

North American Contact Dermatitis Group Patch Test Results: 2009 to 2010

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Background: Patch testing is an important diagnostic tool for determination of substances responsible for allergic contact dermatitis.

Objective: This study reports the North American Contact Dermatitis Group (NACDG) patch testing results from January 1, 2009, to December 31, 2010.

Methods: At 12 centers in North America, patients were tested in a standardized manner with a screening series of 70 allergens. Data were manually verified and entered into a central database. Descriptive frequencies were calculated, and trends were analyzed using χ^2 statistics.

Results: A total of 4308 patients were tested. Of these, 2614 (60.7%) had at least 1 positive reaction, and 2284 (46.3%) were ultimately determined to have a primary diagnosis of allergic contact dermatitis. Four hundred twenty-seven (9.9%) patients had occupationally related skin disease. There were 6855 positive allergic reactions. As compared with the previous reporting period (2007–2008), the positive reaction rates statistically decreased for 20 allergens (nickel, neomycin, *Myroxylon pereirae*, cobalt, formaldehyde, quaternium 15, methyldibromoglutaronitrile/phenoxyethanol, methylchlorisothiazolinone/methylisothiazolinone, potassium dichromate, diazolidinyl urea, propolis, dimethylol dimethylhydantoin, 2-bromo-2-nitro-1,3-propanediol, methyl methacrylate, ethyl acrylate, glyceryl thioglycolate, dibucaine, amidoamine, clobetasol, and dimethyloldihydroxyethyleneurea; $P < 0.05$) and statistically increased for 4 allergens (fragrance mix II, iodopropynyl butylcarbamate, propylene glycol, and benzocaine; $P < 0.05$). Approximately one quarter of tested patients had at least 1 relevant allergic reaction to a non-NACDG allergen. Hypothetically, approximately one quarter of reactions detected by NACDG allergens would have been missed by TRUE TEST (SmartPractice Denmark, Hillerød, Denmark).

Conclusions: These results affirm the value of patch testing with many allergens.

The North American Contact Dermatitis Group (NACDG) is a group of dermatologists in Canada and the United States who

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evaluate patients with suspected allergic contact dermatitis (ACD) using a standardized set of allergens. The composition of the NACDG “screening series” changes slightly every 2-year cycle. Periodically, these epidemiological data are published.^{1–10} This report documents results from the 2009 to 2010 period.

MATERIALS AND METHODS

Between January 1, 2009, and December 31, 2010, the NACDG consisted of 12 dermatologists in North America. Patients were patch tested with a screening series of 70 allergens (allergEAZE; SmartPractice, Calgary, Canada). The most recent NACDG report by Fransway¹⁰ described data collection methods in detail and are unchanged for this reporting cycle. Briefly, patch testing was performed with a standardized technique using Finn chambers (SmartPractice, Phoenix, Ariz) on Scanpore tape (Norgesplaster Alpha AS, Vennesla, Norway). The patches remained in place for 48 hours, and test sites were evaluated initially at 48 to 72 hours and again between 72 and 168 hours after initial placement.

TABLE 1. MOAHLFAP¹⁵ Characteristics

Characteristic	n (%)
Male	1381 (32.1)
Occupational*	427 (9.9)
Atopic Triad	
Hayfever†	1292 (30.0)
Atopic dermatitis	982 (22.8)
Asthma‡	683 (15.9)
Hand‡	866 (20.1)
Leg‡	201 (4.7)
Face‡	667 (15.5)
Age > 40 y	2901 (67.4)
Positivity rate (≥1 allergic reaction)	2,614 (60.7)

*Excludes uncertain.

†Not part of MOAHLFAP¹⁵ (male, occupational, atopic, hand, leg, foot, age >40 y, percent positive).

‡Primary site; when primary sites of lips, nose, eyelids, and eyes are added to face, total for face = 1224 (28.4%).

A positive reaction was defined as a grade of 1, 2, or 3 (degrees of induration, papules, vesicles, and/or spreading); a weak/doubtful reaction (macular erythema) could be coded as an allergic reaction if deemed to likely be a true positive based on appearance, clinical history, cross-reactions, or other factors. The clinical relevance of the positive patch test reaction was determined using the patient's history and clinical skin examination. Current relevance was defined as definite (use test with the suspected item was positive, or a patch test to the object or product was positive), probable (the antigen could be verified as present in known skin contactants and the clinical presentation was consistent), or possible (the patient was exposed to circumstances in which skin contact with materials known to contain the allergen was likely to occur). Past relevance was also indicated. For each positive allergen, the source of the antigen exposure was also coded using a 3-digit code.¹¹ For each patient, occupation and industry were coded by an occupational expert using the US 2000 Census Bureau Codes based on answers to 5 standardized questions.¹² Up to 3 final diagnoses and up to 3 sites of dermatitis could be coded. Reporting of these latter 2 characteristics was based on the total number of a specific diagnoses (or site) divided by the number of patients.

Quality control checks were performed by 1 individual who manually checked all required fields. At a central location, all data were manually entered into a computerized database and checked for quality assurance (Access 2003; Microsoft Corp, Redmond, Wash). All analyses were performed using SAS (Statistical Analysis System; SAS Institute, Inc, Cary, NC) and according to recommended guidelines.¹³ Pearson χ^2 test was used to compare frequencies between time periods. A significance level of 0.05 was used for all analyses. Because this was an exploratory analysis, no adjustments for multiple comparisons were performed. The Significance-Prevalence Index Numbers (SPIN)¹⁴ were calculated as in the last data cycle report.¹⁰ Demographic data were displayed

according to MOAHLFAP (male, occupational, atopic, hand, leg, foot, age >40 y, percent positive) guidelines.^{13,15}

