
Prevalence of sensitization to aeroallergens in California patients with respiratory allergy

Allergy Skin Test Project Team were members of the California State Society of Allergy, Asthma and Immunology: Stanley Galant, MD; William Berger, MD; Sherwin Gillman, MD; Alan Goldsobel, MD; Gary Incaudo, MD; Lewis Kanter, MD; Steven Machtinger, MD; Arthur McLean, MD; Bruce Prenner, MD; William Sokol, MD; Sheldon Spector, MD; Michael Welch, MD; and William Ziering, MD

Background: The number of allergy skin tests required to evaluate patients with respiratory allergy has recently been challenged by the managed care community.

Objectives: The purpose of this study was to determine which aeroallergens are prevalent in patients with respiratory allergy (allergic rhinitis and bronchial asthma) in California.

Methods: Utilizing aeroallergens thought to be relevant from recent aerobiologic and botanic data, 141 allergic and 17 asymptomatic control subjects were tested for the prevalence of 103 allergens. A standardized prick puncture technique and standardized interpretation of wheal/flare responses were utilized using the same lot of allergen for 13 allergy practices distributed throughout California. Frequency curves based on prevalence were established to determine the number of tests required to give up to 90% of positive responses for tree, weed and grass pollen, mold spores, and miscellaneous allergens which included house dust mite, cat, dog, and cockroach allergens.

Results: Positive responses in allergic subjects for grasses ranged from 46% to 54%, for weeds 19% to 37%, and for trees 10% to 42%. For molds the range was from 11% to 22%. The response rate for *Dermatophagoides pteronyssinus* was 53%, for *Dermatophagoides farinae* 42%, for cat pelt 39% and cat hair 37%, for cockroach 23% and dog dander 19%. Asymptomatic control subjects responded to only 4% of all allergens tested. Ninety percent of all positive tests required three miscellaneous allergens (house dust mite, cat, and cockroach), 9 molds, 2 grasses, 16 weeds, and 27 trees for a total of 57 allergens (56% of total tested). There was no clear relationship between locale and specific allergen response, probably related to the limited number of subjects tested and variability within the same geographic region. Several seldom tested tree and weed allergens showed a higher prevalence rate than several commonly tested for allergens.

Conclusions: This preliminary study suggests that approximately 57 aeroallergens might be adequate to detect 90% of all positive responses in patients with respiratory allergy in California. This study was limited by subject number and variability between study sites. It is hoped a standardized model can be developed from this pilot study to definitively determine which aeroallergens are relevant in the United States.

Ann Allergy Asthma Immunol 1998;81:203-210.

INTRODUCTION

For many years skin testing with a variety of inhalant allergens has been

utilized to diagnose specific IgE antibodies in patients with respiratory tract allergic disease. Recent questions regarding the number of tests that would be appropriate for these patients have been raised mainly because of financial concerns.^{1,2} This has brought into focus the lack of precise data to validate current allergy practice. Standard

literature describes regional aerobiology³ and skin test techniques,⁴⁻⁷ but there is no consensus in regard to specific recommendations based on scientific methodology appropriate to the optimal technique (ie, epicutaneous and/or intracutaneous), standardized interpretation of these tests, or the number of allergy skin tests that are necessary for diagnosis and initiation of immunotherapy.²⁻⁸ Furthermore, lack of allergen standardization makes comparison of different studies difficult. Current skin test practices usually reflect information based on previous training and clinical experience, which can vary tremendously. This is in contrast with what has been ideally accepted as the basis for selection of allergens, a thorough history correlated with knowledge of botanical and aerobiological data for a particular area, and information regarding allergenicity of these agents. The purpose of this study, proposed by the California Society of Allergy, Asthma and Clinical Immunology (CSAASI), was to establish a model protocol to determine potentially clinically relevant aeroallergens (eg, pollens, molds, and indoor allergens) that should be considered appropriate for skin testing in the patient with inhalant respiratory tract allergy.

