

## Patch testing for permanent-press allergic contact dermatitis

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During the decade of the 90s, 24 cases of permanent-press textile-resin contact dermatitis were identified. The most common allergen associated with these cases was dimethylol propylene urea (DMPU). Although previous reports had suggested ethylene urea melamine formaldehyde resin (EUMF) or dimethylol dihydroxy ethylene urea (DMDHEU) as the most appropriate test materials for this type of contact dermatitis, we could not confirm EUMF as appropriate but, with some limitations, can support DMDHEU due to its widespread and continued use. DMPU has been withdrawn from the marketplace and replaced with what may be less reactive materials. In this study, we also observed discordance between EUMF patch tests in the range of 30%, which is consistent with previous reports about the biovariability of patch test results.

*Key words:* dimethylol propylene urea; ethylene urea melamine formaldehyde; permanent press; clothing resins; textile resins; allergic contact dermatitis. © Munksgaard, 2002.

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The diagnosis of allergic contact dermatitis due to a textile permanent-press finish is suspected on the basis of a distribution compatible with articles of clothing and supported by a positive patch test. The distribution of the eruption may be increased in areas of moisture or friction or decreased in areas protected by undergarments. An eruption surrounding the axilla but sparing the axillary vault is frequently a clue. But what should be used for the supporting patch test? Formaldehyde was in favor in the 60s and 70s based on reports such as that of Hovding, who found 5000 to 12000 ppm of formaldehyde in rayon and cotton fabrics (1). Schorr et al. (2) also found formaldehyde to be a problem in American clothing. It might seem reasonable to patch test the suspected fabric directly, but such tests are usually negative even when the patient is patch test positive to formaldehyde and the fabric can be shown to contain formaldehyde (3, 4).

Resins used to render clothing wrinkle-resistant are of 2 broad classes: urea-formaldehyde or melamine-formaldehyde and cyclized urea derivatives (5). The latter group of chemicals are the most frequently used. But the industry is constantly evolving. 2 reports of epidemics of permanent-press-related contact dermatitis caused by sheets rather than clothing illustrated that the problem is not

really formaldehyde but the resins. Sheets were marketed that had been treated with a cyclized urea resin which was shown to be the allergen, and none of the patients was found to be formaldehyde sensitive in either the Canadian or London reports (6–8). In some of these cases the fabric did produce a positive patch test.

In 1992, Fowler et al. (9) recommended that ethylene urea melamine formaldehyde resin be used to screen for permanent-press textile allergic contact dermatitis. In 1998, Scheman et al. (10) reported that glycolated dimethylol dihydroxy ethylene urea (DMDHEU) was better at detecting this allergy and was the more widely used textile finish. Furthermore, the formaldehyde content of textiles had been reduced to a level (generally less than 75 ppm) that was unlikely to elicit contact dermatitis (10). Our results over this time period reflect a slightly different pattern of reactivity and may lend support to the argument that the industry is moving away from problematic textile resins.

During the decade of the 1990s 6 permanent-press finishes were available for patch testing patients suspected of having textile-related allergic contact dermatitis. These compounds were manufactured by BASF Corporation (Charlotte, NC) and were available from Chemotechnique Diagnostics (Malmö, Sweden) and their North Ameri-

can distributor Dormer Laboratories Inc. (Rexdale, Ontario, Canada) (Table 1).

The commercially available textile finishes have changed, and the currently available patch test materials reflect the evolving marketplace. The textile permanent-press finishes available from Chemotechnique Diagnostics presently include those seen in Table 2.

This report details our experience with the compounds in Table 1 during the 90s, and the data show that the 2 substances that detected the greatest number of cases of textile contact dermatitis are the 2 that have since been replaced. BASF technical data on these finishes available from their website state that the formaldehyde content of these finishes is less than 75 ppm. Fixapret NF is said to be free of formaldehyde. It is possible that these changes may reduce the frequency with which permanent-press contact dermatitis is seen.

### Materials and Methods

From 1994 through 1999, patients with histories and physical examinations consistent with textile permanent-press finish allergies were tested by 1 author (RLR). The North American Contact Dermatitis Group (NACDG) screening series containing formaldehyde and EUMF was used, as well as the Chemotechnique Diagnostics textile and dye series containing 6 supplemental formaldehyde-re-

lated resins: dimethylol dihydroxy ethylene urea (4.5% aq.) (DMDHEU), dimethylol propylene urea (5% aq.) (DMPU), tetramethylol acetylenediurea (5% aq.) (TMA), ethylene urea melamine formaldehyde resin (5% pet.) (EUMF) also used in the NACDG series, urea formaldehyde (10% pet.) (UF), and melamine formaldehyde (7% pet.) (MF). Before 1995 EUMF was not used as a screening allergen by the NACDG.

