

## ORIGINAL ARTICLE

# Trends in patch-test results and allergen changes in the standard series: A Mayo Clinic 5-year retrospective review (January 1, 2006, to December 31, 2010)

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**Background:** Patch testing is essential for identification of culprits causing allergic contact dermatitis.

**Objective:** We sought to identify trends and allergen changes in our standard series during 2006 to 2010, compared with our previous report (2001-2005).

**Methods:** We conducted a retrospective review of patch-test results.

**Results:** A total of 3115 patients were tested with a mean of 73.0 allergens. Since our prior report, 8 allergens were added to the standard series; 14 were deleted. Significantly higher rates of allergic positive reaction were documented for carba mix, 3%, and Disperse Orange 3, 1%. Rates were lower for 10 allergens: neomycin sulfate, 20%; gold sodium thiosulfate, 0.5%; hexahydro-1,3,5-tris(2-hydroxyethyl) triazine, 1%; disperse blue 124, 1%; disperse blue 106, 1%; diazolidinyl urea, 1%; hexylresorcinol, 0.25%; diazolidinyl urea, 1% aqueous; 2-bromo-2-nitropropane-1,3-diol, 0.25%; and lidocaine, 5%. Many final patch-test readings for many allergens were categorized as mild reactions (erythema only). Overall allergenicity and irritancy rates declined significantly since our prior report. Results were generally comparable with those in a North American Contact Dermatitis Group report from 2005 to 2006.

**Limitations:** This was a retrospective study; there is a lack of long-term follow-up.

**Conclusions:** Since our previous report, our standard series composition has changed, and overall rates of allergenicity and irritancy have decreased. Notably, many final patch-test readings showed mild reactions. (J Am Acad Dermatol 10.1016/j.jaad.2013.09.047.)

**Key words:** allergens/diagnostic use; allergic contact/diagnosis; allergic contact/etiology; dermatitis; patch tests/methods; retrospective studies.

Allergic contact dermatitis (ACD) represents a common reason for presentation to dermatologists.<sup>1</sup> Patients suspected of having ACD often demonstrate pruritic, well-defined, eczema-like dermatitis, which may feature vesicles and bullae in acute forms and lichenification in

## Abbreviations used:

|        |                                         |
|--------|-----------------------------------------|
| ACD:   | allergic contact dermatitis             |
| MCCDG: | Mayo Clinic Contact Dermatitis Group    |
| NACDG: | North American Contact Dermatitis Group |

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chronic cases.<sup>2</sup> Patch testing is used to confirm ACD and detect allergens producing contact sensitivity.<sup>3,4</sup>

The standard series of allergens contains the most frequent sources of ACD.<sup>2</sup> Additional series specific for a patient's exposure history may be added during testing.<sup>5</sup> Generally speaking, allergens in the standard series cause positive reactions at a rate greater than 0.5% to 1.0% during patch testing<sup>6</sup> or are those to which patients have frequent exposure.<sup>7</sup> Allergens are added or deleted depending on current trends in allergenicity,<sup>8</sup> leading to series variation within institutions over time. Series also differ among patch-test groups.<sup>5</sup> The European standard series consists of 26 allergens,<sup>9,10</sup> whereas a larger series of 65 allergens is administered by the North American Contact Dermatitis Group (NACDG), which systematically collects data from patch-test clinics across the United States and Canada.<sup>8</sup>

Along with other groups,<sup>4,5,7,11</sup> NACDG regularly publishes patch-test results<sup>8,12-15</sup> to facilitate identification of trends and comparison with other institutions. Sharing results permits communication of developments and variation among institutions, providing useful information for practitioners who perform patch testing.

Herein, we provide an update of our group's prior report<sup>5</sup> spanning 2001 through 2005 by presenting results for the 5-year period between January 1, 2006, and December 31, 2010. These findings are compared with those of the previous period and with those for 2005 through 2006 from NACDG.<sup>8</sup> Changes in composition of the standard series at Mayo Clinic are noted. Our methods of patch testing are also described.

## METHODS

### Patients

After approval from the Mayo Clinic Institutional Review Board, data were collected from an electronic patch-test database containing demographic information and results from all patients tested from January 1, 2006, through December 31, 2010. Records of patients who did not approve the use of their data for medical research were excluded.

### Patch-test result interpretation

Patch testing was performed as described in previous reports<sup>5,7</sup> and in accordance with NACDG

practices.<sup>8,12-15</sup> Patients were not tested if they had recently administered topical corticosteroids to patch-test sites (our guideline is that patients discontinue such use 1 week before testing); were taking immunosuppressive medications (our guideline is that patients discontinue use 1 month before testing); had tanned skin from sun or tanning bed

exposure 1 week before testing; or had any health condition that might affect evaluation of reactivity. Testing used Finn Chamber (Epitest Ltd Oy, Tuusula, Finland) on Scanpor tape (Norgesplaster Aksjeselskap, Vennesia, Norway). Allergens were acquired from Chemotechnique Diagnostics AB (Vellinge, Sweden) and allergEAZE by SmartPractice Canada (Calgary, Alberta, Canada),

or compounding was requested from the Mayo Clinic pharmacy. Patches were placed on the upper aspect of the back and removed 48 hours later. Reactions were read first at 48 to 72 hours after application and again at 96 to 168 hours. Final reading, result interpretation, and relevancy judgment were conducted by the ordering physician.

Reactions were defined as negative reaction; macular erythema or weak reaction (nonvesicular erythema, infiltration, or papules); strong reaction (edema or vesicles); or extreme reaction (spreading, bullous, or ulcerative).<sup>5,7</sup> Reactions were then assessed for relevancy according to history of confirmed contact with allergen-containing substances or circumstances introducing likely exposure. Relevancy was designated as: I, irritant; N, allergic, not relevant (no history of contact with allergen-containing products); Q, allergic, questionably relevant (current contact with products that may include allergen); P, allergic, formerly relevant (past contact with products containing allergen); and R, allergic, relevant (use test or patch test involving allergen-containing product is positive, or ingredient is confirmed as present in a patient product with verified use). Positive allergic patch-test results were defined as those with either weak, strong, or extreme reactions at final reading (96-168 hours after application), or those with a reaction involving macular erythema as long as the result was relevant after exclusion of irritant reactions.

### Statistical analysis

Patient data were stored in the clinical database Sybase (Sybase Inc, Dublin, CA) with a Uniface

## CAPSULE SUMMARY

- The patch-testing standard series is constantly adjusted to include currently relevant allergens.
- Positive allergic and irritant reactions have decreased significantly overall and most notably for 10 allergens.
- Increased rates have occurred for carba mix, 3% and Disperse Orange 3, 1%.

(Compuware Corp, Detroit, MI) written client server. Statistical analyses were conducted using a software package (Statistical Analysis System, Version 9.3, SAS Institute Inc, Cary, NC).