METHODS AND MATERIALS

Participants

Thirteen members of the Society geographically distributed throughout California (Table 1) volunteered to test their patients prospectively with a series of aeroallergens selected by James Thompson, PhD (Botanical Technical

Financial support: Bayer Corporation/Pharmaceutical Division/Allergy Products.

Received for publication October 28, 1997.

Accepted for publication in revised form July 1, 1998.

Table 1. Investigator Distribution

Investigator	Location	Patients	Controls
Northern			
California			
AG	San Jose	7	2
SM	Redwood City	4	0
GI	Chico	15	1
Central			
California			
AM	San Luis Obispo	11	2
LK	Camarillo	11	1
WZ	Fresno	4	0
Southern			
California			
SPG	Orange (Orange Co)	11	2
WB	Mission Viejo (Orange Co)	20	2
WS	Newport Beach/Irvine (Orange Co)	19	2
SAG	Orange (Orange Co)	4	0
SS	Los Angeles	14	2
MW	San Diego	11	1
BP	San Diego	10	2
Totals		141	17

Services/Bayer Corporation/Pharmaceutical Division/Allergy Products) based on recent botanical field surveys of relevant plants and aerobiologic data. In addition, the prevalence of positive skin tests to house dust mite, cockroach, cat and dog dander was also determined in this population.

Subject Selection

Subjects were evaluated by a standard history and physical examination form. Subjects were included for the study if they demonstrated the following: male or non-pregnant female greater than 18 years of age, history of allergic rhinitis and/or allergic asthma of at least 12 months' duration, symptomatology that was related to aeroallergen exposure, patients living in a specific area for at least the past 2 years, the ability of the subject to withhold all antihistaminic medications for at least 5 days, no previous immunotherapy, and phys-

ical examination consistent with allergic rhinitis and/or asthma. Subjects agreed to undergo 100 to 120 prick-puncture tests. Informed consent was obtained on all subjects. They were excluded if they had received astemizole or were receiving beta-blockers, tricyclic antidepressants or chronic high dosage corticosteroids (greater than 30 mg per day of prednisone or equivalent for greater than 2 weeks). Each center was asked to evaluate 20 allergic subjects and 2 non-atopic, asymptomatic controls established by history and physical examination matched by age and sex.

Skin Testing

Allergen selection. Allergens were provided by Bayer to all investigators with the same lot number used for all centers. These glycerinated allergens were generally designated weight by volume including pollens 1:20, mold

extracts 1:100, cockroach 1:10, and dog dander 1:50, while standardized allergens included cat pelt and cat dander at 10,000 BAU/mL and *Dermatophagoides farinae* (Df) and *D. pteronyssinus* (Dp) 30,000 AU/ml. Histamine phosphate (1 mg/mL histamine based: Eli Lilly Co, Indianapolis, IN) 1:1,000 weight by volume was the positive control and 50% glycerinated saline the negative control. All materials were refrigerated at 4°.

Skin test technique. The prick puncture method utilized a lancet (Prick Lancetter) from Bayer⁹ for epicutaneous testing using the back as a skin test site, separating each test by approximately 3 cm. A different lancet was used for each test to prevent carryover of allergens. In the performance of the prick puncture test, the lancet was pressed at a 90 degree angle to the skin test surface through a drop of extract or control solution exerting moderate pressure. Both wheal and flare response was measured in millimeters as the average of the largest diameter and the perpendicular to the mid-point of this diameter. The results were interpreted as follows: a 1+ was a wheal less than 3 mm greater than the negative control and erythema less than 10 mm; 2+ was a wheal of 3 to 5 mm greater than the negative control and/or a flare of 10 mm or greater;^{9,10} a 3+ reaction was a wheal 5–10 mm greater than the negative control; and a 4+ reaction was a 10 mm wheal greater than the negative control associated with pseudopodia.^{11,12} The histamine control had to be 2+ or greater for the patient's skin to be suitable for interpretation. Tests were interpreted at 15 minutes. All medical personnel participating in the study were instructed and demonstrated competency in the prick puncture technique and interpretation prior to the study. A response was considered positive in this study if the reaction was 2+ or greater.

