

# The Association of Race/Ethnicity and Patch Test Results: North American Contact Dermatitis Group, 1998–2006

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**Background:** The North American Contact Dermatitis Group patch tests patients with suspected allergic contact dermatitis (ACD) to a broad series of screening allergens and publishes periodic reports. We have previously reported on the association of race and ethnicity with the rates of positive responses to standard patch test allergens. This report extends those observations.

**Objective:** The aim of the study was to report the North American Contact Dermatitis Group patch testing results from January 1, 1998, to December 31, 2006, comparing the frequency of positive reactions between white and black subjects.

**Methods and Materials:** Standardized patch testing with 45 allergens was used at 13 centers in North America.  $\chi^2$  analysis of results in black subjects as compared with whites was examined.

**Results:** A total of 19,457 patients were tested; 92.9% (17,803) were white and 7.1% (1,360) were black. The final diagnoses of ACD (whites, 45.9%; blacks, 43.6%) and irritant contact dermatitis (13.0%/13.3%) were similar in the 2 groups. The diagnosis of atopic dermatitis was less common in the white patients (8.9%) as compared with the black patients (13.3%). Positive patch test reactions rates were similar for most allergens. However, statistically, blacks reacted more frequently to *p*-phenylenediamine (7.0% vs 4.4%,  $P < 0.001$ ), bacitracin (11.6% vs 8.3%,  $P = 0.0004$ ), as well as specific rubber accelerators mercaptobenzothiazole (2.7% vs 1.8%), thiuram (6.2% vs 4.3%), and mercapto mix (1.9% vs 0.8%,  $P < 0.001$ ). Whites had an increase in positive reactions to fragrances (12.12% vs 6.77%,  $P < 0.0001$ ), formaldehyde (9.25% vs 5.45%,  $P < 0.0001$ ), and some formaldehyde releaser preservatives used in personal care products and textile resins (9.80% vs 6.18%,  $P < 0.0001$ ).

**Conclusions:** There were statistically different rates of positive patch test reactions to specific allergens between black and white patients suspected of having ACD. The etiology of these differences is unclear but probably relates to culturally determined exposure patterns rather than genetic differences.

The racial and ethnic mix of the population of the United States is changing rapidly, and although in the 1990 Census of the United States, approximately 20% of the population was made up of nonwhite racial/ethnic groups, it is estimated that by 2044, half of the population will belong to nonwhite racial/ethnic groups. This change will have considerable impact on the management of the health of this diverse population.<sup>1</sup>

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The US Census Bureau classifies race as self-identification with 1 of the following 5 groups: white, black or African American, American Indian or Alaska native, Asian, and native Hawaiian and other Pacific Islander. Under this system, Hispanic origin is considered an ethnicity and Hispanics can be of any race.<sup>1</sup> The study of the racial/ethnic variations in epidemiology and health care outcomes is being evaluated in all areas of medicine. These include differences in disease prevalence, risk factors, morbidity, mortality, and quality of life impact of common diagnoses as well as disparities in access to care and health care use.<sup>2</sup>

Dermatology has been at the forefront of this focus on the study of the differences in the anatomy and physiology among various skin types as well as the increased interest in certain diseases more common in darker skin and the differences in expression of the common diseases that affect individuals of all skin colors. This is evident from the number of academic and private

practice centers that focus on “skin of color” and “ethnic skin” as well as the development of the Society for Skin of Color and numerous books addressing these issues.<sup>3–6</sup>

Among the common skin diseases affecting persons of all colors is dermatitis or eczema. Within this category, contact dermatitis of both the irritant and allergic variety is common. Development of such reactions is dependent on many factors both external and those related to the individual. Individual variables may include age, sex, genetic predisposition, pre-existing skin disease, and occupation.<sup>7</sup> Because disease is dependent on environmental exposure to chemical agents, it is natural that ethnicity with related cultural practices will affect the development of these diseases. Nowhere is this more important than in the exposures related to occupation and personal care product usage. There are differences in patterns of exposure to the latter because of culturally related practices used in caring for and cosmetic adornment of the skin, hair, and nails in various ethnic groups.