Rates of allergenicity from the study period were compared with those communicated previously<sup>5</sup> and to those NACDG reported in its 2005 to 2006 results.<sup>8</sup> A  $\chi^2$  test was used to compare results. *P* less than .05 designated statistical significance.

### Institutional structure

Mayo Clinic differs from other ACD centers in several respects. In contrast to dermatologic practices where testing is conducted exclusively by physicians with the most expertise in patch tests, all Mayo Clinic dermatologists (staff physicians, fellows, and residents) can perform patch testing. Staff dermatologists specializing in patch testing treat patients referred specifically for such evaluation.

A patch-test nurse is employed to discuss the procedure with the patient, to obtain consent, to aid the physician during reaction grading and recording, and to facilitate patient education by advising on allergen avoidance with materials from the Contact Allergen Replacement Database.<sup>16,17</sup> Relevancy is determined by patient completion of questionnaires detailing contact and occupational exposures. A quality assurance program ensures that relevancy is assessed and that patients receive allergen avoidance education.<sup>5</sup> The ordering provider is ultimately the clinician who interprets and conveys patch-test results. Supervisory resources for those performing patch testing include the Mayo Clinic Contact Dermatitis Group (MCCDG), composed of 10 physicians (4 at Mayo Clinic, Rochester, MN; 2 at Mayo Clinic, Jacksonville, FL; 1 at Mayo Clinic, Scottsdale, AZ; and 3 with ACD expertise who trained at Mayo Clinic but practice at external institutions and continue MCCDG participation); 3 nurses who serve as patch-test coordinators at each site; and various providers who conduct patch tests and are interested in contact dermatitis. MCCDG members periodically evaluate all components of patch testing with a particular focus on appropriate updates to the series being used.

### RESULTS

A total of 3115 patients with a mean (SD) age of 54.9 years (18.3 years) underwent patch testing between January 1, 2006, and December 31, 2010. Two-thirds (2045 [65.6%]) were female. The mean number of allergens tested per patient was 73.0 (6.6). Two-thirds (2056 [66.0%]) of the patients experienced at least 1 positive allergic reaction. Of all 3115 patients, 486 (15.6%) had 1 positive reaction and 1570 (50.4%) had 2 or more positive reactions. These

2056 patients had a total of 7306 allergic reactions. A total of 445 patients (14.3%) had 1 or more irritant patch-test reactions (224 of 3115 [7.2%] experienced 1 irritant reaction and 221 of 3115 [7.1%] experienced at least 2 irritant reactions). The 445 patients with 1 or more irritant reactions had a total of 1153 irritant patch-test reactions.

The percentages of positive reactions to individual allergens are summarized in Table I (with bold-faced type indicating allergens in our current standard series; available at <http://www.jaad.org>), along with corresponding rates from the prior 5-year period reported by our institution<sup>5</sup> and those described by NACDG.<sup>8</sup> The positive reactions listed in Table I are further categorized by the nature of the reaction as macular erythema (1), weak (2), strong (3), or extreme (4). Notably, many allergens featured a considerable proportion of final patch-test readings categorized as macular erythema only.

Comparison of the current rates of allergic positive reaction to those in the previous 5-year period from our institution<sup>5</sup> showed significantly higher rates of allergic positive reaction (*P* < .05) for carba mix, 3%, and Disperse Orange 3, 1%. Rates were significantly lower for 10 allergens: neomycin sulfate, 20%; gold sodium thiosulfate, 0.5%; hexahydro-1,3,5-tris(2-hydroxyethyl)triazine, 1%; disperse blue 124, 1%; disperse blue 106, 1%; diazolidinyl urea, 1%; hexylresorcinol, 0.25%; diazolidinyl urea, 1% aqueous; 2-bromo-2-nitropropane-1,3-diol, 0.25%; and lidocaine, 5%. For 2006 to 2010, the overall rate of positive allergic reactions (66.0%) was significantly lower (*P* = .006) than the earlier rate (69.1% in 2001-2005). The rate of irritant patch-test results also declined significantly (*P* < .001), from 25.0% in 2001 to 2005 to 14.3% in 2006 to 2010.

Our rate of positive reaction to 1 or more allergens was not significantly different from the NACDG 2005 to 2006 rate (65.3%) (*P* = .52).<sup>8</sup> The NACDG reported an irritant reaction rate of 16.8%, which was significantly higher than our rate (*P* = .003). Seven allergens were among the top 10 most frequent causes of positive reaction in both groups. Demographic data for patients evaluated by NACDG (62.6% female; 70.6% age >40 years) were comparable with those of our population.

### DISCUSSION

This study (3115 patients; 2006-2010) demonstrates that overall rates of positive allergic reactions and irritant reactions have declined significantly from those reported in our previous study (3854 patients; 2001-2005).<sup>5</sup> Twelve individual allergens exhibited significantly different rates of positive allergic reaction. The overall rate of positive allergic