Analysis of Data. A rank order was established for each allergen category based on the prevalence of positive skin test responses. From these data best fit frequency curves were established in each category to determine

Table 2. Frequency of Positive Responses to Grasses Across Investigators' Sites

% Positive	Allergen	No. Positive	Total
54.0	Orchard grass	74	137
51.8	Perennial ryegrass	72	137
51.1	Kentucky bluegrass	70	137
48.2	Smooth brome	66	137
46.0	Bermuda grass	63	137

the number of tree, weed, grass, mold, and environmental allergens required to detect 70%, 80%, and 90% positivity for each allergen.

The study was conducted between October 1994 and December 1995.

RESULTS

Table 1 shows the 13 sites participating and the number of atopic subjects and non-atopic asymptomatic controls for each site. There were 141 atopic subjects and 17 controls. The data analyzes 137 patients for all allergens, except trees with 132 patients, since not all patients had complete testing. The northern, central, and southern areas of California were represented. Seven of the 13 centers were in Southern California (Orange County, San Diego and Los Angeles), which is a large geographic area, and four were in Orange County.

Shown in Tables 2–6 is the frequency and rank order of positive responses for each allergen category. For pollens, grasses were the most preva-

lent ranging from 46% to 54% (Table 2); for weeds the range was 19% to 37% (Table 3), and for trees 10% to 42% (Table 4). At the genus level, the results were fairly similar. For example, Southern California black walnut showed a prevalence of 26% and black walnut 27%, coast live oak was 22%, while swamp oak was 29% (Table 4). Similarly, shad scales were 30% and wing scales were 33% (Table 3). For fungi, the range was 11% to 22% (Table 5). The miscellaneous group is shown in Table 6. For house dust mite, Dp was 53% and Df 42% positive. Cat pelt was 39% and cat hair was 37%, while cockroach was 23% and dog dander 19%. Data were pooled from all sites since the number per site was relatively small.

The best fit frequency curves seen in Figures 1–5 show the number of allergens needed to get 70%, 80%, and 90% of all positive responses in that category determined by extrapolation from the curve. However, the actual number of tests required for 70%,

80%, and 90% were reduced by assumptions of cross-reactivity in the various categories. For example, extrapolating from the frequency curve in Figure 1 for grasses, three were required to give 70%, four for 80%, and approximately five for 90% of all positive responses. However, since orchard, rye, blue and brome grass presumably cross-react, only one from this group and Bermuda or two grasses out of five tested would be necessary for 70%, 80%, or 90% of all positive responses. For weeds, species of the same genera were combined so 18, 21, and 24 shown in Figure 2 were reduced to 13, 14, and 16 out of 27 to give, 70%, 80%, and 90%, respectively. For trees (Fig 3), the numbers were reduced from 30, 36 and 42 to 23, 26 and 27 out of 54. For molds where cross-reactivity is less well established, the data used were taken directly from the curve in Figure 4. Seven of 11 were required for 70, eight for 80 percent and nine for 90 percent. For the miscellaneous group (Fig 5), some degree of cross-reactivity was assumed for Df and Dp, as well as for cat pelt and cat hair, so that two out of six allergens were necessary to give 70%, two for 80%, and three for 90%, which included dust mite, cat, and cockroach. This gave a total number of allergens of 47, 52, and 57 for 70, 80% and 90%, respectively, of all positive responses.

Patients were tested with 103 allergens, plus a positive and negative control, or 105 total skin tests. The number of positive tests as a percentage of the total test in the miscellaneous group was 290/822 or 35%, for the molds 216/1,507 or 14%, for grasses 345/685 or 50%, for weeds 1,053/3,699 or 28%, and for trees 1,661/7,128 or 23%. The total number of positive tests as a percentage of the total tests performed was 3,564/13,841 or 26%.

