen almost as many men as we have seen women with this condition, possibly because men are more likely to be occupationally sensitized to formaldehyde. We have found that patch-test reactions of only questionable strength may be clinically relevant. It has been our experience that many of these cases are of long duration before referral for patch testing. A low index of suspicion leads to a delayed diagnosis, and avoidance after diagnosis is difficult owing to the lack of labeling requirements for textile finishes. Patch testing with the textile resins Fixapret AC and Fixapret CPN most often identified patients with textile allergies. We have prepared a hand-out to give patients more definitive recommendations.

A DIAGNOSIS OF ALLERGIC CONTACT DERMATITIS (ACD) must be strongly considered for patients who present with a chronic or recurrent rash. When the rash is in a clothing (or textile) distribution, it may be due to an allergy to dyes or formaldehyde resins used in the manufacture of the clothing. Generally, textile dermatitis conforms to a pattern that coincides with places on the skin where clothing may fit tightly. Common eruption sites include the posterior neck, upper back, lateral thorax (ie, anterior and posterior axillary folds, with sparing of the axillary vault), waistband, and flexor surfaces, with relative sparing of the undergarment areas (Fig 1). This pattern of textile-related ACD points out the importance of nonimmunologic factors such as pressure, friction, heat, and perspiration to the ultimate clinical response.¹ Although the face is usually spared in dermatitis caused by textile resins, patients who also react to formaldehyde-releasing preservatives may have involvement at any areas on which personal care products are used. In addition, there can be atypical presentations, such as forehead dermatitis induced by textile resins in baseball caps (Fig 2).

Formaldehyde is found in many settings and frequently in materials in which it is not suspected.² Formaldehyde resins are the substances used in today's textile industry to make clothing that is wrinkle resistant (eg, permanent-press clothing). These resins can release significant amounts of formaldehyde.³ Rayon, blended cotton, corduroy, wrinkle-resistant 100% cotton, and any synthetic blended polymer are likely to have been treated with such resins.⁴ Textile formaldehyde resins have been used on fabrics since the mid-1920s.⁵ Formaldehyde resins used in durable-press fabrics can be classified into high, medium, and low formaldehyde releasers.⁵⁻⁷ The textile resins now in use in the United States are listed in Table 1. Since 1961, dimethylol dihydroxyethyleneurea (DMDHEU), which is often blended with glycols, has been the most widely used permanent-press finish.⁸ However, several investigators feel that the use of this resin and older high formaldehyde releasers is decreasing.⁵

Many preservatives used in cosmetics, pharmaceuticals, and industrial biocides can also release formaldehyde.^{6,7} In Fowler's study, in addition to being allergic to the formaldehyde resins, 12 (70%) of his patients also were allergic to formaldehyde-releasing preservatives. Of these, quarternium-15 was the agent to which patients most reacted.⁶ Clinically, these reactions may be significant because formaldehyde preservatives are frequently used in skin care products and topical corticosteroid creams.^{6,7} Thus, ACD from formaldehyde can present with a variety of clinical pictures from several sources, which can be confusing to the practitioner.

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Figure 1. Eczematous rash involving both the posterior and anterior axillary folds. Note that the axillary vault is characteristically spared.

Testing with formaldehyde alone identifies only about 70% of patients who are allergic to the formaldehyde resins; therefore, it is necessary to patch-test with the resins as well. It is not clear which resin or allergen is best for screening for contact dermatitis from textile formaldehyde resin. Currently, six permanent-press finishes from Chemotechnique Diagnostics, Malmö, Sweden, are available for patch testing (Table 2). In 1992, Fowler and colleagues recommended that ethyleneurea/melamine formaldehyde mix in 10% petrolatum (Fixapret AC) be used to screen for ACD from permanent-press textiles as it clearly iden-



Figure 2. An atypical presentation of textile dermatitis from formaldehyde resins. This eczematous scaly rash occurred after the patient wore a baseball cap containing formaldehyde resins in the inner lining.