The criteria for inclusion in this study were (i) positive test reactions to at least 2 of the 6 formaldehyde-related resin allergens in the Chemotechnique series and (ii) a history and physical findings compatible with textile resin contact dermatitis. A wardrobe will consist of many different kinds of textiles with different resin finishes. It will not be possible to test all garments, and the preponderance of the literature does not support the notion that such testing can reliably identify the cause of contact dermatitis when permanent-press finishes are the suspected source. A positive patch test to a resin, accompanied by a pattern of dermatitis consistent with a clothing distribution, would be the usual method of making a diagnosis. If the resin is one rarely used on the predominant type of clothing worn, the likelihood of an accurate diagnosis is diminished. If several resins produce a positive patch test, the likelihood that garments containing such resins are present in the patient's wardrobe would increase and the accuracy of the diagnosis would rise. For this report, for a case to be included we required at least 2 positive permanent-press patch tests as well as a clinical picture consistent with textile dermatitis. Patients with allergic reactions to textile dyes were excluded from this study. 2 days after the allergens were applied using Finn Chambers on Scanpor tape, they were removed and the reactions read, and the reactions were read again after an additional 2 days. The higher or stronger of the 2 reaction readings was listed for each allergen reaction. A test reaction was considered positive when it fulfilled the NACDG criteria for a +1 reaction or greater. A doubtful reaction (macular erythema alone), labeled " $\pm$ ", was not considered a positive reaction for the purpose of diagnosing textile resin allergy. Positive test reactions were rated as +1, +2, +3, according to NACDG guidelines (11).

To calculate discordance between the 2 identical EUMF patch tests, for each individual patient 1 result had to be definitely positive and the other result clearly nonreactive. Accordingly, in this particular calculation, the doubtful ( $\pm$ ) readings were not considered negative reactions, as these reactions differ in intensity rather than absolute discordance.

Our standards for calculating the sensitivity of

*Table 1.* Permanent-press finishes available from Chemotechnique Diagnostics for patch testing for textile-related allergic contact dermatitis in the 1990s

| Compound                                    | BASF name    |
|---------------------------------------------|--------------|
| dimethylol dihydroxy ethylene urea (DMDHEU) | Fixapret CPN |
| dimethylol propylene urea (DMPU)            | Fixapret PH  |
| tetramethylol acetylenediurea (TMA)         | Fixapret 140 |
| ethylene urea melamine formaldehyde (EUMF)  | Fixapret Ac  |
| urea formaldehyde (UF)                      | Kaurit S     |
| melamine formaldehyde (MF)                  | Kaurit M70   |

*Table 2.* Permanent-press finishes currently available from Chemotechnique Diagnostics for patch testing for textile-related contact dermatitis

| Compound                                     | BASF name    |
|----------------------------------------------|--------------|
| dimethylol dihydroxy ethylene urea (DMDHEU)  | Fixapret CPN |
| dimethyl dihydroxy ethylene urea             | Fixapret NF  |
| dimethylol dihydroxy ethylene urea, modified | Fixapret ECO |
| ethylene urea melamine formaldehyde (EUMF)   | Fixapret Ac  |
| urea formaldehyde (UF)                       | Kaurit S     |
| melamine formaldehyde (MF)                   | Kaurit M70   |

the diagnostic screening allergens are the same gold standards used to define a true-positive reaction and a true-positive test result. Namely, a true-positive reaction fulfills the NACDG criteria for a +1 reaction or greater, and a true textile resin allergy is defined as a positive reaction to at least 2 of the 6 formaldehyde-related resins of the Chemotechnique series. For our study, the sensitivity of the screening allergen test is the probability (%) that those patients having a true textile resin allergy will test positive for it.

### Results

Of the 188 patients tested with suspected textile allergic contact dermatitis, 35 had a positive test reaction to at least 1 of the permanent press allergens, and 24 of these patients met the criterion for at least 2 positive test results to 2 of the 6 Chemotechnique textile series. As seen in Table 3, the allergen DMPU was clearly the best screening agent, producing 23 of 24 positive test reactions and 1 doubtful reaction with a sensitivity of 96%. For both TMA and the NACDG screening allergen EUMF, the sample size was 23 since 1 patient was not tested for TMA and 1 patient was tested

before 1995, when EUMF was not an NACDG screening allergen. For the purposes of these calculations, doubtful reactions were considered negative tests.