The objectives of this study are to examine the differences in reaction rates to specific antigens and final diagnoses between white and black individuals referred for testing for suspected allergic contact dermatitis (ACD).

## MATERIALS AND METHODS

The North American Contact Dermatitis Group (NACDG), composed of 15 dermatologists in the United States (12 members) and Canada (3 members), collects deidentified data and periodically reports the results of testing with a standardized series of allergens. The NACDG used a standard set of allergens (Chemotechnique Diagnostics AB, Malmö, Sweden). The allergen sets were changed in 2-year cycles. The data reported here comprise the results from the following four 2-year cycles: 1998–2000, 2001–2002, 2003–2004, and 2005–2006.<sup>8–11</sup> The number of allergens in the test battery evolved during these periods from 50 to 65 allergens. We report the data only on the 45 allergens that were tested throughout the 4 cycles.

Patch testing was performed with a standardized technique using Finn chambers (Epitest Ltd Oy, Tuusula, Finland) on Scanpor tape (Norgesplaster Alparma AS, Vennesla, Norway).<sup>8</sup> Patches remained in place for 48 hours. The first and second patch test readings were performed at 48 hours and 72 to 168 hours, respectively, after the initial test placement. Allergic patch test reactions were graded as +, ++, or +++ on the basis of intensity of positive reactions manifested by erythematous papules, vesicles, and/or a spreading reaction sometimes with crusting and ulceration. A separate final determination of allergic versus nonallergic reaction was also coded. Doubtful reactions (macular erythema) were generally coded as nonallergic reactions. If the clinical history or other positive reactions to the same allergen in a different vehicle or a cross-reacting substance were identified, the investigator had the discretion to make a final determination that the macular erythema represented an allergic reaction.

The data are reported for that final determination of a positive allergic reaction.

Deidentified patient characteristics recorded included age, sex, race, and presence or absence of personal atopy (hay fever/allergic rhinitis, asthma, atopic eczema). Race of each patient was ascertained by self-identification and categorized as 1 of the following 4 groups: white, black, Asian, or Hispanic. Although there is interest in responses to patch testing in other racial/ethnic groups including Asians and Hispanics, the number of patients in these groups in our database was not sufficient to make reasonable comparisons, so this study is limited to only individuals classified as white or black.

On the basis of the history, physical examination, and patch-testing results, the investigator recorded up to 3 final diagnoses, which included ACD, irritant contact dermatitis (ICD), atopic dermatitis, stasis dermatitis, nummular eczema, other dermatitis types, psoriasis, other dermatoses, seborrheic dermatitis, and pompholyx. We reported the final diagnoses of the first 3 types.

One individual manually checked the data sheets for quality control. At a central location, data were manually entered into a computerized database (Microsoft Excel, 2003, Microsoft Corporation, Redmond, Wash) and checked for quality assurance. Descriptive statistics were performed using SPSS Statistics software (IBM, Armonk, NY). Pearson  $\chi^2$  test and the calculation of relative risk and confidence intervals were used to compare sensitization rates between the white and black patients. The high number of statistical tests performed ( $n = 45$ ) increases the type 1 error rate, that

**TABLE 1. Demographics, Atopic History, and Final Diagnoses in 19,457 Patients Patch Tested in This Study**

| N = 19,163        | White           | Black        |
|-------------------|-----------------|--------------|
| Sex               |                 |              |
| Male              | 6634<br>33.1%   | 434<br>2.3%  |
| Female            | 11,463<br>59.8% | 926<br>4.8%  |
| Total             | 17,803<br>92.9% | 1360<br>7.1% |
| Atopic history    |                 |              |
| Hay fever         | 4682<br>26.3%   | 220<br>16.2% |
| Asthma            | 2564<br>14.4%   | 220<br>16.2% |
| Eczema            | 2884<br>16.2%   | 280<br>20.6% |
| Final diagnosis   |                 |              |
| ACD               | 8160<br>45.9%   | 592<br>43.6% |
| ICD               | 2315<br>13.0%   | 181<br>13.3% |
| Atopic dermatitis | 1583<br>8.9%    | 164<br>13.3% |