During this period, the NACDG screening tray consisted of 70 allergens/allergen mixes. Compared with the previous period (2007–2008, 65 allergens), the following 10 antigens were new: dimethylaminopropylamine 1.0% aqueous (aq), oleamidopropyl dimethylamine 0.1% aq, shellac 20.0% alcohol (alc), decyl glucoside 5.0% petrolatum (pet), majantole 5.0% pet, carvone 5.0% pet, *Jasminum officinale* oil (*Jasminum grandiflorum*) 2.0% pet, *Mentha piperita* oil (peppermint oil) 2.0% pet, *Lavendula angustifolia* oil (lavender oil) 2.0% pet, and D-limonene 3.0% pet. The following 5 antigens present in the 2007 to 2008 testing period were deleted from the 2009 to 2010 series: imidazolidinyl urea 2.0% aq, dimethylol dimethyl (DMDM) hydantoin 1.0% aq, diazolidinyl urea 1.0% aq, bisphenol F epoxy resin 0.25% pet, and triamcinolone acetonide 1.0% pet. The composition/concentration of 2 antigens were changed; benzophenone-3 was tested at a 10% concentration (compared with a 3% concentration in previous years)¹⁶ and disperse blue mix 106/124 replaced disperse blue 106.

RESULTS

Patient Characteristics

The demographics of the patch-tested patients are summarized in Tables 1 to 3. Most were white (87.3%) and female (67.9%). The mean age was 48.4 years (range, 0–95 years; mode 44). The most common body locations of dermatitis were as follows: scattered/generalized pattern, hands, and face. Of the 4308 patients tested, 60.7% had at least 1 positive reaction, 23.4% had polysensitization (had >3 allergic reactions,¹⁷ Table 4), and 46.5% had a final primary diagnosis of ACD.

TABLE 2. Race and Common Occupations of Patch Tested Patients

Characteristic	n (%)
Race (n = 4308)	
White	3760 (87.3)
Asiatic	193 (4.5)
Black	168 (3.9)
Other	110 (2.6)
Hispanic	77 (1.8)
Occupation (n = 4088*)	
Not Employed	1584 (38.7)
Retired	719 (17.6)
Homemaker	382 (9.3)
Student	349 (8.5)
Unemployed, looking for work	134 (3.3)
Health care	358 (8.8)
Educator	180 (4.4)
Hairdresser/cosmetologist	58 (1.4)

*Excludes 220 individuals missing industry/occupation codes.

TABLE 3. Body Sites of Dermatitis and Final Diagnoses

Characteristic	Primary, n (%)	Total of Up to 3 Listed, [†] n (%)
Dermatitis site	n = 4300*	n = 4308
Scattered/generalized	907 (21.1)	1101 (25.6)
Hand	866 (20.1)	1031 (24.9)
Face	667 (15.5)	926 (21.5)
Eyelids	392 (9.1)	466 (10.8)
Trunk	250 (5.8)	505 (11.7)
Leg	201 (4.7)	469 (10.9)
Arm	184 (4.3)	596 (13.8)
Scalp	150 (3.5)	236 (5.5)
Lips	138 (3.2)	181 (4.2)
Foot	110 (2.6)	263 (6.1)
Anal/Genital	106 (2.5)	134 (3.1)
Other	102 (2.4)	129 (3.0)
Neck	72 (1.7)	366 (8.5)
Most Exposed Areas	62 (1.4)	76 (1.8)
Ears	47 (1.1)	76 (1.8)
Eyes	24 (0.6)	36 (0.8)
Only under clothes	17 (0.4)	27 (0.6)
Nose	3 (0.1)	3 (0.1)
Erythroderma	2 (0.1)	3 (0.1)
Final diagnoses	n = 4285‡	n = 4308
ACD	1993 (46.5)	2361 (54.8)
Other dermatitis	637 (14.9)	746 (17.3)
Atopic dermatitis	545 (12.7)	688 (16.0)
Irritant contact dermatitis	401 (9.3)	643 (14.9)
Other dermatoses	305 (7.1)	413 (9.6)
Psoriasis	143 (3.3)	222 (5.2)
Nummular dermatitis	87 (2.0)	100 (2.3)
Seborrheic dermatosis	66 (1.5)	92 (2.1)
Photo dermatitis	37 (0.9)	62 (1.4)
Pompholyx	28 (0.7)	28 (0.9)
Contact urticaria	23 (0.5)	34 (0.8)
Stasis dermatitis	20 (0.5)	32 (0.7)

*Excludes 8 with no primary site listed.

†Total of any of up to 3 sites or up to 3 diagnoses listed.

‡Excludes 23 patients with no primary final diagnosis.

Occupation

Of patch-tested patients, almost two fifths (38.7%) were not working. Most in this category were retirees (17.6%), homemakers (9.3%), or students (8.5%); only 3.3% were unemployed/looking for work (Table 2). Common occupations included health care workers (8.8%), educators (4.4%), and hairdresser/cosmetologists (1.4%). Among all tested patients, 9.9% (n = 427) had dermatitis, which was determined to be related to their occupation (Table 1). Of the 812 patients who had a relevant irritant identified, 40.1% (n = 326) were deemed occupationally related. Of the 1022 patients who had relevant non-NACDG allergens identified, 13.9% (n = 142) were related to their occupation.

Allergen Frequencies (Table 5)

There were a total of 6855 positive allergic reactions. The top 10 most frequent allergens (and respective prevalence rates) were as follows: nickel sulfate (15.5%), neomycin (8.7%), fragrance mix I (8.5%), bacitracin (8.3%), *M. pereirae* (7.2%), cobalt chloride (6.2%), formaldehyde (5.8%), quaternium 15 (5.8%), *p*-phenylenediamine (5.5%), and fragrance mix II (4.7%). The performance of the new allergens added to the 2009 to 2010 period, in order of frequency, were as follows: dimethylaminopropylamine (2.0%), oleamidopropyl dimethylamine (1.8%), shellac (1.7%), decyl glucoside (1.5%), majantole (1.4%), carvone (1.1%), *J. grandiflorum* (1.0%), *M. piperita* oil (0.6%), *L. angustifolia* oil (0.2%), and D-limonene (0.1%).