The sensitivities of the allergens are also shown in Table 3. The least effective screening agent in our study was EUMF, with the NACDG screening resin testing positive in only 11 of 23 patients (sensitivity 48%) and the Chemotechnique series EUMF resin testing positive in only 11 of 24 patients (sensitivity 46%), and not the same 11 patients. This EUMF result does not agree with previously reported results (1). However, the NACDG screening EUMF resin allergen showed the largest number of severe positive reactions, with 3 of 23 reactions being +3.

Textile-allergic patients frequently have multiple resin reactions. Reactions to the 6 supplemental textile allergens showed that 3 patients were positive to 2 of 6 allergens, 5 patients to 3 of 6 allergens, 4 patients to both 4 of 6 and 5 of 6 allergens, and a full 1/3 of all patients positive to all 6 of the 6 supplemental allergens (8 of 24 patients).

Of the 24 patients, 8 (33%) had no reaction to the NACDG screening allergen formaldehyde. The number of patients who are textile resin sensitive

Table 3. Textile resin reaction data

| Patient #                     | Study year | Age (years) | Sex | NACDG screen formaldehyde (n=24) | NACDG screen EUMF (n=23) | DMDHEU (n=24) | DMPU (n=24) | TMA (n=23) | Chemo-technique EUMF (n=24) | UF (n=24) | MF (n=24) |
|-------------------------------|------------|-------------|-----|----------------------------------|--------------------------|---------------|-------------|------------|-----------------------------|-----------|-----------|
| 1                             | 1994       | 52          | M   | —                                | NT                       | +2            | +2          | +2         | —                           | +1        | +2        |
| 2                             | 1995       | 68          | F   | +2                               | +2                       | +1            | +1          | +1         | +1                          | +1        | +2        |
| 3                             | 1996       | 60          | M   | +2                               | +3                       | +1            | +2          | +2         | +2                          | +3        | +2        |
| 4                             | 1996       | 59          | F   | +2                               | +1                       | (±)           | +1          | +1         | —                           | —         | —         |
| 5                             | 1996       | 83          | M   | +2                               | +1                       | +1            | +1          | +1         | +1                          | +2        | +1        |
| 6                             | 1997       | 26          | F   | (±)                              | (±)                      | (±)           | +1          | NT         | +1                          | +1        | +1        |
| 7                             | 1997       | 43          | F   | —                                | +1                       | +2            | +2          | +2         | (±)                         | +2        | +2        |
| 8                             | 1998       | 50          | M   | —                                | —                        | (±)           | (±)         | —          | +1                          | +1        | —         |
| 9                             | 1998       | 55          | F   | +1                               | —                        | +1            | +1          | +1         | —                           | —         | (±)       |
| 10                            | 1998       | 59          | M   | +2                               | —                        | +1            | +2          | +2         | —                           | —         | —         |
| 11                            | 1998       | 81          | M   | —                                | —                        | +1            | +1          | +1         | —                           | —         | —         |
| 12                            | 1999       | 63          | F   | +2                               | +3                       | +1            | +2          | +2         | +1                          | +1        | +2        |
| 13                            | 1999       | 49          | M   | +2                               | +3                       | +1            | +3          | +3         | +2                          | +2        | +3        |
| 14                            | 1999       | 54          | M   | +1                               | —                        | +1            | +2          | +2         | +1                          | +2        | +2        |
| 15                            | 1999       | 47          | M   | —                                | —                        | +1            | +1          | +1         | +1                          | +1        | +1        |
| 16                            | 1999       | 69          | M   | +2                               | +2                       | +1            | +2          | +2         | (±)                         | +1        | +1        |
| 17                            | 1999       | 52          | M   | +3                               | +2                       | (±)           | +2          | +2         | —                           | +2        | +1        |
| 18                            | 2000       | 54          | M   | +2                               | —                        | —             | +2          | +2         | —                           | (±)       | +2        |
| 19                            | 2000       | 31          | F   | —                                | —                        | (±)           | +1          | —          | +1                          | —         | —         |
| 20                            | 2000       | 47          | F   | +2                               | +1                       | +1            | +1          | +2         | —                           | —         | +1        |
| 21                            | 2000       | 41          | F   | +1                               | (±)                      | +2            | +2          | +2         | (±)                         | +2        | +2        |
| 22                            | 2000       | 50          | F   | —                                | —                        | —             | +1          | +1         | —                           | +1        | +1        |
| 23                            | 2000       | 79          | F   | +2                               | +2                       | +1            | +2          | +2         | +2                          | +2        | +1        |
| 24                            | 2000       | 66          | F   | +2                               | —                        | (±)           | +2          | +1         | —                           | (±)       | (+1)      |
| total # of positive reactions |            |             |     | 16                               | 11                       | 16            | 23          | 21         | 11                          | 16        | 18        |
| sensitivity                   |            |             |     | 0.67                             | 0.48                     | 0.67          | 0.96        | 0.91       | 0.46                        | 0.67      | 0.75      |