**Table II.** Allergens added to or deleted from the Mayo Clinic standard series since the 2001 to 2005 report

| Allergens added                                       |                                      |                                                                                                                                                                                           |
|-------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test substance                                        | Allergen use or group                | Rationale for addition                                                                                                                                                                    |
| 2-Bromo-2-nitropropane-1,3-diol, 0.5%                 | Preservative                         | 0.5% Concentration is used by NACDG and European groups (0.25% was already tested in our series); irritancy rate was adequately low                                                       |
| Benzophenone-3 (2-hydroxy-4-methoxybenzophenone), 10% | UV absorber                          | 10% Concentration included in addition to existing 3% formulation because higher concentration has not been shown to cause irritant reactions                                             |
| Budesonide, 0.01%                                     | Corticosteroid                       | Lower concentration of 0.01% is more sensitive than the 0.1% formulation already tested in our series                                                                                     |
| Fragrance mix II                                      | Fragrance                            | Detection of additional patients sensitive to fragrances not included in the other fragrance mixes featured in the standard series                                                        |
| Gold sodium thiosulfate, 2%                           | Metal                                | Addition necessitated by change in formulation percentage concentration offered by vendor                                                                                                 |
| Iodopropynyl butylcarbamate, 0.1% and 0.2%            | Bactericide, fungicide, preservative | Allergen is infrequent but has increasing reports of allergenicity and is becoming ubiquitous in use; allergen may be otherwise undetected unless cosmetic or machinist series is applied |
| Propylene glycol, 20% in water                        | Preservative, solvent                | Addition necessitated by change in formulation percentage concentration offered by vendor                                                                                                 |
| Allergens deleted                                     |                                      |                                                                                                                                                                                           |
| Test substance                                        | Allergen use or group                | Explanation for removal                                                                                                                                                                   |
| 1H benzotriazole, 1%                                  | Anticorrosive                        | Low reactivity and rarely found in products                                                                                                                                               |
| 2-Tert-butyl-4-methoxyphenol (BHA), 2%                | Antioxidant                          | Low reactivity rate (moved to bakery series and cosmetics series)                                                                                                                         |
| Caine mix III                                         | Anesthetic                           | Replaced by testing with lidocaine and benzocaine (to screen for amide and ester anesthetics), given that testing anesthetics individually detects allergy better                         |
| Chlorquinaldol, 5%                                    | Bactericide, fungistat               | Decreased reactivity and infrequent use in products (moved to cosmetics series and medical series)                                                                                        |
| Clioquinol, 5%                                        | Antiamoebic, anti-infective          | Decreased reactivity and infrequent use in products (moved to cosmetics series and medical series)                                                                                        |
| <i>Dermatophagoides</i> mix, 0.1% and 20%             | Dust mite aeroallergen               | High rate of irritant reactions and nonrelevant allergic reactions                                                                                                                        |
| DMDM hydantoin, 1% aqueous                            | Preservative                         | Avoid unnecessary redundancy given that DMDM hydantoin, 1%, is also in standard series                                                                                                    |
| Glutaral (glutaraldehyde), 1%                         | Preservative                         | High rate of irritant reactions                                                                                                                                                           |
| Hexachlorophene, 1%                                   | Antiseptic                           | Infrequent clinical use; other halogenated phenols are in standard series                                                                                                                 |
| MCI/MI, 100 ppm                                       | Biocide, preservative                | Lack of availability for testing                                                                                                                                                          |
| Phenoxyethanol, 1%                                    | Bactericide, fixative                | Low reactivity rate                                                                                                                                                                       |
| Thimerosal, 0.1%                                      | Preservative                         | Difficulty interpreting results and relevancies; lack of clinical relevance (moved to cosmetics series and medical series)                                                                |
| Tocopherol (vitamin E), 10%                           | Antioxidant                          | Replaced with $\alpha$ -tocopherol, 100%, which is better absorbed by the skin and more commonly found in skin care products                                                              |

BHA, Butylated hydroxyanisole; DMDM, 1,3-dimethylol-5,5'-dimethyl; MCI/MI, methylchloroisothiazolinone/methylisothiazolinone; NACDG, North American Contact Dermatitis Group; UV, ultraviolet.

**Table III.** Allergens used in the Mayo Clinic standard series but not in the North American Contact Dermatitis Group standard series

| Test substance                                    | Allergen use or group                  |
|---------------------------------------------------|----------------------------------------|
| 2,6-Di tert-butyl-4-cresol (BHT), 2%              | Antioxidant                            |
| Benzalkonium chloride, 0.1% aqueous               | Antiseptic                             |
| Benzoic acid, 5%                                  | Antifungal, preservative               |
| Cetyl alcohol, 5%                                 | Emollient, emulsifier                  |
| Disperse blue 124, 1%                             | Textile dye                            |
| Disperse Orange 3, 1%                             | Textile dye                            |
| Fragrance mix II                                  | Fragrance                              |
| Gold sodium thiosulfate, 0.25%, 0.5%, and 2%      | Metal                                  |
| Hexahydro-1,3,5-tris (2-hydroxyethyl)triazine, 1% | Bactericide                            |
| Hexylresorcinol, 0.25%                            | Anesthetic, antihelminthic, antiseptic |
| Isopropyl myristate, 20%                          | Emollient                              |
| Natural fragrance mix, 2%                         | Fragrance                              |
| Phenol formaldehyde resin, 1%                     | Synthetic resin                        |
| Sorbic acid, 2%                                   | Preservative                           |
| Stearyl alcohol, 30%                              | Antifoam agent, lubricant              |
| Triclosan, 2%                                     | Preservative                           |
| Triethanolamine, 2%                               | Emulsifier                             |

BHT, Butylated hydroxytoluene.

reaction was similar to NACDG findings published in their recent report (4454 patients; 2005-2006).<sup>8</sup>

Our methods of patch testing and interpreting results resemble those of other institutions and organizations.<sup>4,8</sup> However, the ability of all dermatology providers to order and interpret patch tests is a distinct feature of the structure of patch testing at Mayo Clinic. Although maximizing access to patch testing, this process does permit less experienced providers to execute patch tests and interpret results. Attendance of the patch-test nurse at readings helps ensure uniformity. MCCDG members are also actively involved with patient consultations, teaching of patch testing, and fielding queries from colleagues. They also see most of the patients who undergo patch testing.

Importantly, we have included strength in our results for the first time. It has recently been proposed that these data should be provided in patch-test reports.<sup>18</sup> Many of our final patch-test reactions were mild (macular erythema only). Whether these types of reactions should be counted as positive reactions is controversial. In previous NACDG publications, only more vigorous papular reactions were included in calculations of patch-test reaction data. However, mild reactions have since

been recognized as possibly having clinical significance.<sup>19</sup> More recent calculations of positive allergic reaction rates from NACDG included mild reactions featuring only macular erythema if relevance was indicated by patient history, if the patient tested positive to the allergen in an alternate vehicle, or if a cross-reacting component was discovered.<sup>8</sup> Here, we have included mild reactions that the evaluating physician deemed relevant to calculate our positive allergic reaction rates. Such reactions are discussed with patients at our institution and avoidance is recommended.

Two allergens, carba mix, 3%, and Disperse Orange 3, 1%, demonstrated significantly higher rates of positive allergic reaction in this study compared with our previous report. We are not certain why these rates have increased. Carba mix, which is a common occupational contact allergen,<sup>20</sup> has been found to be a more common cause of positive reactions in older subjects than in children and adults,<sup>21</sup> which suggests that elevated rates of positivity could result from an increase in the population of elderly persons.<sup>22</sup> Disperse Orange 3 has previously been revealed as one of the more common disperse dyes causing ACD,<sup>23,24</sup> which has been attributed to frequent opportunities for exposure in hair dyes and textiles.<sup>25,26</sup>

Since our last report,<sup>5</sup> several allergens have been added to our standard series, demonstrating its dynamic composition (Table II). Allergens were added when a high rate of allergenicity developed, when opportunities for their exposure to patients increased, or when changes occurred in the concentration of particular allergens offered by the allergen supplier.<sup>27</sup> Allergens deleted from the standard series are listed in Table II. Allergens were removed for decreased or low reactivity, high irritancy rates, and reduced opportunities for patient exposure. The standard series at Mayo Clinic continues to be large (currently 71 allergens), supported by studies demonstrating that comprehensive series enable detection of relevant allergens that would otherwise be missed.<sup>15,28,29</sup> In all, 65 allergens composed the standard NACDG series during the 2005 to 2006 comparison period.<sup>8</sup>

Some allergens in our series were not tested by NACDG (Table III). Most are preservatives or other ingredients in skin care products. Their inclusion is justified by the possibility of clinical relevance rather than by a high rate of positive reaction.<sup>5,7</sup> Table IV lists NACDG allergens not used by Mayo Clinic. Tea tree oil, 5%, has since been added to our standard series. Table V summarizes allergens tested by Mayo Clinic and NACDG in differing concentrations.