Prevalence Rates for Allergens in the 2009 to 2010 Period as Compared With 2007 to 2008

As shown in Table 5, the positive allergic reaction rates significantly decreased for 20 allergens (nickel, neomycin, *M. pereirae*, cobalt, formaldehyde, quaternium 15, methyldibromoglutaronitrile/phenoxethanol, methylchlorisothiazolinone/methylisothiazolinone, potassium dichromate, diazolidinyl urea, propolis, DMDM hydantoin, 2-bromo-2-nitro-1,3-propanediol, methyl methacrylate, ethyl acrylate, glyceryl thioglycolate, dibucaine, amidoamine, clobetasol, and dimethyloldihydroxyethyleneurea) and significantly increased for 4 allergens (fragrance mix II, iodopropynyl butylcarbamate, propylene glycol, and benzocaine).

Prevalence Rates for Allergens in the 2009 to 2010 Period as Compared With 2001 to 2008

When the positive allergic reaction rates of each antigen in 2009 to 2010 were compared with the pooled prevalence rates for the previous 8 years (2001–2008), 27 allergens had statistically significantly lower rates in 2009 to 2010 (nickel, neomycin,

TABLE 4. Number of Positive Patch Test Reactions Per Patient

No. Positive Reactions to NACDG Screening Series	No. Patients	Percentage, n = 4308
0	1694	39.3%
1	955	22.2%
2	650	15.1%
3	392	9.1%
4	244	5.7%
5	136	3.2%
6	92	2.1%
7	56	1.3%
8	27	0.6%
9	25	0.6%
10	18	0.4%
>10	19	0.4%

TABLE 5. Frequencies of Positive Reactions to NACDG Allergens

Patch Test Allergen	2009–2010						2009–2010 vs 2007–2008 P Value, RR (95% CI)
	n*	Positive Reaction, %	Relevance, %				
			Definite	Probable	Possible	Past	
Nickel sulfate 2.5% pet	4294	15.5	4.4	19.4	43.7	18.3	<.0001, 0.80 (0.73–0.87)
Neomycin 20% pet	4298	8.7	5.9	13.8	10.9	55.9	0.0217, 0.86 (0.76–0.98)
Fragrance mix I 8% pet	4303	8.5	2.5	30.7	57.0	3.3	0.1349, 0.91 (0.80–1.03)
Bacitracin 20% pet	4305	8.3	9.2	25.2	13.2	33.9	0.4849, 1.04 (0.92–1.20)
<i>M. pereirae</i> 25% pet	4308	7.2	1.6	33.0	51.6	3.8	<0.001, 0.65 (0.57–0.75)
Cobalt chloride 1% pet	4303	6.2	0.8	8.6	43.2	15.8	0.0020, 0.76 (0.65–0.88)
Formaldehyde 1% aq	4305	5.8	0.4	26.3	62.5	2.4	0.0003, 0.75 (0.65–0.88)
Quaternium 15 2% pet	4302	5.8	1.6	28.7	61.8	2.8	<0.001, 0.68 (0.58–0.79)
<i>P</i> -Phenylenediamine 1% pet	4292	5.5	5.1	44.1	16.5	16.9	0.6740, 1.04 (0.87–1.24)
Fragrance mix II 14% pet	4307	4.7	3.0	39.3	51.7	1.0	0.0085, 1.31 (1.07–1.61)
Carba mix 3% pet	4308	4.6	7.0	34.5	46.0	1.5	0.8380, 1.02 (0.85–1.23)
Iodopropynyl butylcarbamate 0.5% pet	4304	4.3	3.2	36.6	49.5	0.0	0.0022, 1.38 (1.12–1.70)
Methyldibromoglutaronitrile/phenoxxyethanol 2.0% pet	4303	3.8	1.9	24.1	58.6	3.1	0.0001, 0.69 (0.57–0.84)
Propylene glycol 30% aq	4304	3.2	22.8	32.4	36.0	1.5	0.0009, 1.52 (1.19–1.95)
Thiuram mix 1% pet	4304	3.1	10.6	36.4	35.6	8.3	0.3904, 0.91 (0.73–1.13)
Colophony 20% pet	4306	2.7	5.9	22.0	28.0	22.9	0.7684, 0.96 (0.76–1.23)
Lanolin alcohol 30% pet	4306	2.5	9.3	33.6	47.7	0.9	0.1953, 1.19 (0.91–1.55)
Methylchlorisothiazolinone/methylisothiazolinone 100 ppm aq	4302	2.5	6.5	48.1	38.9	2.8	0.0023, 0.70 (0.55–0.88)
Potassium dichromate 0.25% pet	4306	2.3	0.0	27.6	32.7	4.1	<0.001, 0.56 (0.44–0.71)
Cinnamic aldehyde 1% pet	4304	2.3	2.0	29.0	63.0	1.0	0.7458, 0.96 (0.74–1.24)
Diazolidinyl urea 1% pet	4304	2.2	8.6	31.2	55.9	1.1	0.0072, 0.71 (0.55–0.91)
Imidazolidinyl urea 2% pet	4305	2.2	4.3	28.7	60.6	2.1	0.5334, 0.92 (0.71–1.20)
Propolis 10% pet.	4304	2.1	5.6	15.6	46.7	2.2	<0.0001, 0.43 (0.34–0.54)
Dimethylaminopropylamine 1% aq	4308	2.0	1.1	34.1	58.0	4.5	—
Hydroxyethyl methacrylate 2% pet	4301	2.0	4.6	25.3	31.0	23.0	0.1805, 0.83 (0.63–1.09)
Tixocortol-21-pivalate 1% pet	4304	2.0	20.7	46.0	21.8	8.0	0.1048, 0.80 (0.61–1.05)
Compositae mix 6% pet	4302	1.9	1.2	22.9	43.4	2.4	0.0527, 1.36 (1.00–1.87)
Benzocaine 5% pet	4306	1.8	7.6	10.1	21.5	31.6	0.0440, 1.39 (1.01–1.93)
Oleamidopropyl dimethylamine 0.1% aq	4300	1.8	3.8	23.1	57.7	0.0	—
Shellac 20% alc	4301	1.7	2.7	9.6	37.0	11.0	—
Epoxy resin 1% pet	4306	1.6	4.5	29.9	23.9	14.9	0.7271, 0.95 (0.69–1.30)
<i>P</i> -tert-butylphenol formaldehyde resin 1% pet	4308	1.5	4.5	16.7	34.8	15.2	0.1962, 1.26 (0.89–1.78)
Decyl glucoside 5% pet	4302	1.5	7.6	24.2	48.5	3.0	—
Ethylenediamine dihydrochloride 1% pet	4307	1.4	0.0	8.5	18.6	40.7	0.6757, 0.93 (0.67–1.30)
Cocamidopropyl betaine 1% aq	4304	1.4	6.8	40.7	49.2	1.7	0.2018, 1.27 (0.88–1.82)
Majantole 5% pet	4303	1.4	0.0	23.0	54.1	4.9	—
<i>Canaga odorata</i> oil (ylang ylang) 2% pet	4303	1.3	0.0	25.9	55.2	0.0	0.6877, 0.93 (0.66–1.32)
Carvone 5% pet	4302	1.1	0.0	29.2	47.9	6.3	—
DMDM hydantoin 1% pet	4304	1.0	4.4	26.7	62.2	0.0	<0.0001, 0.37 (0.26–0.52)
Mixed dialkyl thioureas 1% pet	4303	1.0	18.2	25.0	34.1	11.4	0.6398, 1.10 (0.73–1.67)
2-Bromo-2-nitro-1,3-propanediol 0.5% pet	4304	1.0	0.0	19.5	63.4	2.4	<0.0001, 0.32 (0.23, 0.45)
DL-alpha tocopherol 100%	4304	1.0	7.3	36.6	51.2	0.0	0.9836, 1.00 (0.67–1.49)
Disperse blue mix 106/124 1% pet†	4300	1.0	0.0	25.6	34.9	2.3	0.6381, 1.10 (0.73–1.67)
Tea tree oil, oxidized 5% pet	4299	1.0	14.3	35.7	21.4	4.8	0.0797, 0.72 (0.49–1.04)
<i>J. officinale</i> oil (<i>J. grandiflorum</i>) 2% pet	4302	1.0	0.0	17.8	73.3	4.4	—
2-Hydroxy-4-methoxy-benzophenone (benzophenone-3) 10% pet‡	4302	0.9	15.8	31.6	39.5	2.6	0.9936, 1.00 (0.66–1.53)
Tosylamide formaldehyde resin 10% pet	4299	0.9	10.3	30.8	25.6	10.3	0.6307, 0.90 (0.60–1.37)