NACDG: North American Contact Dermatitis Group; EUMF: ethylene urea melamine formaldehyde resin; TMA: tetramethylol acetylenediurea; NT: not tested; (±): doubtful reaction; DMDHEU: dimethylol dihydroxy ethylene urea; DMPU: dimethylol propylene urea; UF: urea formaldehyde; MF: melamine formaldehyde.

with missed reactions to the NACDG screening allergen EUMF was high; 12 of 23 (52%) were nonreactive. The number of patients nonreactive to both allergens of the NACDG screening panel of formaldehyde and EUMF was 6 of 23 or 26% missed reactions. The number of patients, however, with missed reactions to both formaldehyde and DMPU was only 1 of 24 or only 4% of missed reactions. If we had considered doubtful reactions as positive for diagnostic purposes, 24 of 24 patients tested would have been positive to DMPU. Likewise, if the doubtful reactions were considered positive tests, the DMDHEU allergen would have picked up 22 of 24 cases, which is close to the observations of Scheman et al. (2). The calculated discordance between the 2 EUMF allergens (concomitant testing) was 7 of 23 (30%), consistent with previous reports of simultaneous patch tests (12).

### Discussion

Since 1/3 of the patients who do have textile-resin sensitivity had no reaction to formaldehyde, formaldehyde is an inadequate test for the identification of textile resin allergy. Furthermore, formaldehyde-related materials are commonly used in skin care products, and a reaction may relate to those exposures rather than textiles.

Both EUMF resin allergens failed to identify at least 1/2 of the patients with textile resin allergy, showing EUMF to be even more inadequate to detect textile-resin allergic contact dermatitis. This is consistent with the findings of Scheman et al. (10).

Our results indicate that DMPU is clearly the best single screening agent for permanent-press fabric sensitivity. This allergen missed only 4% of the study patients who have textile-resin allergy. The current screening series of formaldehyde and EUMF misses 26% of patients who are actually permanent-press fabric sensitive, and this % is heightened by the greater number of formaldehyde-positive reactions (18 of 24) versus EUMF-positive reactions (only 11 of 23). However, DMPU is no longer available from Chemotechnique and is no longer used in the industry. Our 2nd best allergen based on sensitivity was TMA, which is also no longer in use or available for patch testing. The allergen DMDHEU was recommended by Scheman et al. (10) as it is the most commonly used resin and all their patients were positive to it. Using the strict criteria that doubtful reactions should be considered as negative, this allergen had a sensitivity of 0.67, but if doubtful reactions were considered as positive results, then DMDHEU would have a sensitivity of 0.91 in our series, and it would be the best of the available

options still in commercial use for the detection of permanent-press allergy. As the difference between a doubtful and +1 reaction can be as little as the difference between macular and palpable erythema, it may be unreasonable to make too much of this issue.

A previous study of textile allergic contact dermatitis, from 1990 to 1998, also found that DMPU resin elicited the greatest number of allergic reactions and that DMDHEU resin produced the 2nd largest number of positive reactions, and suggested that DMPU and DMDHEU may be a sufficient screening series for suspected textile-finish allergy (13).

This study provided an opportunity to make an additional observation unrelated to textile contact dermatitis. The EUMF patch test that is included in the NACDG series is the same allergen from the same supplier as found in the Chemotechnique textile and dye series. This built-in redundancy allowed us to comment on patch test concordance. In a perfect world the reactions would always be the same, or at least nearly so, but this is not the case in diagnostic patch testing. Prior patch test studies have addressed paired patch tests and the frequency of identical versus discordant results (12). A range of 8% to 44% discordance has been reported (14). A study of identical patch tests using several different companies' allergens found nonreproducibility or discordance of 17.9% for allergens from Pharmacia AB, Uppsala, Sweden; 18.5% for allergens from Hermal, Reinbeck, Germany; and 29.4% for allergens from Maser, Herne, Germany (15). These differences were not statistically significant. The discordance for the paired EUMF tests was 30% in our data, which is within the range of the previous reports. While the EUMF tests each identified 11 individuals as positive, they were not the same 11. The 2 tests gave a negative reading at one site and a positive reading at the other site in 7 of 23 cases (30%). This represents a fundamental biological variable in the patch test procedure that at present has not been overcome (16).