Forty of the 81 allergens tested between 2006 and 2010 demonstrated significantly different results in rates of positive allergic reaction among the Mayo Clinic sites:

**Table IV.** Allergens used in the North American Contact Dermatitis Group standard series but not in the Mayo Clinic standard series

| Test substance       | Allergen use or group | Presence in Mayo Clinic supplemental series                                     |
|----------------------|-----------------------|---------------------------------------------------------------------------------|
| Bisphenol F, 1%      | Resin                 | Plastics and glues series (as 2.5% formulation in combination with epoxy resin) |
| Dibucaine, 2.5%      | Anesthetic            | Caine series and metals study series (as 5% formulation)                        |
| Dithiomorpholine, 1% | Scorch retardant      | Rubber series                                                                   |
| Jasmine absolute, 2% | Fragrance             | Cosmetics/fragrance/botanical series                                            |
| Tea tree oil, 5%     | Antiseptic, fragrance | Cosmetics/fragrance/botanical series and plant series                           |
| Ylang ylang, 2%      | Fragrance             | Cosmetics/fragrance/botanical series                                            |

**Table V.** Mayo Clinic standard series allergens featured in concentrations different from those of the North American Contact Dermatitis Group\*

| Test substance                                   | Allergen use or group                                                   | Concentration  |                   | Rationale for Mayo Clinic concentration                                                                                                              |
|--------------------------------------------------|-------------------------------------------------------------------------|----------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  |                                                                         | NACDG          | Mayo Clinic       |                                                                                                                                                      |
| 2-Bromo-2-nitropropane-1, 3-diol                 | Preservative                                                            | 0.5%           | 0.25%, 0.5%       | 0.25% Concentration used to reduce irritant reaction; 0.5% used for comparison with NACDG and European series                                        |
| Benzophenone-3 (2-hydroxy-4-methoxybenzophenone) | UV absorber                                                             | 3%             | 3%, 10%           | 10% Concentration has not been shown to cause irritant reactions                                                                                     |
| Compositae mix                                   | Mix contains plants used medicinally, cosmetically, and for consumption | 6%             | 5%                | 5% Concentration offered by allergen supply company                                                                                                  |
| DMDM hydantoin                                   | Preservative                                                            | 1%, 1% aqueous | 1%, 2% aqueous    | 2% Aqueous concentration offered by allergen supply company                                                                                          |
| Glutaral (glutaraldehyde)                        | Preservative                                                            | 1%             | 0.2%              | 0.2% Concentration used, because 1% was suspected to be an irritant                                                                                  |
| Iodopropynyl butylcarbamate                      | Bactericide, fungicide, preservative                                    | 0.1%, 0.5%     | 0.1%, 0.2%        | 0.2% Concentration added because of change in percentage concentration offered by allergen supplier                                                  |
| Lidocaine                                        | Anesthetic                                                              | 15%            | 5%                | 5% Concentration tested in standard series; 15% tested in caine series                                                                               |
| Methyldibromo glutaronitrile/ phenoxyethanol     | Preservative                                                            | 2.5%           | 1.5%              | Lower concentration used to reduce irritant reactions                                                                                                |
| Paraben mix                                      | Preservative                                                            | 12%            | 16%               | Higher concentration used to elicit a greater percentage of relevant allergic reactions because its irritancy rate is low and the allergen is common |
| Propylene glycol                                 | Preservative, solvent                                                   | 30%            | 10%; 20% in water | Lower concentrations used to reduce irritant reactions                                                                                               |
| Quaternium-15                                    | Preservative                                                            | 2%             | 1%                | Lower concentration used to reduce irritant reactions                                                                                                |

DMDM, 1,3-Dimethylol-5,5'-dimethyl; NACDG, North American Contact Dermatitis Group; UV, ultraviolet.

\*Designated as tested at a different concentration or in an alternate solution in Table I.

Rochester, MN; Scottsdale, AZ; and Jacksonville, FL (results not shown). This dissimilarity is likely caused by distinct climates, differences in the patient population,

uneven numbers of patch tests performed, different individuals executing the final reading, variations in allergen exposure, and disparate referral rates.<sup>5,30,31</sup>

One limitation of this study is that relevance was assessed at the time of the last patch-test reading without corroboration by the patient after avoidance of the allergen for several weeks. Also, results may not apply to other populations because our study reports data acquired at a single tertiary care center.

We have described our results and experience of patch testing at Mayo Clinic over a 5-year period. The standard series was adjusted appropriately as the clinical significance of certain allergens increased or decreased. Our findings may be used to inform future adjustments.

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**Table I.** Rates of allergic patch-test reaction to allergens in the standard series