Table 1. Common Formaldehyde Resins

<i>Resin Type</i>	<i>Relative Formaldehyde Release*</i>
Urea formaldehyde/DMU	High
Melamine formaldehyde	High
DMDHEU (Fixapret CPN)	Low
DMDHEU blended or reacted with glycols (modified) (Fixapret ECO)	Very low
Dimethoxymethyl dihydroxyethylene urea (methylated DMDHEU)	Very low
Dimethyl dihydroxyethylene urea (Fixapret NF)	None

Adapted from Hatch KL, Maibach HI⁵; Fowler JF et al.⁶

DMDHEU = dimethylol dihydroxyethyleneurea; DMU = dimethylol urea.

*High signifies a formaldehyde release of > 1,000 ppm; low, a release of < 100 ppm; and very low, a release of < 30 ppm.⁵

tified 14 of their 17 patients.^{5,6} In 1998, Scheman and colleagues reported that testing with glycolated DMDHEU (modified, also known as Fixapret ECO) was better at detecting this allergy because all of their patients reacted to it, and this agent is the more widely used textile finish.⁹ These commercially available materials for patch testing change with and reflect the evolving marketplace.¹⁰ Reactions are often negative on the initial reading at 48 hours and may not develop until days 5 to 7.

Methodology

Patch tests were performed on 852 patients in the University Hospitals of Cleveland Environmental and Occupational Dermatitis Clinic from August 1999 to April 2004. We tabulated patch-test reactions to formaldehyde and to several of the formaldehyde textile resins supplied by

Table 2. Permanent-Press Finishes Used in Patch Tests for Textile-Related Allergic Contact Dermatitis*

Dimethylol dihydroxyethyleneurea 4.5% aqueous (Fixapret CPN)
Dimethyl dihydroxyethyleneurea 4.5% aqueous (Fixapret NF)
Dimethylol dihydroxyethyleneurea, modified 5% aqueous (Fixapret ECO)
Ethyleneurea/melamine formaldehyde 5% mix in petrolatum (Fixapret AC)
Urea formaldehyde 10% in petrolatum
Melamine formaldehyde 7% in petrolatum

Adapted from Fowler JF et al⁶; Scheman AJ et al⁹; Metzler-Brenckle L, Rietschel RL.¹⁰

*Finishes were supplied by Chemotechnique Diagnostics, Malmö, Sweden.

Chemotechnique Diagnostics. Antigens placed in Finn Chambers (Epitest Ltd Oy, Tuusula, Finland) on Scanpor tape (Norgesplaster A/S, Vennesla, Norway) were removed at 48 hours, and readings were taken on day 3 or 4 and on day 7 (for the first 250 patients, only a day 7 reading was done owing to logistic constraints). We contacted numerous textile manufacturers in an attempt to find those that use low-formaldehyde-releasing resins or no such resins in the finishing of their products, and we obtained a list of garment manufacturers that comply with the stricter Japanese standards for formaldehyde release from textile finishes. We included only those that agreed to be included in the study. Subsequently, we distributed our revised patient education materials to patients who were allergic to formaldehyde resins, and we have received preliminary feedback.

Results

As shown in Table 3, we grouped the + or greater reactions and the questionable reactions together because we believe the latter to be more clinically relevant than once thought. When patients with questionable reactions complied with the avoidance guidelines for formaldehyde resins in clothing, a significant proportion improved, which emphasized the relevance of questionable reactions. Overall, 7.2% of patients had positive reactions to formaldehyde 1% aqueous. Allergic reactions to formaldehyde were found in 28 (10.1%) of the men and 33 (5.7%) of the women. Of these reactions, 79.0% were + or greater, and 21.0% were questionable.