**TABLE 2. Results of Patch Tests to 46 Allergens in 19,163 Patients, 1998–2006**

|                                              | Black + Patch,<br>n (%) | White + Patch,<br>n (%) | $\chi^2$ | P        | Risk Ratio | 95% CI          |
|----------------------------------------------|-------------------------|-------------------------|----------|----------|------------|-----------------|
| Benzocaine 5% pet                            | 26 (1.95)               | 313 (1.76)              | 0.249    | 0.617    | 1.1062     | 0.7443–1.644    |
| Mercaptobenzothiazole 1% pet                 | 36 (2.65)               | 224 (1.76)              | 18.196   | <0.0001  | 2.1032     | 1.4857–2.9771 * |
| Potassium dichromate 0.25% pet               | 62 (4.67)               | 862 (4.85)              | 0.03     | 0.86     | 0.978      | 0.7605–1.2577   |
| Colophony 20% pet                            | 18 (1.32)               | 460 (2.59)              | 8.257    | <0.004   | 0.5121     | 0.332–0.827     |
| p-Phenylenediamine 1% pet                    | 95 (6.99)               | 790 (4.44)              | 18.597   | <0.0001  | 1.5560     | 1.273–1.889 *   |
| Imidiazolidinyl urea 1% aq                   | 18 (1.32)               | 311 (1.74)              | 1.34     | 0.228    | 0.7574     | 0.4725–1.2142   |
| Lanolin 30% pet                              | 23 (1.69)               | 395 (2.22)              | 1.651    | 0.1987   | 0.7620     | 0.5023–1.156    |
| Carba mix 3% pet                             | 69 (5.07)               | 775 (4.35)              | 1.552    | 0.2129   | 1.165      | 0.9166–1.4812   |
| Neomycin 20% pet                             | 163 (11.99)             | 1984 (11.16)            | 0.089    | 0.764    | 1.0232     | 0.8804–1.1892   |
| Thiuram mix 1% pet                           | 84 (6.18)               | 764 (4.30)              | 10.60    | 0.0011   | 1.4389     | 1.1565–1.7901 * |
| Formaldehyde 1% aq                           | 74 (5.45)               | 1646 (9.25)             | 22.544   | <0.0001  | 0.5825     | 0.4685–0.7368 * |
| Ethylenediamine dihydrochloride 1% pet       | 28 (2.06)               | 443 (2.49)              | 0.975    | 0.03234  | 0.8272     | 0.5668–1.2070   |
| Epoxy resin 1% pet                           | 42 (3.09)               | 364 (2.05)              | 6.627    | 0.010    | 1.51       | 1.1024–2.0683   |
| Quaternium-15 2% pet                         | 84 (6.18)               | 1743 (9.80)             | 19.115   | <0.0001  | 0.631      | 0.5105–0.7799 * |
| p-tert-Phenol formaldehyde resin 1% pet      | 25 (1.84)               | 307 (1.73)              | 0.095    | 0.757    | 1.0657     | 0.7116–1.596    |
| Mercapto mix 1% pet                          | 26 (1.91)               | 150 (0.84)              | 15.86    | <0.0001  | 2.268      | 1.5014–3.4273 * |
| Myroxylon perei (Balsam of Peru) 25% pet     | 92 (6.77)               | 2154 (12.12)            | 34.787   | <0.0001  | 0.5463     | 0.444–0.672 *   |
| Nickel sulfate 2.5% pet                      | 213 (15.67)             | 3044 (17.15)            | 1.86     | 0.17     | 0.9157     | 0.787–1.044     |
| Diazolidinyl urea 1 % pet                    | 20 (1.47)               | 615 (3.45)              | 15.531   | <0.0001  | 0.4354     | 0.282–0.672 *   |
| DMDM hydantoin 1% pet                        | 17 (1.25)               | 452 (2.54)              | 8.79     |          | 0.4922     | 0.3042–0.807    |
| Imidiazolidinyl urea 2% pet                  | 26 (1.91)               | 452 (2.54)              | 4.438    | 0.035    | 0.035      | 0.4473–0.9759   |