There were 17 asymptomatic negative control subjects. 7/102 or 7% reacted to the miscellaneous group, 5 of these positive responses were to house dust mite. The response rate for house dust mite was 5/34 or 15%, for molds, 6/187 or 3%, for grasses 1/85 or 1%, for weeds 9/459 or 2%, and for trees

Table 3. Frequency of Positive Responses to Weeds Across Investigators' Sites

% Positive	Allergen	No. Positive	Total
37.2	Carelessweed	51	137
35.8	Lamb's quarters	49	137
35.8	Russian thistle	49	137
33.6	Iodine bush	48	137
32.8	Redroot pigweed	43	137
32.8	Sagebrush, Mugwort	45	137
32.8	Scale, Wing	45	137
32.1	Bassia	44	137
31.4	Scale, Lens	43	137
30.7	Plantain, English	42	137
29.9	Sagebrush, Common	41	137
29.9	Winter fat	41	137
29.9	Scale, Shad	41	137
29.2	Ragweed, Desert	40	137
28.5	Dock, Yellow	39	137
27.7	Ragweed, Western	38	137
27.0	Burro bush	37	137
25.5	Sagebrush, Coast	35	137
25.5	Castor bean	35	137
24.8	Ragweed, False	34	137
24.8	Mustard, Common Yellow	34	137
24.1	Cocklebur, Common	33	137
24.1	Sheep sorrel	33	137
22.6	Pellitory	31	137
21.2	Rabbit brush	28	132
19.7	Poverty weed	37	137
19.0	Baccharis/Mulefat	26	137

Table 4. Frequency of Positive Responses to Trees Across Investigators' Sites

% Positive	Allergen	No. Positive	Total
42.4	Olive	58	132
36.4	Mesquite	48	132
36.4	Ash, Green	48	132
36.4	Privet, Common	48	132
35.6	Ash, Arizona	47	132
31.8	Olive, Russian	42	137
31.1	Palo Verde	41	132
29.5	Acacia, Golden	30	132
29.5	Locust, Black	39	132
28.8	Oak, Swamp	38	132
27.3	Walnut, Black	36	132
27.3	Bottlebrush	36	132
27.3	Willow, Arroyo	36	132
27.3	Elm, Chinese	36	132
25.8	Peppertree, Calif.	34	132
25.8	Horse Chestnut	34	132
25.8	Walnut S. Calif. Black	34	132
25.0	Palm, Canary Is. Date.	33	132
25.0	Willow, Yellow	33	132
24.2	Oak, Calif. Black	32	132
24.2	Tree of Heaven	32	132
23.5	Alder, White	31	132
23.5	Alder, Red	31	132
23.5	Pecan	31	132
23.5	Mulberry, White	31	132
23.5	Cottonwood, Fremont	31	132
23.5	Poplar, Lombardy	31	132
23.5	Cedar, Salt (Tamarisk)	31	132
22.7	Birch, White	30	132
22.7	Cedar, White	30	132
22.7	Beech, American	30	132
22.7	Oak, Coast Live	30	132
22.7	Eucalyptus/Blue Gum	30	132
22.7	Willow, Yellow	30	132
22.0	Oak, Red	29	132
22.0	Gum, Sweet	29	132
22.2	Boxelder	28	132
22.2	Elm, Siberian	28	132
20.5	Mulberry, Paper	27	132
18.9	Cedar, Incense	25	132
18.9	Linden/Basswood	25	132
18.2	Maple, Red	24	132
18.2	Juniper, Chinese	24	132
18.2	Cottonwood, Black	24	132
17.4	Juniper, California	23	132
16.7	Cypress, Monterey	22	132
15.2	Pine, Ponderosa	20	132
13.6	Cedar, Port Orford	18	132
13.6	Cypress, Italian	18	132
13.6	Redwood	18	132
12.9	Cedar, Deodar	17	132
12.1	Hemlock, Western	16	132
10.6	Fir, Douglas	14	132
9.8	Cedar, Japanese	13	132

44/918 or 5%. Three of the 44 tree positive tests or 7% were to mesquite.

The total number of control subjects giving at least one positive test was

6/17 or 35%, while the total number of positive skin tests as a percentage of the total tests performed were 67/1,751 or 4%.