(Continued on next page)

2001–2008								2009–2010 vs 2001–2008 P Value, RR (95% CI)
2007–2008		2005–2006		2004–2003		2001–2002		
Pos, %	n	Pos, %	n	Pos, %	n	Pos, %	n	
19.5	5045	19.0	4428	18.7	5129	16.9	4515	<0.0001, 0.84 (0.77–0.90)
10.1	5072	10.0	4439	10.6	5137	11.4	4517	0.004, 0.83 (0.74–0.91)
9.4	5079	11.5	4439	9.1	5140	10.2	4511	0.030, 0.85 (0.76–0.95)
7.9	5077	9.2	4437	7.9	5143	7.7	4514	0.7624, 1.02 (0.91–1.14)
11.0	5083	11.9	4449	10.6	5140	11.5	4524	<0.001, 0.64 (0.57–0.72)
8.2	5080	8.4	4429	8.4	5141	7.5	4512	<0.001, 0.76 (0.67–0.86)
7.7	5081	9.0	4445	8.7	5142	8.5	4523	<0.001, 0.69 (0.60–0.78)
8.6	5081	10.3	4446	8.9	5139	9.3	4524	<0.001, 0.63 (0.55–0.72)
5.3	5074	5.0	4428	4.7	5136	4.8	4517	0.1373, 1.11 (0.97–1.28)
3.6	5071	—	—	—	—	—	—	—
4.5	5080	3.9	4443	4.0	5142	4.5	4521	0.2803, 1.09 (0.93–1.27)
3.1	5082	2.4	4435	—	—	—	—	<0.001, 1.55 (1.29–1.86)
5.5	5083	5.8	4437	6.1	5140	5.5	4511	<0.001, 0.66 (0.57–0.78)
2.1	5083	2.9	4439	3.3	5143	4.1	4513	0.6700, 1.04 (0.87–1.25)
3.4	5079	3.9	4443	4.6	5141	4.6	4521	0.0017, 0.75 (0.63–0.90)
2.8	5083	2.2	4447	2.8	5143	2.7	4522	0.8309, 1.02 (0.84–1.25)
2.1	5079	1.8	4451	2.2	5145	2.3	4521	0.1012, 1.19 (0.97–1.47)
3.6	5075	2.8	4437	2.2	5137	2.3	4509	0.4108, 0.92 (0.75–1.13)
4.1	5081	4.8	4449	4.3	5142	4.1	4526	<0.001, 0.53 (0.43–0.65)
2.4	5079	3.1	4435	2.4	5138	—	—	0.2602, 0.88 (0.71–1.10)
3.1	5082	3.7	4439	3.5	5139	3.2	4511	<0.0001, 0.66 (0.53–0.81)
2.4	5082	2.9	4438	2.9	5139	3.1	4511	0.0257, 0.78 (0.63–0.97)
4.9	5067	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2.4	5065	—	—	—	—	—	—	—
2.5	5083	2.7	4437	2.7	5142	2.9	4515	0.0089, 0.74 (0.59–0.93)
1.4	5080	1.2	4434	1.3	5138	1.0	4500	0.0006, 1.55 (1.21–1.98)
1.3	5082	1.9	4446	1.7	5145	1.7	4522	0.4162, 1.11 (0.87–1.42)
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1.7	5075	1.8	4439	1.8	5143	2.4	4522	0.1651, 0.84 (0.65–1.08)
1.2	5080	1.3	4444	1.8	5142	1.9	4524	0.8321, 0.97 (0.74–1.27)
—	—	—	—	—	—	—	—	—
1.5	5078	1.9	4444	2.4	5143	2.8	4523	0.0016, 0.65 (0.50–0.85)
1.1	5082	1.8	4436	1.8	5137	2.9	4505	0.0318, 0.74 (0.57–0.98)
—	—	—	—	—	—	—	—	—
1.4	5080	1.5	4434	1.2	5137	1.2	4506	0.8989, 0.98 (0.74–1.31)
—	—	—	—	—	—	—	—	—
2.7	5082	2.6	4439	2.3	5140	2.8	4511	<0.0001, 0.39 (0.28–0.53)
0.9	5081	1.0	4430	1.0	5140	0.7	4512	0.5491, 1.11 (0.79–1.54)
3.7	5081	3.4	4435	2.3	5140	3.4	4511	<0.0001, 0.33 (0.24–0.45)
1.0	5082	0.7	4435	1.1	5139	1.1	4493	0.9161, 1.02 (0.73–1.42)
0.9	5080	2.1	4426	1.9	5136	3.0	4501	<0.0001, 0.52 (0.38–0.70)
1.4	5078	1.4	4435	0.9	5137	—	—	0.2351, 0.82 (0.59–1.14)
—	—	—	—	—	—	—	—	—
0.9	5083	0.7	4436	0.7	5144 5139	0.6	4513	0.2291, 1.23 (0.87–1.77)
1.0	5078	1.3	4434	1.7	—	1.5	4511	0.0135, 0.66 (0.47–0.92)