| Bacitracin 20% pet                           | 150 (11.62)             | 1475 (8.29)             | 12.238   | 0.00046  | 1.339      | 1.356–1.5597 *  |
| Thioureas 1% pet                             | 20 (1.47)               | 168 (0.94)              | 3.607    | 0.057    | 1.558      | 0.9832–2.4687   |
| MCI/MI 0.01% aq                              | 19 (1.40)               | 460 (2.59)              | 7.309    | 0.0068   | 0.5405     | 0.3428–0.8524   |
| Paraben mix 12% pet                          | 14 (1.03)               | 75 (0.98)               | 9.966    | 0.0015   | 2.4291     | 1.367–3.596     |
| Fragrance mix 8% pet                         | 93 (6.84)               | 1868 (7.79)             | 18.394   | <0.0001  | 0.6515     | 0.533–0.7964 *  |
| Amidoamine 0.1% aq                           | 18 (1.32)               | 444 (2.50)              | 7.363    | 0.0066   | 0.5205     | 0.3323–0.8477   |
| Bronopol 0.5% pet                            | 35 (2.58)               | 524 (2.95)              | 0.613    | 0.40     | 0.8741     | 0.635–1.1216    |
| Sesquiterpene lactone 0.1% pet               | 6 (0.44)                | 125 (0.33)              | 1.269    | 0.259    | 0.6282     | 0.2774–1.4224   |
| Propylene glycol 30% aq                      | 39 (2.87)               | 595 (3.37)              | 0.708    | 0.400    | 0.8723     | 0.6339–1.2003   |
| Benzophenone 3 % pet                         | 16 (1.18)               | 97 (0.55)               | 8.566    | 0.0034   | 2.1562     | 1.2743–3.6486   |
| PCMX 1% pet                                  | 19 (1.40)               | 115 (0.877)             | 10.258   | 0.0013   | 2.1622     | 1.3349–3.502    |
| DMDM hydantoin 1% aq                         | 14 (1.03)               | 310 (1.74)              | 3.856    | 0.049    | 0.591      | 0.3469–1.0068   |
| Diazolidinyl urea 1% aq                      | 21 (1.5)                | 589 (3.32)              | 12.772   | 0.00035  | 0.4666     | 0.303–0.7185 *  |
| Ethylene urea melamine formalin resin 5% pet | 19 (1.42)               | 554 (3.11)              | 12.818   | 0.000343 | 0.4488     | 0.2851–0.7067 * |
| Methyl dibromo glutaronitrile 2.5% pet       | 63 (4.64)               | 1101 (6.20)             | 5.345    | 0.0207   | 0.7488     | 0.5845–0.9594   |
| Iodopropynyl butyl carbamate 0.1% pet        | 2 (0.159)               | 74 (0.42)               | 2.479    | 0.07     | 0.3418     | 0.085–1.3707    |
| Glutaral 1% pet                              | 14 (1.03)               | 256 (1.43)              | 1.48     | 0.22     | 0.7189     | 0.438–1.3686    |
| Ethyl acrylate 0.1% pet                      | 21 (1.38)               | 210 (1.18)              | 1.407    | 0.235    | 1.3087     | 0.852–1.938     |
| Glycerol thioglycolate 1% pet                | 9 (0.62)                | 313 (1.76)              | 9.273    | 0.0023   | 0.3749     | 0.1937–0.7256   |
| Tosyl 10% pet                                | 19 (1.40)               | 256 (1.44)              | 0.964    | 0.326    | 0.795      | 0.502–1.2591    |
| Cobalt chloride 1% pet                       | 112 (8.09)              | 1336 (7.51)             | 0.608    | 0.435    | 1.076      | 0.8948–1.2951   |
| Tixocortol pivalate 1% pet                   | 33 (2.42)               | 491 (2.76)              | 0.524    | 0.0469   | 0.8796     | 0.621–1.2458    |
| Budesonide 0.1% pet                          | 8 (0.5)                 | 266 (1.50)              | 7.362    | 0.006    | 0.3936     | 0.206–0.809     |
| Methyl methacrylate 2% pet                   | 22 (1.59)               | 247 (1.39)              | 0.487    | 0.485    | 1.1665     | 0.7569–1.7978   |