| Test substance <sup>†‡</sup>                            | Mayo Clinic (2006-2010) |             |          |                                                         |       |       |       |                                   |      |      |      | Mayo Clinic (2001-2005) |                      | NACDG (2005-2006)    |                      |
|---------------------------------------------------------|-------------------------|-------------|----------|---------------------------------------------------------|-------|-------|-------|-----------------------------------|------|------|------|-------------------------|----------------------|----------------------|----------------------|
|                                                         | Patients tested, No.    | Reaction, % |          | Reaction grade among allergic reactions, % <sup>§</sup> |       |       |       | Relevance of allergic reaction, % |      |      |      | Patients tested, No.    | Allergic reaction, % | Patients tested, No. | Allergic reaction, % |
|                                                         |                         | Allergic    | Irritant | 1                                                       | 2     | 3     | 4     | R                                 | Q    | P    | N    |                         |                      |                      |                      |
| Gold sodium thiosulfate, 2%                             | 1110                    | 17.0        | 2.4      | 28.57                                                   | 46.56 | 16.93 | 7.94  | 19.6                              | 51.9 | 4.2  | 24.3 | NT                      | NT                   | NT                   | NT                   |
| <b>Nickel sulfate hexahydrate, 2.5%</b>                 | 3087                    | 16.5        | 0.9      | 20.87                                                   | 43.70 | 24.02 | 11.42 | 41.5                              | 31.1 | 15.2 | 12.2 | 3822                    | 17.1                 | 4428                 | 19.0                 |
| <b>Myroxylon pereirae resin (balsam of Peru), 25%</b>   | 3082                    | 12.6        | 1.5      | 55.56                                                   | 33.33 | 9.56  | 1.55  | 56.8                              | 40.8 | 1.0  | 1.3  | 3837                    | 13.7                 | 4449                 | 11.9                 |
| <b>Cobalt chloride, 1%</b>                              | 3092                    | 11.6        | 2.8      | 39.11                                                   | 37.99 | 14.80 | 8.10  | 29.3                              | 55.3 | 3.1  | 12.3 | 3818                    | 10.3                 | 4429                 | 8.4                  |
| <b>Fragrance mix, 8%</b>                                | 3092                    | 10.4        | 0.7      | 44.58                                                   | 40.25 | 12.07 | 3.10  | 59.8                              | 37.2 | 1.5  | 1.5  | 3844                    | 11.3                 | 4439                 | 11.5                 |
| <b>Neomycin sulfate, 20%</b>                            | 3085                    | 10.3        | 0.5      | 32.81                                                   | 36.91 | 23.97 | 6.31  | 46.1                              | 30.3 | 13.6 | 9.8  | 3834                    | 11.8                 | 4439                 | 10.0                 |
| Gold sodium thiosulfate, 0.5%                           | 3081                    | 9.2         | 0.7      | 35.11                                                   | 40.43 | 17.02 | 7.45  | 23.8                              | 55.7 | 2.1  | 18.1 | 3646                    | 13.5                 | NT                   | NT                   |
| <b>Quaternium-15, 1%</b>                                | 3091                    | 8.9         | 0.5      | 27.64                                                   | 41.82 | 26.55 | 4.00  | 64.4                              | 33.5 | 1.1  | 1.1  | 3841                    | 8.1                  | TADC                 | TADC                 |
| <b>Benzalkonium chloride, 0.1% aqueous</b>              | 2979                    | 8.8         | 0.7      | 57.85                                                   | 36.40 | 4.98  | 0.77  | 34.1                              | 62.5 | 1.1  | 1.5  | 3838                    | 8.3                  | NT                   | NT                   |
| <b>Formaldehyde, 1% aqueous</b>                         | 3093                    | 7.8         | 0.4      | 41.08                                                   | 43.15 | 14.11 | 1.66  | 64.3                              | 34.4 | 0.8  | 0.4  | 3836                    | 9.0                  | 4445                 | 9.0                  |
| <b>Potassium dichromate, 0.25%</b>                      | 3092                    | 7.4         | 1.3      | 55.46                                                   | 32.31 | 10.04 | 2.18  | 31.0                              | 59.0 | 2.2  | 7.9  | 3835                    | 6.7                  | 4449                 | 4.8                  |
| <b>Bacitracin, 20%</b>                                  | 3084                    | 7.3         | 0.4      | 19.91                                                   | 38.50 | 31.42 | 10.18 | 45.1                              | 30.1 | 13.3 | 11.1 | 3844                    | 8.1                  | 4437                 | 9.2                  |
| Methyl dibromo glutaronitrile /phenoxyethanol, 1.5%     | 3077                    | 6.6         | 1.4      | 52.71                                                   | 41.87 | 4.43  | 0.99  | 35.0                              | 64.0 | 0.0  | 0.5  | 3839                    | 6.1                  | TADC                 | TADC                 |
| <b>Fragrance mix II</b>                                 | 2713                    | 6.1         | 0.7      | 58.18                                                   | 29.09 | 11.52 | 1.21  | 53.3                              | 44.2 | 1.2  | 0.6  | NT                      | NT                   | NT                   | NT                   |