We also screened with ethyleneurea/melamine formaldehyde resin mix 5% in petrolatum (Fixapret AC, Chemotechnique). Seventeen patients had positive patch-test results, giving a total incidence of 2.0%. The incidence of a positive patch test to Fixapret AC was 1.4 % in the men and 2.3 % in the women tested. Three patients were allergic to Fixapret AC but not to formaldehyde, which again emphasizes the need to patch-test with the resins in addi-

tion to formaldehyde alone. Occupational data on several patients who tested positive to Fixapret AC are available. These patients included three male retirees, one female office worker, one female dialysis technician, and one female machinist.

Throughout this period, we also patch-tested patients for whom there was a high degree of clinical suspicion for textile dermatitis from several of the resins from the standard textile series obtained from Chemotechnique (see Table 2). Of our 60 tested patients, 6 (10%) had positive reactions to formaldehyde resins. Of these, 4 (66.7%) had questionably positive reactions to Fixapret CPN (Chemotechnique) yet reacted negatively to ethyleneurea/melamine formaldehyde mix. As a result of these findings, we added DMDHEU (Fixapret CPN) to our standard screening series. Of the 398 general contact dermatitis clinic patients screened to date, 2.3% have reacted to Fixapret CPN. The incidence of positive patch tests to Fixapret CPN was 2.9% in men and 1.9% in women.

In reviewing the data, we have seen a trend toward an increase in textile resin dermatitis, as shown by positive patch-test results over the last couple of years. This could be due to increased patch testing with textile resins. We observed that Fixapret CPN or Fixapret AC caused positive reactions most often, and the use of these together would detect most of our cases.

We were successful in locating several manufacturers that claim to use low-formaldehyde-releasing resins or no such resins in the finishing of their textiles, adhering to the stricter Japanese standard. These companies are listed in Table 4, which also includes Japanese manufacturers and several American companies that market in Japan, all of whose products may be safe for patients with formaldehyde sensitivity.

A textile finish handout was created for use in educating patients with sensitivity to formaldehyde textile resins at the University Hospital Dermatitis Clinic (Table 5). The handout was distributed to eight patients who tested positive to formaldehyde textile resins. Verbal feedback

Table 3. Patch-Test Results from August 1999 to April 2004

<i>Allergen Tested</i>	<i>Total No. of Patients Tested</i>		<i>No. of Patients Testing Positive</i>		
	<i>Women</i>	<i>Men</i>	<i>Women (%)</i>	<i>Men (%)</i>	<i>Total (%)</i>
Formaldehyde 1% aqueous	574	278	33 (5.7)	28 (10.1)	61 (7.2)
Ethyleneurea/melamine formaldehyde 5% pet (Fixapret AC)	574	278	13 (2.3)	4 (1.4)	17 (2)
DMDHEU 4.5% aqueous (Fixapret CPN)	260	138	5 (1.9)	4 (2.9)	9 (2.3)

DMDHEU = dimethylol dihydroxyethyleneurea; pet = petrolatum.

Table 4. Recommended Garment Manufacturers

<i>Companies That Market in Japan*</i>	<i>Companies That Claim to Adhere to Japanese Standard†</i>
Gap	Gap/Old Navy/Banana Republic
Talbots	Eddie Bauer
J. Crew	Liz Claiborne
Coromo, Inc. ¹⁸	Levi Strauss
	Avantall U.S.
	Vermont Country Store

*Companies that market their own clothing in Japan as listed on public reports filed by the Securities and Exchange Commission as of May 2004.

†Information obtained by contacting each company about their use of low-formaldehyde-releasing resins or no such resins in their textile finishing; this list is not necessarily comprehensive, and only companies that responded are included.