\*P &lt; 0.0011.

CI indicates confidence interval; MCI/MI, Methylisothiazolinone-Methylthiazolinone; PCMX, Para Chlorometaxyleneol.

is, the rate of falsely rejecting the null hypothesis. Therefore, a significance level of a P value of 0.0011 was used as the threshold for statistical significance using Bonferroni correction. Relative risk and confidence interval were included, in part because of variable population size in comparing the white patients and the black patients.

## RESULTS

### Patient Characteristics

For the four 2-year cycles, 19,457 individuals suspected of having ACD were tested to the same 45 allergens. A total of 92.9% of these

**TABLE 3. Allergen Ranking by Percent Positive Patch Tests**

| Rank of the Most Common Positive Patch by Allergen | Black                      | White                         |
|----------------------------------------------------|----------------------------|-------------------------------|
| 1                                                  | Nickel sulfate             | Nickel sulfate                |
| 2                                                  | Neomycin                   | <i>Myroxylon pereirae</i>     |
| 3                                                  | Bacitracin                 | Neomycin                      |
| 4                                                  | Cobalt chloride            | Quaternium-15                 |
| 5                                                  | <i>p</i> -Phenylenediamine | Formaldehyde                  |
| 6                                                  | Fragrance mix 1            | Bacitracin                    |
| 7                                                  | <i>Myroxylon pereirae</i>  | Fragrance mix 1               |
| 8                                                  | Thiuram mix                | Cobalt chloride               |
| 9                                                  | Quaternium-15              | Methyl dibromo glutaronitrile |
| 10                                                 | Formaldehyde               | <i>p</i> -Phenylenediamine    |

individuals were white and 7.1% were black. This included 6634 white males and 434 black males as well as 11,463 white females and 926 black females (Table 1). This sex predominance of females is routinely seen in patch test populations.<sup>8–11</sup>

History of atopic diseases was recorded for all patients. Whites were more likely to report a history of hay fever as compared with blacks (26.3% vs 16.2%). Although blacks were more likely to report a history of atopic dermatitis as compared with whites (20.6% vs 16.2%), asthma was reported at a slightly higher rate for blacks than whites (16.2% vs 14.4%, Table 1).

From 1 to 3 different final diagnoses could be recorded for each patient by the investigator. There was little difference in the final diagnoses of ACD and ICD between the whites and blacks in the study. Allergic contact dermatitis was recorded for 45.9% of whites and 43.6% of blacks and ICD for 13% of whites and 13.3% of blacks. However, atopic eczema was reported as a final diagnosis in 13.3% of blacks and only 8.9% of whites (Table 1).

Results of the positive patch tests coded as allergic by the investigators for each of the 45 allergens for black subjects as compared with white subjects are shown in Table 2. Values of positive allergic reactions for those allergens in which there were significant differences between the black and white subjects are shown.

The 10 most common allergens resulting in positive patch tests in the 2 groups are shown in Table 3.