| Gold sodium thiosulfate, 0.25%                          | 1904                    | 5.8         | 0.4      | 33.33                                                   | 38.74 | 19.82 | 8.11  | 27.0                              | 54.1 | 1.8  | 17.1 | 410                     | 4.6                  | NT                   | NT                   |
| <b>Benzoic acid, 5%</b>                                 | 3077                    | 5.7         | 0.8      | 63.64                                                   | 31.82 | 4.55  | 0.00  | 42.6                              | 54.5 | 0.6  | 1.7  | 1963                    | 4.9                  | NT                   | NT                   |
| <b>Carba mix, 3%</b>                                    | 3085                    | 5.7         | 1.6      | 53.71                                                   | 34.86 | 10.86 | 0.57  | 42.9                              | 53.7 | 1.7  | 1.7  | 3841                    | 4.6                  | 4443                 | 3.9                  |
| <b>P-phenylenediamine, 1%</b>                           | 3088                    | 5.2         | 0.5      | 27.50                                                   | 40.63 | 19.38 | 12.50 | 56.9                              | 35.0 | 2.5  | 4.4  | 3832                    | 4.5                  | 4428                 | 5.0                  |
| <b>Cocamidopropyl betaine, 1% aqueous</b>               | 3003                    | 4.0         | 1.1      | 79.17                                                   | 19.17 | 1.67  | 0.00  | 40.0                              | 60.0 | 0.0  | 0.0  | 1093                    | 4.5                  | 4436                 | 1.8                  |
| Natural fragrance mix, 2%                               | 1907                    | 3.6         | 0.6      | 47.06                                                   | 30.88 | 20.59 | 1.47  | 64.7                              | 29.4 | 1.5  | 2.9  | 3236                    | 3.6                  | NT                   | NT                   |
| <b>Hexahydro-1,3,5-tris(2-hydroxyethyl)triazine, 1%</b> | 3086                    | 3.5         | 0.5      | 49.54                                                   | 44.04 | 5.50  | 0.92  | 36.7                              | 62.4 | 0.0  | 0.9  | 3709                    | 4.5                  | NT                   | NT                   |
| Disperse blue 124, 1% <sup>  </sup>                     | 3083                    | 3.4         | 0.8      | 73.08                                                   | 24.04 | 0.96  | 1.92  | 35.6                              | 63.5 | 1.0  | 0.0  | 2099                    | 6.3                  | NT                   | NT                   |
| <b>Iodopropynyl butylcarbamate, 0.2%</b>                | 118                     | 3.4         | 0.8      | 25.00                                                   | 50.00 | 0.00  | 25.00 | 50.0                              | 50.0 | 0.0  | 0.0  | NT                      | NT                   | TADC                 | TADC                 |
| <b>MCI/MI, 100 ppm aqueous</b>                          | 3091                    | 3.4         | 0.3      | 20.95                                                   | 52.38 | 18.10 | 8.57  | 56.2                              | 40.0 | 1.9  | 1.0  | 3740                    | 3.0                  | 4437                 | 2.8                  |
| <b>Thiuram mix, 1%</b>                                  | 3094                    | 3.1         | 0.4      | 26.32                                                   | 27.37 | 33.68 | 12.63 | 51.6                              | 41.1 | 4.2  | 2.1  | 3838                    | 3.3                  | 4443                 | 3.9                  |
| Disperse blue 106, 1% <sup>  </sup>                     | 3086                    | 2.8         | 0.6      | 74.42                                                   | 18.60 | 4.65  | 2.33  | 37.2                              | 61.6 | 0.0  | 1.2  | 2096                    | 5.3                  | 4426                 | 2.1                  |
| <b>Colophony, 20%</b>                                   | 3076                    | 2.6         | 0.7      | 35.00                                                   | 30.00 | 27.50 | 7.50  | 51.3                              | 45.0 | 1.3  | 1.3  | 3842                    | 2.6                  | 4447                 | 2.2                  |
| <b>2-Bromo-2-nitropropane-1,3-diol, 0.5%</b>            | 2142                    | 2.5         | 0.8      | 35.85                                                   | 56.60 | 5.66  | 1.89  | 30.2                              | 69.8 | 0.0  | 0.0  | NT                      | NT                   | 4435                 | 3.4                  |
| <b>Diazolidinyl urea, 1%</b>                            | 3091                    | 2.5         | 0.3      | 55.26                                                   | 31.58 | 10.53 | 2.63  | 55.3                              | 43.4 | 0.0  | 0.0  | 3842                    | 3.5                  | 4439                 | 3.7                  |
| <b>Ethylenediamine dihydrochloride, 1%</b>              | 3090                    | 2.5         | 0.4      | 22.37                                                   | 39.47 | 19.74 | 18.42 | 35.5                              | 57.9 | 0.0  | 6.6  | 3843                    | 2.4                  | 4444                 | 1.9                  |
| <b>Imidazolidinyl urea, 2%</b>                          | 3091                    | 2.5         | 0.3      | 47.44                                                   | 34.62 | 14.10 | 3.85  | 56.4                              | 43.6 | 0.0  | 0.0  | 3819                    | 2.8                  | 4438                 | 2.9                  |
| <b>Propylene glycol, 20% aqueous</b>                    | 1190                    | 2.5         | 0.5      | 53.33                                                   | 46.67 | 0.00  | 0.00  | 36.7                              | 60.0 | 0.0  | 0.0  | TADC                    | TADC                 | TADC                 | TADC                 |