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TABLE 5. Frequencies of Positive Reactions to NACDG Allergens (continued)

Patch Test Allergen	2009–2010						2009–2010 vs 2007–2008 P Value, RR (95% CI)
	n*	Positive Reaction, %	Relevance, %				
			Definite	Probable	Possible	Past	
Cocamide DEA 0.5% pet	4304	0.9	2.6	31.6	60.5	0.0	0.1666, 0.75 (0.51–1.13)
Glutaral 1% pet	4293	0.9	0.0	15.0	15.0	7.5	0.3465, 0.82 (0.55–1.24)
Paraben mix 12% pet	4304	0.8	5.6	47.2	41.7	0.0	0.1223, 0.72 (0.47–1.10)
Methyl methacrylate 2% pet	4305	0.8	5.9	38.2	26.5	17.6	0.0472, 0.66 (0.43–1.00)
Budesonide .01% pet	4304	0.8	11.4	31.4	31.4	17.1	0.5458, 0.87 (0.56–1.36)
Mercaptobenzothiazole 1% pet	4307	0.07	0.0	37.5	43.8	9.4	0.1092, 0.69 (0.44–1.09)
Black rubber mix 0.6% pet	4307	0.7	0.0	21.9	21.9	18.8	0.1090, 0.69 (0.44–1.09)
Ethyl acrylate 0.1% pet	4301	0.7	3.4	27.6	34.5	17.2	0.0131, 0.58 (0.38–0.90)
Hydrocortisone-17-butyrate 1% pet	4304	0.7	12.5	40.6	28.1	9.4	0.2346, 1.38 (0.81–2.34)
Lidocaine 15% pet	4300	0.7	34.5	20.7	17.2	13.8	0.2621, 0.77 (0.49–1.22)
Mercapto mix 1% pet	4307	0.6	0.0	40.7	44.4	7.4	0.9333, 1.02 (0.61–1.73)
Sesquiterpene lactone mix 0.1% pet	4302	0.6	4.0	40.0	36.0	4.0	0.9322, 1.02 (0.61–1.73)
Glyceryl thioglycolate 1% pet	4291	0.6	3.7	22.2	25.9	25.9	<0.0001, 0.34 (0.22–0.52)
<i>M. piperita</i> oil (peppermint oil) 2% pet	4303	0.6	0.0	36.0	36.0	4.0	—
4-chloro-3,5-xyleneol (PCMX, chloroxylenol) 1% pet.	4304	0.5	0.0	31.8	50.0	0.0	0.3946, 1.30 (0.71–2.38)
Dibucaine (cinchocaine hydrochloride) 2.5% pet	4299	0.5	13.6	4.5	13.6	45.5	0.0010, 0.44 (0.27–0.73)
Amidoamine (stearamidopropyl dimethylamine) 0.1% aq	4304	0.3	7.1	50.0	35.7	0.0	<0.0001, 0.19 (0.11–0.34)
Clobetasol-17-propionate 1% pet	4304	0.3	15.4	46.2	30.8	7.7	0.0393, 0.51 (0.27–0.98)
Dimethylol dihydroxyethyleneurea 4.5% aq.	4302	0.3	0.0	21.4	35.7	0.0	0.0392, 0.51 (0.27–0.98)
Desoximetasone 1% pet	4304	0.2	0.0	28.6	28.6	28.6	0.8987, 1.06 (0.43–2.61)
Benzyl alcohol 1% pet	4304	0.2	0.0	37.5	37.5	12.5	0.1088, 0.53 (0.24–1.17)
<i>L. angustifolia</i> oil (lavender oil) 2% pet	4302	0.2	10.0	20.0	50.0	10.0	—
D-limonene 3% pet	4304	0.1	0.0	0.0	100.0	0.0	—

*n, number tested to specific allergen.