was received from three patients at a follow-up visit, and two patients sent written feedback. Two obstacles to compliance were identified as (1) frustration with labeling and (2) difficulty in avoiding formaldehyde resins in “dress” clothes. Two factors observed to be helpful were (1) having a list of suggested stores from which to purchase new clothes and (2) being able to telephone the clinic nurse with questions. Many questions revealed concerns over contact with fabrics in the home environment, including “craft fabrics” and those used in sheets, upholstered furniture, needlework floss, and knitting yarn. We have seen textile-allergic patients react to upholstered furniture and to fabrics used for crafts, and our handout was modified to include these materials. Also, questions regarding contact with starched or dry-cleaned clothes and about touching clothes while doing the family wash were common. Several patients were curious as to whether washing clothes many times would eventually eliminate formaldehyde and formaldehyde resins from the clothing. We have modified our handout to indicate that washing a new garment may reduce the levels of free formaldehyde but is not sufficient to prevent elicitation of a textile resin reaction in a previously sensitized patient. In addition, we have stated that starching, dry cleaning, and contact with family laundry should be safe. We deleted the statement that 100% cotton fabric that wrinkled easily was acceptable because many patients misconstrued this to mean that all 100% cotton fabrics were acceptable (see Table 5).

Discussion

The prevalence of textile formaldehyde resin dermatitis in the United States has previously been established as 1.2 to 2.3% of an eczematous population.^{5,6,11} The North

American Contact Dermatitis Group (NACDG) for 1998 to 2000 tested 50 allergens on more than 5,800 patients suspected of having contact dermatitis.¹² Results from tests with formaldehyde 1% aqueous were positive in 9.2% of patients, a percentage that has remained stable since the 1994-to-1996 data were collected.^{13,14} Our data show that 10% of men tested positively for formaldehyde but that only about 5% of women in our population were allergic to formaldehyde. Unfortunately, the NACDG data have no breakdown by gender, which would be interesting for comparison. The gender difference in our population may be explained by the large number of machinists in our area who are occupationally exposed to formaldehyde-releasing biocides in coolants. In the NACDG data, Fixapret AC was found to be reactive in 5% of those tested, down from 7.2% since the release of the 1996-to-1998 NACDG data.¹⁴ Sensitization to this screening mix in our population was lower, at around 2%.

Variation between medical centers in regard to the incidence of textile dermatitis and to the results of patch tests with textile resins may result from several factors. Variation may occur owing to differences in climate as humidity and perspiration may cause more resin to leach from garments. Also, clinics vary in their timing of patch-test readings. For instance, the relatively late readings in our clinic may have enhanced the detection of very-late-reacting antigens. Additionally, this may decrease the sensitivity for antigens that react early (days 2 to 3) and are subsequently lost early. The reactivity of different formaldehyde resins may peak at different times so that results will vary depending on when one reads the results.

The above data depict a greater percentage of men than women having positive patch-test results from formaldehyde as well as from some of the textile resins. Historically, women have tended to be afflicted with textile dermatitis more often than men¹; estimates have ranged from 3:1 to 5:1, favoring women.^{15,16} It was thought that the tighter fit of women's clothing to skin when compared to men's clothing was a possible explanation.¹ Our data show that this trend may now be reversing, approximating a ratio of 1:1. In 1992, Fowler and colleagues' study group consisted of 9 women and 8 men with positive test reactions to formaldehyde resins.⁶ Our data, which include a total of 852 patients, show an incidence rate of 10% in men for formaldehyde allergy alone and show that a greater percentage of men than women react to several of the formaldehyde resins. The higher incidence of formaldehyde allergy in men in our population may influence the number of men who also cross-react to formaldehyde-related textile finishes.

The automotive industry is the backbone of the regional economy for our patient population, and many retired men in this region have had occupational exposure to

Table 5. Educational Handout for Patients with Textile Finish/Formaldehyde Resin Allergic Contact Dermatitis

University Hospitals

Health System

University Hospitals of Cleveland

For **Textile Finish/Formaldehyde Resin Allergic Dermatitis**, it is recommended:

1. **WEAR** clothes with labels that say:
 - 100% silk
 - 100% linen (if it wrinkles easily)
 - 100% polyester
 - 100% acrylic
 - 100% nylon
 - spandex
 - flannel (if soft)
 - denim (jeans)
 - wool (may cause irritation)
2. **DO NOT WEAR** clothes with labels that say:
 - Permanent press
 - Wrinkle resistant
 - Color-fast
 - Stain-resistant
 - "Blends" (including rayon, polyester-cotton)
 - corduroy or shrink-proof wool
3. It may be helpful to remember this:
 - Soft, easily wrinkled fabrics = SAFE**
 - Heavy, stiff fabrics = UNSAFE**
4. Things that cause rubbing, pressure or sweating could cause your condition to flare. So, **loose fitting** clothes are helpful and you may be able to tolerate more kinds of fabrics in **cooler temperatures** than you can in higher temperatures (in the summer).
5. Start by **READING THE LABELS IN YOUR CLOSET**. Put to one side all the clothes that are safe to wear. **See #1 above**. Wear only these clothes for one month.
6. If you need to buy new clothes, remember that **clothing made in Japan may be the safest choice for imported textiles**. Japan enforces the strictest standards for formaldehyde release from the textile finishes. Also, the companies that market in or out of Japan meet acceptable standards and are generally safe.

Table 5. (continued)

7. Clothing made by GAP, OLD NAVY, BANANA REPUBLIC, LIZ CLAIBORNE, EDDIE BAUER, CUDDL DUDS, and LEVI STRAUSS is recommended. Also, products from VERMONT COUNTRY STORE and AVANTAL U.S. claim to use very low amounts of formaldehyde resins in finishing their textiles (amounts below the U.S. industry standard).
8. Do note that washing clothing will not significantly reduce the levels of formaldehyde resins in your clothing necessary for an allergic reaction. Use of dry cleaning fluids and spray starch are okay. Washing your family's clothes is okay if you do not develop fingertip dermatitis.
9. If exposure to formaldehyde resins in your clothes cannot be avoided, then you may consider wearing undergarments to protect your skin. Silk is an acceptable choice for an undergarment.
10. If you have been told that you are also allergic to **formaldehyde preservatives**, you also need to check your personal care products such as cosmetic creams, medication, nail products and shampoo. The Contact Allergen Replacement Database (CARD) printout provided by your doctor can be your shopping list for products that do not contain the allergens.
11. You may also come in contact with fabrics containing formaldehyde in other than clothes, such as bed sheets, upholstered furniture and craft fabrics. Use of knitting yarns and needlework floss is acceptable.
12. Keep in mind that you **MUST AVOID FORMALDEHYDE RESINS AT ALL TIMES**. Even exposure once a month would be enough to cause a rash to continue. "Dress clothes" only worn on weekends is enough to maintain your dermatitis.
13. Also, realize that since you have had an allergic reaction, now even low levels of formaldehyde may be enough to cause flares. Try to add only one new product per week. If you have a flare after a new product, **STOP FOR 3 WEEKS** until clear.
14. Remember this is a difficult process. **Be patient and call with questions**.

formaldehyde released from biocides. Thirty-eight of the 198 patients for whom we listed occupational data in our database were retired. More retired men than women had positive reactions to the formaldehyde textile resins. This included 3 of the 18 retired men who reacted positively to formaldehyde, and all three of these men were sensitive to at least one formaldehyde resin. Of the 20 retired women,

none were found to have positive reactions to formaldehyde or formaldehyde resin on patch testing. However, 2 of the 3 textile-allergic women—one a dialysis technician, the other a machinist—for whom we have occupational data also had opportunities for occupational sensitization to formaldehyde in the forms of disinfectant for dialysis tubing and biocide, respectively. The dialysis technician was exposed and sensitized while working and then reacted positively to formaldehyde resins in her laboratory coat. The machinist who tested positive was one of only six female machinists in our database. We speculate that many patients who are allergic to textile resins are originally sensitized to formaldehyde and then cross-react with the textile resin finishes later in life.