## DISCUSSION

Although the effects of irritants on the skin of white individuals as compared with blacks have been extensively studied, published data investigating differences in allergy have been largely lacking.<sup>4</sup>

In North America, we are aware of only a few studies that have addressed the differences of ACD in different racial/ethnic groups. Dickel et al<sup>12</sup> reviewed the test results of 1000 patients patch tested between 1988 and 1991 and found no overall differences in a variety of parameters between black and white patients; however, they did find some differences in positive tests to certain antigens. In 2002, our group published a study examining

the differences in sensitization rates between white and black individuals in approximately 10,000 patients from the following 3 different 2-year periods: 1992–1994, 1994–1996, and 1996–1998. Similar to the study by Dickel et al,<sup>12</sup> we reported similar incidences of allergic and irritant dermatitis and did note some trending of differences in response to certain allergens but with a low level of significance.<sup>13</sup>

Our objective here was to examine data from a larger combined group of patients, comparing the results of testing between the white and black study participants. The rates of positive allergic patch test responses were remarkably similar for 36 of the 45 allergens tested. It is of interest that those allergens which produced significantly different response rates between the 2 groups of study participants, with some exceptions, fell into 2 categories.

First, blacks reacted to 3 of the 4 rubber accelerator allergens more frequently than whites did. They reacted in significantly greater numbers to mercaptobenzothiazole, mercapto mix, and thiuram mix, whereas there was no difference in reactivity to carba mix between the 2 groups. In our previous study, there was a similar trend in higher rates of positive reactivity to these rubber accelerators in most of the study periods, but the differences did not reach statistical significance. Rubber accelerator allergy is commonly associated with exposure to gloves and shoes, but how this is related to the differences between blacks and whites is unknown.

Second, whites were statistically more likely to react to preservatives including formaldehyde and related formaldehyde-releasing preservatives (quaternium-15 and diazolidinyl urea). Whites also reacted more frequently to the textile resin ethylene urea formaldehyde resin, which could be due to cross-reactivity with formaldehyde or related compounds.

Although a similar trend of greater positive rates for whites to other formaldehyde releasers including dimethylol dimethyl (DMDM) hydantoin (pet,  $P < 0.003$ ), (aq,  $P < 0.049$ ), and imidazolidinyl urea (pet,  $< 0.035$ ), (aq,  $P < 0.228$ ), these differences did not meet the stated level of significance for this study. This trend did not hold true for the formaldehyde releaser bronopol, which seemed to react equally in both groups ( $P < 0.4$ ). Similar but less significant findings of greater sensitivity to these formaldehyde-related personal care product

preservatives were also found in our previous publication,<sup>13</sup> but contradictory results were reported in a smaller study on quaternium-15 where the authors reported greater reactivity in their black patients.<sup>14</sup>

Other nonformaldehyde preservatives tested in this study also seemed to produce greater levels of positive reactions in whites as compared with blacks, although not in a statistically significant manner, including methylchloroisothiazolinone/methylisothiazolinone ( $P < 0.0068$ ), parachlorometaxylenol ( $P < 0.0013$ ), methyl dibromoglutaronitrile ( $<0.0207$ ), and iodopropynyl butylcarbamate ( $P < 0.07$ ). In contrast, blacks were more likely to react to paraben mix than whites although the difference did not reach significance ( $P = 0.0015$ ).

Whites also reacted more frequently to fragrances than blacks. The natural fragrance mixture, *Myroxylon pereirae* (Balsam of Peru), produced approximately twice the percentage of positive reactions in whites as in blacks. Although the fragrance mix also was found to be more sensitizing in whites, this difference was not statistically significant.

In contrast, blacks reacted more frequently to another important cosmetic allergen, *p*-phenylenediamine. This same result was found in our previous study<sup>13</sup> and in the study by Dickle et al<sup>12</sup> where they reported a higher incidence of reaction to this allergen in black men. We did not look at the sex differences in our study. As noted in Table 3, *p*-phenylenediamine is the fifth most common positive allergen among our black patients as compared with white patients where it is the tenth.