†2007 to 2008 cycle tested disperse blue 106 (not the 106/124 mix).

‡2007 to 2008 cycle tested 3% benzophenone (not 10%).

CI, confidence interval; DEA, diethanolamine; DMDM, dimethylol dimethyl; NC, not calculated; NT, not tested; RR, risk ratio; PCMX, parachlorometaxylenol; Pos, percent positive. Values in italics are statistically significant ($p > 0.05$).

fragrance mix I, *M. pereirae*, cobalt, formaldehyde, quaternium 15, methyldibromoglutaronitrile/phenoxyethanol, thiuram mix, potassium dichromate, diazolidinyl urea, imidazolidinyl urea, tixocortol pivalate, ethylenediamine, cocamidopropyl betaine, DMDM hydantoin, 2-bromo-2-nitro-1,3-propanediol, disperse blue 106/124, tosylamide formaldehyde resin, methyl methacrylate, budesonide, ethyl acrylate, glyceryl thioglycolate, dibucaine, amidoamine, clobetasol, and dimethyloldihydroxyethyleneurea). Only 2 allergens had statistically higher rates in 2009 to 2010 (iodopropynyl butylcarbamate and compositae mix).

Detection Rate of NACDG Standard

Of tested patients, 23.7% ($n = 1022$) had a relevant allergen that was not on the NACDG standard. Specific names of non-NACDG allergens are not collected in the database. The 10 most common sources of non-NACDG allergens were personal care products (not otherwise specified), clothing, moisturizers, jewelry, hair dye, adhesives, topical antibiotics, food products, fragrances, and lipstick (Table 6).

Hypothetical Detection Rate of TRUE TEST Versus NACDG Standard

During this data period, there were 3 antigens on the 36-panel TRUE TEST (SmartPractice Denmark, Hillerød, Denmark) that

TABLE 6. Ten Most Common Sources of Non-NACDG Allergens

Source	No. Patients	Percentage, $n = 1022$
Cosmetics (personal care products), not otherwise specified	218	21.3%
Clothing	83	8.1%
Moisturizers, lotions	71	6.9%
Jewelry	65	6.3%
Hair dye	37	3.6%
Adhesives, glues, bonding agents	27	2.6%
Topical antibiotics	26	2.5%
Food products	20	2.0%
Perfumes, fragrances	20	2.0%
Lipstick	19	1.9%

2001–2008								2009–2010 vs 2001–2008 P Value, RR (95% CI)
2007–2008		2005–2006		2004–2003		2001–2002		
Pos, %	n	Pos, %	n	Pos, %	n	Pos, %	n	
1.2	5082	1.0	4437	1.1	5137	1.2	4500	0.2055, 0.80 (0.57–1.13)
1.1	5072	1.3	4413	1.2	5135	1.3	4489	0.0859, 0.75 (0.53–1.04)
1.1	5082	1.2	4439	1.1	5142	0.6	4512	0.1895, 0.78 (0.55–1.12)
1.2	5077	1.0	4427	1.6	5143	1.5	4514	0.0036, 0.59 (0.42–0.85)
0.9	5083	1.5	4439	1.8	5141	1.1	4515	0.0034, 0.59 (0.41–0.85)
1.0	5083	0.9	4442	1.3	5143	0.8	4521	0.0550, 0.69 (0.47–1.01)
1.0	5082	1.0	4442	1.0	5141	1.0	4521	0.0662, 0.70 (0.48–1.03)
1.2	5076	0.9	4428	1.1	5141	1.3	4512	0.0115, 0.62 (0.42–0.90)
0.5	4937	0.6	4438	0.5	5140	0.4	4502	0.1203, 1.38 (0.92–2.08)
0.9	5077	1.1	4429	0.6	5137	0.7	4505	0.3970, 0.85 (0.57–1.25)
0.6	5082	0.8	4444	0.9	5143	0.6	4522	0.3916, 0.83 (0.55–1.27)
0.6	5078	0.7	4432	0.6	5140	0.6	4510	0.8994, 0.97 (0.64–1.49)
1.8	5073	1.6	4422	1.1	5134	1.9	4510	<0.0001, 0.38 (0.26–0.57)
—	—	—	—	—	—	—	—	—
0.4	5083	0.5	4436	0.7	5141	0.6	4512	0.7670, 0.93 (0.59–1.48)
1.1	5074	1.1	4426	1.0	5137	1.0	4504	0.0006, 0.47 (0.30–0.73)
1.6	5081	2.0	4434	1.7	5139	2.4	4511	<0.0001, 0.16 (0.09–0.28)
0.6	5082	0.8	4435	0.7	5140	—	—	0.0039, 0.44 (0.25–0.78)
0.6	5078	0.6	4424	0.8	5138	1.1	4502	0.0007, 0.39 (0.22–0.69)
0.2	5070	—	—	—	—	—	—	—
0.4	5083	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—

were not on the NACDG screening series (thimerosal, gold, and quinoline mix). Assuming that individual components of a mix would have been detected with a mix and vice versa (eg, benzocaine and dibucaine NACDG antigens would have been detected by the caine mix of TRUE TEST; sesquiterpene lactone mix and compositae mix NACDG antigens would have been detected by parthenolide of TRUE TEST), there were 35 NACDG antigens that would have been theoretically detected by the current 36-panel TRUE TEST. The remaining 35 NACDG allergens (not on TRUE TEST) accounted for 1834 allergic reactions. Thus, theoretically, TRUE TEST alone would have missed 26.7% of reactions (1834/6855) found during this NACDG data cycle.

Significance-Prevalence Index Numbers for NACDG Allergens

The SPIN calculations¹⁴ and order ranking for this reporting period are listed in Table 7.