|                                                       |      |     |     |       |       |       |       |      |      |      |      |      |      |      |      |
|-------------------------------------------------------|------|-----|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|
| Lanolin alcohol (wool alcohol), 30%                   | 3032 | 2.4 | 0.5 | 58.90 | 30.14 | 9.59  | 1.37  | 52.1 | 39.7 | 6.8  | 1.4  | 3842 | 1.9  | 4451 | 1.8  |
| Compositae mix, 5%                                    | 3086 | 2.3 | 0.7 | 44.44 | 29.17 | 13.89 | 12.50 | 54.2 | 45.8 | 0.0  | 0.0  | 280  | 2.9  | TADC | TADC |
| Tixocortol-21-pivalate, 1%                            | 3091 | 2.3 | 0.1 | 15.71 | 42.86 | 25.71 | 15.71 | 58.6 | 30.0 | 7.1  | 1.4  | 3844 | 3.0  | 4437 | 2.7  |
| Disperse Orange 3, 1%                                 | 3087 | 2.2 | 0.3 | 26.09 | 31.88 | 15.94 | 26.09 | 40.6 | 50.7 | 2.9  | 5.8  | 2096 | 0.9  | NT   | NT   |
| Benzocaine, 5%                                        | 3086 | 2.1 | 0.2 | 36.36 | 40.91 | 13.64 | 9.09  | 30.3 | 48.5 | 6.1  | 15.2 | 2153 | 1.5  | 4446 | 1.9  |
| Amidoamine, 0.1% aqueous                              | 2988 | 2.0 | 0.5 | 47.46 | 44.07 | 8.47  | 0.00  | 49.2 | 50.8 | 0.0  | 0.0  | 1054 | 1.7  | 4434 | 2.0  |
| DMDM hydantoin, 1%                                    | 3087 | 2.0 | 0.5 | 57.38 | 40.98 | 1.64  | 0.00  | 63.9 | 36.1 | 0.0  | 0.0  | 3757 | 2.2  | 4439 | 2.6  |
| Hexylresorcinol, 0.25%                                | 3085 | 2.0 | 0.7 | 69.35 | 27.42 | 3.23  | 0.00  | 22.6 | 72.6 | 1.6  | 3.2  | 3835 | 3.3  | NT   | NT   |
| Ethylene urea melamine—formaldehyde mix, 5%           | 3085 | 1.9 | 0.2 | 53.45 | 36.21 | 8.62  | 1.72  | 53.4 | 43.1 | 1.7  | 1.7  | 3844 | 2.4  | 4426 | 2.1  |
| Glyceryl thioglycolate, 1%                            | 3073 | 1.9 | 0.4 | 41.38 | 41.38 | 12.07 | 5.17  | 27.6 | 41.4 | 12.1 | 17.2 | 3842 | 1.5  | 4422 | 1.6  |
| Cinnamic aldehyde, 1%                                 | 3085 | 1.8 | 0.4 | 66.07 | 32.14 | 1.79  | 0.00  | 53.6 | 44.6 | 0.0  | 1.8  | 3114 | 2.0  | 4435 | 3.1  |
| Imidazolidinyl urea, 2% aqueous                       | 3069 | 1.7 | 0.4 | 56.86 | 35.29 | 7.84  | 0.00  | 47.1 | 52.9 | 0.0  | 0.0  | 3843 | 2.1  | 4447 | 1.3  |
| Paraben mix, 16%                                      | 3090 | 1.7 | 0.5 | 54.72 | 35.85 | 7.55  | 1.89  | 45.3 | 52.8 | 1.9  | 0.0  | 3841 | 1.7  | TADC | TADC |
| Ethyl acrylate, 0.1%                                  | 3087 | 1.6 | 0.3 | 45.83 | 39.58 | 12.50 | 2.08  | 41.7 | 41.7 | 6.3  | 10.4 | 3835 | 1.0  | 4428 | 0.9  |
| Methyl methacrylate, 2%                               | 3086 | 1.5 | 0.2 | 26.67 | 53.33 | 17.78 | 2.22  | 42.2 | 42.2 | 4.4  | 8.9  | 3848 | 1.4  | 4427 | 1.0  |
| 4-Tert-butylphenol formaldehyde resin, 1%             | 3091 | 1.4 | 0.2 | 32.56 | 34.88 | 30.23 | 2.33  | 37.2 | 62.8 | 0.0  | 0.0  | 3842 | 2.0  | 4444 | 1.3  |
| Benzophenone-3 (2-hydroxy-4-methoxybenzophenone), 10% | 208  | 1.4 | 0.5 | 66.67 | 33.33 | 0.00  | 0.00  | 33.3 | 66.7 | 0.0  | 0.0  | TADC | TADC | TADC | TADC |
| DMDM hydantoin, 2% aqueous                            | 3085 | 1.4 | 0.4 | 53.49 | 39.53 | 6.98  | 0.00  | 58.1 | 41.9 | 0.0  | 0.0  | 411  | 1.2  | TADC | TADC |
| Epoxy resin, 1%                                       | 3089 | 1.4 | 0.3 | 16.67 | 42.86 | 33.33 | 7.14  | 52.4 | 38.1 | 4.8  | 4.8  | 3846 | 1.6  | 4439 | 1.8  |
| Diazolidinyl urea, 1% aqueous                         | 3086 | 1.3 | 0.3 | 48.78 | 41.46 | 9.76  | 0.00  | 63.4 | 36.6 | 0.0  | 0.0  | 3840 | 2.4  | 4433 | 2.2  |
| Budesonide, 0.1%                                      | 975  | 1.2 | 0.5 | 56.00 | 24.00 | 20.00 | 0.00  | 66.7 | 25.0 | 0.0  | 8.3  | 3843 | 1.5  | 4439 | 1.5  |
| Budesonide, 0.01%                                     | 2096 | 1.2 | 0.4 | 50.00 | 8.33  | 25.00 | 16.67 | 36.0 | 48.0 | 4.0  | 12.0 | TADC | TADC | 4435 | 1.5  |
| Coconut diethanolamide (cocamide DEA), 0.5%           | 3085 | 1.2 | 0.6 | 63.16 | 31.58 | 5.26  | 0.00  | 44.7 | 50.0 | 0.0  | 5.3  | 410  | 1.5  | 4437 | 1.0  |
| Phenol formaldehyde resin, 1%                         | 3086 | 1.2 | 0.3 | 63.16 | 31.58 | 5.26  | 0.00  | 36.8 | 57.9 | 0.0  | 5.3  | 3824 | 1.5  | NT   | NT   |
| Toluenesulfonamide formaldehyde resin, 10%            | 3086 | 1.1 | 0.2 | 35.29 | 44.12 | 20.59 | 0.00  | 64.7 | 29.4 | 5.9  | 0.0  | 3844 | 1.3  | 4434 | 1.3  |
| Dimethylol dihydroxyethylene urea, 4.5% aqueous       | 3017 | 1.0 | 0.4 | 51.72 | 41.38 | 6.90  | 0.00  | 34.5 | 65.5 | 0.0  | 0.0  | 411  | 1.9  | 4424 | 0.6  |
| Iodopropynyl butylcarbamate, 0.1%                     | 1229 | 1.0 | 0.2 | 50.00 | 50.00 | 0.00  | 0.00  | 25.0 | 75.0 | 0.0  | 0.0  | NT   | NT   | 4433 | 0.5  |
| Hydrocortisone-17-butyrate, 1% alcohol                | 3058 | 0.9 | 0.2 | 58.62 | 34.48 | 6.90  | 0.00  | 55.2 | 31.0 | 3.4  | 10.3 | 2796 | 0.8  | 4438 | 0.6  |
| Sesquiterpene lactone mix, 0.1%                       | 3084 | 0.9 | 0.3 | 34.48 | 27.59 | 27.59 | 10.34 | 51.7 | 37.9 | 6.9  | 3.4  | 3845 | 0.9  | 4432 | 0.7  |
| Triethanolamine, 2%                                   | 3087 | 0.9 | 0.5 | 70.37 | 22.22 | 7.41  | 0.00  | 40.7 | 59.3 | 0.0  | 0.0  | 3845 | 0.8  | NT   | NT   |
| $\alpha$ -Tocopherol (vitamin E), 100%                | 2974 | 0.8 | 0.4 | 60.00 | 20.00 | 12.00 | 8.00  | 36.0 | 52.0 | 0.0  | 8.0  | 411  | 1.0  | 4435 | 0.7  |
| Black rubber mix, 0.6%                                | 3092 | 0.8 | 0.3 | 50.00 | 23.08 | 11.54 | 15.38 | 26.9 | 61.5 | 0.0  | 11.5 | 3840 | 0.9  | 4442 | 1.0  |
| Clobetasol-17-propionate, 1%                          | 3083 | 0.8 | 0.2 | 80.77 | 15.38 | 0.00  | 3.85  | 30.8 | 69.2 | 0.0  | 0.0  | 411  | 0.0  | 4435 | 0.8  |
| Sorbic acid, 2%                                       | 3084 | 0.8 | 0.5 | 68.00 | 32.00 | 0.00  | 0.00  | 40.0 | 56.0 | 0.0  | 0.0  | 410  | 0.5  | NT   | NT   |
| 2-Bromo-2-nitropropane-1, 3-diol, 0.25%               | 944  | 0.7 | 0.5 | 14.29 | 85.71 | 0.00  | 0.00  | 42.9 | 42.9 | 0.0  | 14.3 | 3841 | 2.1  | TADC | TADC |