Finally, blacks reacted more frequently to the antibiotic bacitracin than whites, but interestingly, there was no difference in reactivity between the races to neomycin even though those 2 topical antibiotics are frequent coreactors. In Table 3, bacitracin positivity rate ranks third in blacks with a rate almost as high as that of neomycin.

This study has several limitations. Patients in this study were referred because they were suspected of having ACD, so there is selection bias and the results of this study cannot be generalized to the population as a whole. The racial breakdown of our study was also not necessarily representative of the population because only 7.1% of the study population was black. In the United States and Canada, blacks make up approximately 13% and 3% of the population, respectively. In addition, because of the small number of such patients, this study did not examine reactions in our patients identified as Hispanic and Asian.

## CONCLUSIONS

In conclusion, our study presented the patch test results of whites as compared with those of blacks at referral centers in North

America. We found that after testing, almost half of these patients were diagnosed as having ACD regardless of race. Thirteen percent of both races were found to have ICD. Both by history and by final diagnoses black individuals were more frequently noted to have atopic eczema. Whites reacted more frequently to allergens found in personal care products including formaldehyde releasers but not to *p*-phenylenediamine, whereas blacks reacted more frequently to that allergen and to rubber-associated allergens and bacitracin. Although it is possible that these differences in reactivity could be genetically determined, it is more likely that they relate more to exposure patterns.

## REFERENCES

- 2010 Census Redistricting Data (Public Law 94-171) Summary file.
- Olden K, White SL. Health-related disparities: influence of environmental factors. *Med Clin North Am* 2005;89(4):721–738.
- Taylor SC, Kelly AP, Lim HW, et al. *Taylor and Kelly's Dermatology for Skin of Color*. 2nd ed. New York: McGrawHill; 2016.
- Alexis AF, Barbosa VH, eds. *Skin of Color: A Practical Guide to Dermatologic Diagnosis and Treatment*. Springer: New York; 2012.
- Alder RM. *Dermatology and Dermatological Therapy of Pigmented Skins*. Philadelphia: Taylor and Francis; 2005.
- Jackson-Richards D, Pandya AJ. *Dermatology Atlas for Skin of Color*. New York: Springer; 2014.
- Marks JG Jr, Anderson BE, DeLeo VA. *Contact and Occupational Dermatology*. 4th ed. Philadelphia: Jaypee; 2016.
- Marks JG, Belsito DV, DeLeo VA, et al. North American Contact Dermatitis Group patch-test results, 1998 to 2000. *Am J Contact Dermat* 2003;14(2):59–62.
- Pratt MD, Belsito DV, DeLeo VA, et al. North American Contact Dermatitis Group patch-test results, 2001–2002 study period. *Dermatitis* 2004;15(4):176–183 Erratum: *Dermatitis* 2005; 16(2):106.
- Warshaw EM, Belsito DV, DeLeo VA, et al. North American Contact Dermatitis Group patch-test results, 2003–2004 study period. *Dermatitis* 2008;19(3):129–136.
- Zug KA, Warshaw EM, Fowler JF Jr, et al. Patch-Test results of the North American Contact Dermatitis Group 2005–2006. *Dermatitis* 2009; 20(3):149–160.
- Dickel H, Taylor JS, Evey P, et al. Comparison of patch test results with a standard series among white and black racial groups. *Am J Contact Dermat* 2001;12(2):77–82.
- DeLeo VA, Taylor SC, Belsito DV, et al. The effect of race and ethnicity on patch test results. *J Am Acad Dermatol* 2002;46(suppl 2): S107–S112.
- Parker LU, Taylor JS. A 5-year study of contact allergy to quaternium-15. *Am J Contact Dermat* 1991;2:231.