Common Sources of Irritants

The 10 most common sources of identified irritants were soaps (not meant for skin use; eg, laundry detergent, industrial cleansers),

personal care products, persons (eg, saliva, sweat), skin soaps, moisturizers, water, metalworking fluids, and athletic equipment (Table 8).

DISCUSSION

Many of the current findings are consistent with previous NACDG reports. As compared with the last reporting cycle, the individual components of MOAHLFAP¹⁵ varied by less than 3%. The polysensitization rate in the last cycle was 26.3% and is 23.4% this cycle. The sites of dermatitis and final diagnoses (Table 3) are relatively unchanged as well.¹⁰

The composition of the top 10 most frequently positive allergens continues to be 2 metals (nickel and cobalt), 2 antibiotics (neomycin and bacitracin), 3 fragrances (fragrance mix I, fragrance mix II, and *M. pereirae*), 2 preservatives (formaldehyde and quaternium 15), and paraphenylenediamine. This is similar to the 2007 to 2008 top 10 list with the exception of fragrance mix II (which moved up from position no. 14 to 10) and methyldibromoglutaronitrile/phenoxyethanol (which moved down from position no. 9 to 13). In the current top 10 group, there were statistically significant decreases in rates from both the previous

TABLE 7. Significance-Prevalence Index Number

Rank	Patch Test Allergen	SPIN
1	Nickel sulfate 2.5% pet	491
2	Fragrance mix I 8% pet	354
3	<i>M. pereirae</i> 25% pet	291
4	Bacitracin 20% pet	250
5	Quaternium 15 2% pet	238
6	Formaldehyde 1% aq	223
7	P-Phenylenediamine 1% pet	218
8	Fragrance mix II 14% pet	216
9	Carba mix 3% pet	207
10	Iodopropynyl butylcarbamate 0.5% pet	188
11	Propylene glycol 30% aq	180
12	Neomycin 20% pet	162
13	Thiuram mix 1% pet	143
14	Methylidibromoglutaronitrile/phenoxyethanol 2.0% pet	142
15	Cobalt chloride 1% pet	129
16	Methylchloroisothiazolinone/Methylisothiazolinone 100 ppm aq	128
17	Lanolin 30% pet	118
18	Tixocortol-21-pivalate 1% pet	116
19	Diazolidinyl urea 1% pet	105
20	Cinnamic aldehyde 1% pet	96
21	Imidazolidinyl urea 2% pet	95
22	Dimethylaminopropylamine 1% aq	85
23	Colophony 20% pet	80
24	Cocamidopropylbetaine 1% aq	70
25	Oleamidopropyl dimethylamine 0.1% aq	68
26	Potassium dichromate 0.25% pet	67
27	Propolis 10% pet	65
28	Hydroxyethyl methacrylate 2% pet	63
29	Decyl glucoside 5% pet	60
30	Compositae mix 6% pet	58
31	Epoxy resin 1% pet	51
32	DL alpha tocopherol 100%	48
33	Majantole 5% pet	46
34	Ylang ylang 2% pet	46
35	Thioureas 1% pet	46
36	Tea tree oil 5% pet	45
37	Benzophenone-3 10% pet†	45
38	DMDM hydantoin 1% pet	43
39	<i>p</i> -tert-Butylphenol formaldehyde resin 1% pet	41
40	Paraben mix 12% pet	40
41	Benzocaine 5% pet	39
42	Cocamide DEA 0.5% pet	39
43	Carvone 5% pet	38
44	Lidocaine 15% pet	38
45	Shellac 20% alc	36
46	<i>J. grandiflorum</i> 2% pet	36
47	Tosylamide formaldehyde resin 10% pet	35
48	2-bromo-2-nitro-1,3-propanediol 0.5% pet	34
49	Budesonide .01% pet	34
50	Hydrocortisone-17-butyrate 1% pet	34
51	Methyl methacrylate 2% pet	31
52	Disperse blue 106/124 mix 1% pet*	28
53	Sesquiterpene lactone mix 0.1% pet	26

TABLE 7. (Continued)

Rank	Patch Test Allergen	SPIN
54	Mercapto mix 1% pet	25
55	Ethyl acrylate 0.1% pet	23
56	<i>M. piperita</i> oil 2% pet	22
57	PCMX 1% pet	19
58	Clobetasol-17-propionate 1% pet	17
59	Ethylenediamine 1% pet	16
60	Glyceryl thioglycolate 1% pet	16
61	Amidoamine 0.1% aq	16
62	Black rubber mix 0.6% pet	15
63	Glutaraldehyde 1% pet	13
64	Dibucaine 2.5% pet	10
65	Dimethyloldihydroxyethyleneurea 4.5% aq	8
66	Benzyl alcohol 1% pet	8
67	<i>L. angustifolia</i> oil 2% pet	8
68	Desoximetasone 1% pet	6
69	Mercaptobenzothiazole 1% pet	3
70	D-limonene 3% pet	3

SPIN,¹⁴ a weighted calculation depending upon the degree of certainty ascribed to relevance.

Calculation = (proportion of population allergic) × (1 × Rdefinite + 0.66 × Rpossible + 0.33 × Rprobable) × 100.

*2007 to 2008 used disperse blue 106 (not the 106/124 mix).