Success in the treatment of ACD lies in identifying its cause correctly and educating the patient about avoidance of the allergen. Patients who are allergic to formaldehyde may also cross-react with formaldehyde-releasing preservatives such as quaternium-15. With certain allergens (eg, vehicles and preservatives) found in topical preparations, it is important to impress upon patients the need to read labels. The Contact Allergen Replacement Database (CARD) may be helpful in finding products that are free of these formaldehyde-releasing preservatives.¹⁷

Formaldehyde can also be released from the formaldehyde-releasing resins used to make stain- and wrinkle-resistant clothing. Table 4 lists manufacturers we located who claim to use low-formaldehyde-releasing resins or no such resins, as well as manufacturers who market in Japan. A low-formaldehyde-releasing resin is one that releases 75 ppm. (This is also the Japanese standard for textile finishes, as opposed to 300 ppm in the United States).¹ This information was collected by contacting industries and inquiring about the use of formaldehyde resins in their textiles. Only manufacturers who replied and wished to be included in this study are listed. These newer resin-yielding fabrics that claim to contain fewer than 75 ppm free formaldehyde may cause occasional reactions but are more likely to be tolerated by patients with textile dermatitis.⁹

Although some US manufacturers are using newer low-formaldehyde or “no formaldehyde” finishes, the amount of clothing being imported is increasing, and we are unaware of the details of these overseas manufacturers’ finishing techniques (ie, the amount of formaldehyde used).⁵ In 2001, a comprehensive database containing information about Japanese textiles and their manufacturers was opened to individuals seeking Japanese clothing. This company (Coromo, Inc., Tokyo, Japan) provides an international gateway to Japan’s fashion world and may

be helpful to physicians in periodically updating information about companies that market in Japan.¹⁸ Japan enforces the strictest standards for formaldehyde release from textile finishes. Also, the companies that market in or out of Japan meet acceptable standards, and their products are generally safe (see Table 4).¹⁹

There are also those 30% of patients who have negative patch-test results for formaldehyde but positive results for the formaldehyde resins. It is believed that these patients are not reacting to the formaldehyde released by the resins but rather are reacting to the resins themselves. Thus, we recommend testing persons suspected of textile allergy with the formaldehyde resins Fixapret AC and Fixapret CPN.

The lack of clear labeling on clothing contributes to the difficulty in avoiding formaldehyde resins. The care symbols, conceived by the American Society for Testing and Materials, were instituted to make laundry care easier. Interestingly, a permanent-press symbol in the shape of a bucket with one line underneath exists; however, there is no standardization for its usage (J. Pullen, E-mail communication, February 12, 2004). In other words, manufacturers may recommend this wash cycle for apparel that does not have a “permanent-press” finish because it will reduce the formation of wrinkles. Thus, patients with formaldehyde-related textile dermatitis are unable to make use of these laundry care symbols with certainty when selecting which clothing to purchase.

Unfortunately for patients and physicians, the allergenic component of many materials are rarely labeled. The lack of labeling on textile fabrics is a major contributor to the difficulty of avoiding allergens. CARD is not helpful in regard to clothing. Recommendations regarding the avoidance of specific textiles and textile resins were spelled out in the patient handout (see Table 5). Counseling and encouragement are especially helpful at this stage.

Conclusions

Patch testing with formaldehyde is a fair marker for textile resins, and positive results in a patient with rash in a textile distribution should raise suspicion and prompt further textile resin testing. This is especially true if the dermatitis in areas of textile contact does not resolve following the avoidance of formaldehyde releasers in personal care products. It is important to understand that although patch-test reactions to these resins may be weak and late, they are clinically significant. Patch testing with Fixapret AC and Fixapret CPN most often detected textile allergies. Educating patients about textile-related dermatitis is

difficult, and the lack of clear labeling on clothing adds to the problem. Generally speaking, clothing from companies that market from Japan is safe. Our data suggest that individuals who may have been occupationally sensitized in the past are now cross-reacting to the textile resins. We believe the gender gap has closed significantly and that men now react to the textile finishes on patch testing with a frequency at least equal to that of women.

Allergic contact dermatitis from textile resins is greatly underdiagnosed. However, with a higher index of suspicion clinically and proper patch testing, more patients with this condition can be identified. Proper treatment, along with patient education and follow-up support, can improve the lives of those suffering with this condition.

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