Continued

Table I. Cont'd

| Test substance <sup>†‡</sup>                         | Mayo Clinic (2006-2010) |             |          |                                                         |       |       |       |                                   |      |      |      | Mayo Clinic (2001-2005) |                      | NACDG (2005-2006)    |                      |
|------------------------------------------------------|-------------------------|-------------|----------|---------------------------------------------------------|-------|-------|-------|-----------------------------------|------|------|------|-------------------------|----------------------|----------------------|----------------------|
|                                                      | Patients tested, No.    | Reaction, % |          | Reaction grade among allergic reactions, % <sup>§</sup> |       |       |       | Relevance of allergic reaction, % |      |      |      | Patients tested, No.    | Allergic reaction, % | Patients tested, No. | Allergic reaction, % |
|                                                      |                         | Allergic    | Irritant | 1                                                       | 2     | 3     | 4     | R                                 | Q    | P    | N    |                         |                      |                      |                      |
| <b>Chloroxyleneol (PCMX), 1%</b>                     | 3087                    | 0.7         | 0.1      | 39.13                                                   | 43.48 | 17.39 | 0.00  | 47.8                              | 52.2 | 0.0  | 0.0  | 3845                    | 0.7                  | 4436                 | 0.5                  |
| <b>Mercaptobenzothiazole, 1%</b>                     | 3089                    | 0.7         | 0.3      | 36.36                                                   | 40.91 | 13.64 | 9.09  | 54.5                              | 40.9 | 4.5  | 0.0  | 3842                    | 0.8                  | 4442                 | 0.9                  |
| <b>Glutaral (glutaraldehyde), 0.2%</b>               | 3071                    | 0.6         | 0.2      | 64.71                                                   | 11.76 | 17.65 | 5.88  | 41.2                              | 41.2 | 5.9  | 11.8 | 3831                    | 0.8                  | TADC                 | TADC                 |
| <b>Mixed dialkyl thioureas, 1%</b>                   | 3085                    | 0.6         | 0.2      | 21.05                                                   | 15.79 | 26.32 | 36.84 | 63.2                              | 31.6 | 0.0  | 5.3  | 3843                    | 0.6                  | 4430                 | 1.0                  |
| Benzophenone-3 (2-hydroxy-4-methoxybenzophenone), 3% | 2859                    | 0.5         | 0.3      | 69.23                                                   | 23.08 | 7.69  | 0.00  | 38.5                              | 61.5 | 0.0  | 0.0  | 3845                    | 0.7                  | 4436                 | 0.7                  |
| <b>Mercapto mix, 1%</b>                              | 3091                    | 0.5         | 0.0      | 66.67                                                   | 13.33 | 13.33 | 6.67  | 53.3                              | 46.7 | 0.0  | 0.0  | 3842                    | 0.6                  | 4444                 | 0.8                  |
| Propylene glycol, 10%                                | 1905                    | 0.5         | 0.2      | 44.44                                                   | 55.56 | 0.00  | 0.00  | 33.3                              | 55.6 | 0.0  | 11.1 | 3845                    | 0.4                  | TADC                 | TADC                 |
| <b>Triamcinolone acetonide, 1%</b>                   | 3085                    | 0.5         | 0.2      | 92.86                                                   | 7.14  | 0.00  | 0.00  | 64.3                              | 35.7 | 0.0  | 0.0  | 3848                    | 0.4                  | 4438                 | 0.3                  |
| Triclosan, 2%                                        | 3088                    | 0.4         | 0.4      | 63.64                                                   | 27.27 | 9.09  | 0.00  | 18.2                              | 72.7 | 9.1  | 0.0  | 3813                    | 0.3                  | NT                   | NT                   |
| <b>Lidocaine, 5%</b>                                 | 3083                    | 0.3         | 0.5      | 30.00                                                   | 50.00 | 20.00 | 0.00  | 0.0                               | 90.0 | 10.0 | 0.0  | 1895                    | 0.8                  | TADC                 | TADC                 |
| <b>Stearyl alcohol, 30%</b>                          | 3087                    | 0.3         | 0.3      | 44.44                                                   | 44.44 | 11.11 | 0.00  | 22.2                              | 66.7 | 0.0  | 0.0  | 3844                    | 0.3                  | NT                   | NT                   |
| <b>2,6-Di-tert-butyl-4-cresol (BHT), 2%</b>          | 3084                    | 0.2         | 0.3      | 57.14                                                   | 42.86 | 0.00  | 0.00  | 14.3                              | 57.1 | 0.0  | 28.6 | 3743                    | 0.3                  | NT                   | NT                   |
| <b>Cetyl alcohol, 5%</b>                             | 3085                    | 0.2         | 0.1      | 83.33                                                   | 16.67 | 0.00  | 0.00  | 33.3                              | 66.7 | 0.0  | 0.0  | 3846                    | 0.3                  | NT                   | NT                   |
| Isopropyl myristate, 20%                             | 3086                    | 0.2         | 0.2      | 66.67                                                   | 33.33 | 0.00  | 0.00  | 50.0                              | 50.0 | 0.0  | 0.0  | 3844                    | 0.2                  | NT                   | NT                   |
| <i>Dermatophagoides</i> mix, 20%                     | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 839                     | 27.4                 | NT                   | NT                   |
| Thimerosal, 0.1%                                     | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 1747                    | 10.5                 | NT                   | NT                   |
| <i>Dermatophagoides</i> mix, 0.1%                    | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 1855                    | 5.0                  | NT                   | NT                   |
| Glutaral (glutaraldehyde), 1%                        | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | 743                     | 4.8                  | 4413                 | 1.3                  |
| Caine mix III                                        | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 1669                    | 4.5                  | NT                   | NT                   |
| Hexachlorophene, 1%                                  | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 3432                    | 1.3                  | NT                   | NT                   |
| MCI/MI, 100 ppm                                      | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | 2672                    | 1.3                  | TADC                 | TADC                 |
| DMDM hydantoin, 1% aqueous                           | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | 3428                    | 1.3                  | 4433                 | 1.4                  |
| Clioquinol, 5%                                       | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 2705                    | 0.6                  | NT                   | NT                   |
| Tocopherol (vitamin E), 10%                          | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | 3389                    | 0.5                  | NT                   | NT                   |
| 1H benzotriazole, 1%                                 | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 2701                    | 0.3                  | NT                   | NT                   |
| 2-Tert-butyl-4-methoxyphenol (BHA), 2%               | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 2702                    | 0.3                  | NT                   | NT                   |
| Chlorquinaldol, 5%                                   | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 2665                    | 0.3                  | NT                   | NT                   |
| Phenoxyethanol, 1%                                   | NT                      | NT          | NT       | NT                                                      | NT    | NT    | NT    | NT                                | NT   | NT   | NT   | 2700                    | 0.1                  | NT                   | NT                   |
| Quaternium-15, 2%                                    | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | TADC                    | TADC                 | 4446                 | 10.3                 |
| Methyldibromo glutaronitrile/phenoxyethanol, 2.5%    | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | TADC                    | TADC                 | 4437                 | 5.8                  |
| Propylene glycol, 30% aqueous                        | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | TADC                    | TADC                 | 4439                 | 2.9                  |
| Iodopropynyl butylcarbamate, 0.5%                    | TADC                    | TADC        | TADC     | TADC                                                    | TADC  | TADC  | TADC  | TADC                              | TADC | TADC | TADC | NT                      | NT                   | 4435                 | 2.4                  |

|                         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|
| Dithiomorpholine, 1%    | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4408 | 1.8 |
| Ylang ylang, 2%         | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4434 | 1.5 |
| <b>Tea tree oil, 5%</b> | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4435 | 1.4 |
| Paraben mix, 12%        | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | 4439 | 1.2 |
| Compositae mix, 6%      | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | 4434 | 1.2 |
| Jasmine absolute, 2%    | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4447 | 1.1 |
| Lidocaine, 15%          | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | TADC | 4429 | 1.1 |
| Dibucaine, 2.5%         | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4426 | 1.1 |
| Bisphenol F, 1%         | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | NT   | 4413 | 0.2 |

Boldfaced type indicates allergens in our current standard series.

*BHA*, Butylated hydroxyanisole; *BHT*, butylated hydroxytoluene; *DEA*, diethanolamide; *DMDM*, 1,3-dimethylol-5,5'-dimethyl; *MCI/MI*, methylchloroisothiazolinone/methylisothiazolinone; *N*, allergic, not relevant; *NACDG*, North American Contact Dermatitis Group; *NT*, not tested; *P*, allergic, formerly relevant; *PCMX*, chloroxylenol; *Q*, allergic, questionably relevant; *R*, allergic, relevant; *TADC*, tested at a different concentration or in an alternate solution.

\*Ranked according to the frequency of positive reactions documented at our institution.

<sup>†</sup>Allergens in petrolatum unless specified "aqueous" or "alcohol."

<sup>‡</sup>Boldfaced entries in "Test substance" column demarcate allergens present in current Mayo Clinic standard series.

<sup>§</sup>Key: 1 = macular erythema; 2 = weak; 3 = strong; and 4 = extreme.

<sup>||</sup>Disperse blue 124, 1%, and disperse blue 106, 1%, are not boldfaced but are represented in the current standard series by a disperse blue mix, 1%.