In our study, the NACDG screening series EUMF resin produced the most number of severe (+3) reactions (3 of 23) to an allergen with the least number of positive reactions (11 of 23). In contrast, the Chemotechnique series EUMF resin, although identical, produced no +3 reactions. The 3 patients exhibiting +3 reactions to the NACDG series EUMF resin did, however, all produce positive reactions to the other EUMF textile series allergen (two +2 reactions and one +1 reaction).

The removal from the marketplace of the 2 finishes that produced the greatest number of clear-cut allergic reactions provides some degree of opti-

mism that the industry is moving away from problematic resins. It is not yet clear whether the newer materials will prove safer, but the results of Scheman et al. (10) indicate that only about 1/5 of patients sensitive to the resins in Table 1 react to the resins in Table 2. Longitudinal studies of the newer resins will be necessary to determine if this optimism is warranted.

### References

1. Hovding G. Free formaldehyde in textiles. *Acta Dermatovenereologica* 1959; 39: 357.
2. Schorr W F, Keran E, Plotka E. Formaldehyde allergy. The quantitative analysis of American clothing for free formaldehyde and its relevance in clinical practice. *Arch Dermatol* 1974; 110: 73–76.
3. Berrens L, Young E, Jansen L H. Free formaldehyde in textiles in relation to formalin contact sensitivity. *Br J Dermatol* 1964; 76: 110–115.
4. Fisher A A, Kanof N B, Biondi E M. Free formaldehyde in textiles and paper. Clinical significance. *Arch Dermatol* 1962; 86: 97.
5. Foussereau J. Clothing. In: Rycroft R J G, Menné T, Frosch P J, Benezra C (eds): *Textbook of contact dermatitis*. Berlin: Springer-Verlag, 1992: 506.
6. Panaccio F, Montgomery D C, Adam J E. Follicular contact dermatitis due to coloured permanent-pressed sheets. *Can Med Assoc J* 1973; 109: 23–26.
7. Wilkinson R D. Sheet dermatitis *Can Med Assoc J* 1973; 109: 14.
8. Rycroft R J G, Cronin E, Calnan C D. Canadian sheet dermatitis. *Br Med J* 1976; 2 (6045): 1175.
9. Fowler J F Jr, Skinner S M, Belsito D V. Allergic contact dermatitis from formaldehyde resins in permanent press clothing: an underdiagnosed cause of generalized dermatitis. *J Am Acad Dermatol* 1992; 27: 962–968.
10. Scheman A J, Carroll P A, Brown K H, Osburn A H. Formaldehyde-related textile allergy: an update. *Contact Dermatitis* 1998; 38: 332–336.
11. Rietschel R L, Fowler J F Jr. *Fisher's Contact dermatitis*. 4th edition. Baltimore, MD: Williams & Wilkins, 1995: 29.
12. Gollhausen R, Przybilla B, Ring J. Reproducibility of patch tests. *J Am Acad Dermatol* 1989; 21: 1196–1202.
13. Rietschel R L. Experience with supplemental allergens in the diagnosis of contact dermatitis. *Contact Dermatitis* 2000; 65: 27–30.
14. Bourke J F, Batta K, Prais L, Abdullah A, Foulds I S. The reproducibility of patch tests. *Br J Dermatol* 1999; 140: 102–105.
15. Gollhausen R, Przybilla B, Ring J. Reproducibility of patch test results: comparison of TRUE Test and Finn Chamber test results. *J Am Acad Dermatol* 1989; 21 (4 Pt 2): 843–846.
16. Brasch J, Henseler T, Aberer W, Henseler T, Aberer W, Bäumler G, Frosch P J, Fuchs T, Fünfstück V, Kaiser G, Lischka G G, Pilz B, Sauer C, Schaller J, Scheuer B, Szliska C. Reproducibility of patch tests. A multicenter study of synchronous left- versus right-sided patch tests by the German Contact Dermatitis Research Group. *J Am Acad Dermatol* 1994; 31: 584–591.

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