†2007 to 2008 used 3% benzophenone (not 10%)

DEA, diethanolamine; NT, not tested.

reporting cycle (2007–2008) and the pooled rates from the previous 8 years (2001–2008) for 6 allergens: nickel, neomycin, *M. pereirae*, cobalt, formaldehyde, and quaternium 15. This could be due to several reasons: (1) change in antigen manufacturer (quality control checks of several of these allergens, however, found acceptable levels; data not shown), (2) true decreased prevalence, and (3) referral bias (these allergens are all found on the TRUE TEST; thus, it is possible that patients with positive reactions to

TABLE 8. Ten Most Common Sources of Irritants

Source	No. Patients, n = 812	Percentage
Soaps, detergents, cleansers (not meant for skin use), not otherwise specified	151	18.6%
Cosmetics (personal care products), not otherwise specified	82	10.1%
Persons (eg, saliva, sweat)	37	4.6%
Soaps, detergents, cleansers (meant for skin use), not otherwise specified	23	2.8%
Liquid, lotion and bar skin soaps	23	2.8%
Moisturizers, lotions	23	2.8%
Miscellaneous health care devices	23	2.8%
Water	19	2.3%
Metalworking fluids	18	2.2%
Recreational, athletic equipment	17	2.1%

these allergens were not sent to NACDG tertiary referral centers for further testing, resulting in lower rates). Importantly, this is the first year since 1994 that the positive reaction rate to nickel has not increased. Unlike Europe, there is no nickel^{18,19} or methyldibromoglutaronitrile²⁰ regulation in the United States or Canada. It is possible that international companies that market products globally use the same formulation (with decreased content required by the European Union) in the United States and Canada as in Europe. The next several data cycles will help clarify whether these decreases are true trends.

The positivity rates for 4 allergens (propylene glycol, benzocaine, iodopropynyl butylcarbamate, and fragrance mix II) were statistically significantly increased. For propylene glycol (3.2%) and benzocaine (1.8%), this is likely due to an isolated dip during the 2007 to 2008 cycle (2.1% and 1.3%, respectively); previous cycles are consistent with current 2009 to 2010 rates (2.9%–4.1% and 1.7%–1.9%, respectively). Iodopropynyl butylcarbamate and fragrance mix II are relatively new screening allergens. A 0.5% concentration of iodopropynyl butylcarbamate has been tested on the NACDG screening series for a total of 3 data cycles; the positivity rate has steadily increased over that time (2.4%, 3.1%, 4.3%). Detailed NACDG data on iodopropynyl butylcarbamate are reported elsewhere.²¹ Fragrance mix II was formulated to address the changing composition of fragrance ingredients in consumer products^{22,23}; it has been tested by the NACDG since 2007. The increase in positivity from 3.6% to 4.7% may indicate clinical importance; however, current relevance rate (94.0%) was similar to fragrance mix I (90.2%), likely because of both the ubiquitous nature of fragrance ingredients and lack of listing of individual fragrance ingredients, resulting in a large number of “possible” relevance ratings. As with fragrance mix I, caution should be used when interpreting weak/doubtful reactions.²⁴

The positivity rate of the new allergens added to the 2009 to 2010 data period were 1% to 2% for the surfactants dimethylaminopropylamine (2.0%), oleamidopropyl dimethylamine (1.8%), and decyl glucoside (1.5%); current relevance rates were high for this group (93.2%, 84.6%, and 80.3%, respectively). Like cocamidopropyl betaine and amidoamine, these agents are mild irritants so macular erythema should be interpreted with caution.^{25,26} The positivity rate to shellac was 1.7%, but only 49.3% of those reactions were currently relevant. Most reported cases of confirmed shellac allergy have been due to eye^{27–29} or lip^{30,31} products. Anecdotal experience from the NACDG is that shellac 20% in alcohol may also be an irritant. The remaining new allergens were flavoring/perfume ingredients; positive rates and respective current relevance rates were as follows: majantole (1.4%, 77.1%), carvone (1.1%, 77.1%), *J. grandiflorum* (1.0%, 91.1%), *M. piperita* oil (0.6%, 72.0%), *L. angustifolia* oil (0.2%, 80%), and D-limonene (0.1%, 100%).

There was no statistically significant difference in positivity rate to benzophenone-3 when the concentration was increased from 3% to 10%. Although there was no statistically significant change in positivity rate for disperse blue 124/106 mix (1.0%)

compared with disperse blue 106 alone in the last data cycle (0.9%), the rate was about half that of the previous 4 cycles.

Of the 35 antigens on the current TRUE Test, 3 are not on, or related to, NACDG standard antigens (thimerosal, gold, and quinoline mix). Hypothetically, the 32 antigens common to TRUE Test and the NACDG standard would have detected up to 73.7% of reactions found during this data period. Of the top 40 NACDG allergens, the following antigens are not on TRUE Test: fragrance mix II, iodopropynyl butylcarbamate, propylene glycol, propolis, dimethylaminopropylamine, hydroxyethyl methacrylate, oleamidopropyl dimethylamine, shellac, decyl glucoside, cocamidopropyl betaine, majantole, ylang ylang oil, carvone, DMDM hydantoin, and mixed dialkyl thioureas.

Importantly, the NACDG screening series is not meant to serve as a general series; the American Contact Dermatitis Society Core Antigen Series (up to 80 allergens) is recommended for this purpose³² (also available at www.contactderm.org). NACDG antigens are added and deleted based on new data in the literature and the member experience. All NACDG members patch test with additional allergens; almost one quarter of patients tested during this data period had at least 1, currently relevant reaction to a non-NACDG antigen. This underscores the importance of testing supplemental antigens, personal products, and workplace materials.

There are several limitations of these data. First, the NACDG data represent a referral patient group and thus does not reflect the general population nor general dermatology patients. Second, patch testing is less of a perfect science and more of a learned art. Distinctions between positive and irritant reactions, occupational relevance, source codes, and other collected variables are, in some cases, subjective. Third, the NACDG does not collect data on non-NACDG allergens other than presence and source.

CONCLUSIONS

Appropriate history, skin examination, and patch testing can lead to significant benefit in the diagnosis and management of care for patients with eczematous eruptions. Patch testing remains a critical diagnostic tool in the evaluation of patients with suspected ACD. This latest NACDG data summary for 2009 to 2010 adds to the references available on emerging trends and patterns in the field.

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