DISCUSSION

In this prospective study protocol utilizing the same allergens at 13 centers throughout California, employing a standard technique of prick puncture and the same grading system, we found that the number of skin tests to give 70%, 80%, and 90% of all positive tests to be 47, 52, and 57, respectively. Ninety percent of all positive skin tests included three environmental allergens (dust mite, cat, and cockroach), 9 molds, 2 grasses, 16 weeds and 27 trees. Negative control subjects generally did not react to these allergens (4% of the total test applied), except for house dust mite which was positive in 5 out of 34 tests (approximately 15%), indicating good specificity for the total responses to allergens tested and for specific allergy categories. The response rate in this asymptomatic population was similar to that previously reported.¹²

In a retrospective study of 126 patients from 10 different allergists in California reviewed by Sokol et al² utilizing both prick puncture and intradermal tests, grasses were found positive in 60%, weeds 53%, trees 46%, mold spores 37%, and miscellaneous inhalant allergens, primarily animal danders, dust mite and cockroach, in 35%. Using a 90% cutoff and combining both intradermal and prick puncture positive responses, they found that 90% of all allergens could be identified by 32 weeds, 27 trees, 10 grasses, 11 molds, and 17 environmental indoor allergens for a total of 97 tests. Despite major differences in study design when looking at individual allergens, our study results are fairly similar to that reported by Sokol et al for the most frequently found trees, weeds and grasses. However, the prevalence of allergen reactivity is lower probably due to the use of epicutaneous tests only in our study and assumptions regarding cross-reactivity. Further, several weeds and tree allergens were

Table 5. Frequency of Positive Responses to Fungi Across Investigators' Sites

% Positive	Allergen	No. Positive	Total
21.9	Smut, Bermuda grass	30	137
17.5	Alternaria tenuis	24	137
16.8	Epicoccum purpurescens	23	137
16.1	Curvularia spicifera	22	137
15.3	Helminthosporium intersem.	21	137
12.4	Botrytis cinerea	17	137
12.4	Penicillium mix	17	137
11.7	Hormodendrum/Cladosporium	16	137
11.7	Mucor racemosus	16	137
10.9	Aspergillus mix	15	137
10.9	Stemphyllium botryosum	15	137

Table 6. Frequency of Positive Responses Across Investigators' Sites

% Positive	Allergen	No. Positive	Total
Mite			
52.6	Standardized Mite, DP	72	137
41.6	Standardized Mite, DF	57	137
Cat			
38.7	Standardized Cat Pelt	53	137
37.2	Standardized Cat Hair	51	137
Cockroach			
22.8	Cockroach mix	31	137
Dog			
19.0	Dog Hair/Dander	26	137

found to be frequently positive in our study that were not previously reported for the California allergist.² For example, we found the weeds iodine bush and pellitory and the trees Russian olive (not related to common olive), Palo

Verde, Black Locust and Horse Chestnut to be frequently positive.

Using pollen analysis from Burkard trap collection and skin tests of 100 atopic patients in his practice in Orange County, Ellis et al⁸ found strong

positivity for 34 pollen allergens. Among 12 trees the percent positivity was 29% to 73%, for weeds 30% to 72%, and grasses 55% to 77%. There was no report of mold skin tests or environmental allergens such as animal danders, dust mite or cockroach. In general, there was a correlation between the types of pollens collected and skin test reactivity. However, there were some significant exceptions to this, perhaps reflecting the allergenicity of the extracts used. His data utilized the prick test as did ours, although the exact technique was not described. It is not clear why he had a higher percentage positivity, but it could reflect patient selection, technique, interpretation, and the fact that his data reflected Orange County responses compared to statewide responses reported in our study.

The report by the Joint Task Force for Practice Parameters states that the number of skin tests appropriate at any one time might vary depending on the nature of the clinical problem, the age of the patient, potential allergen exposure, and area of the country in which the patients reside.¹³ The report concludes that the evaluation of inhalant allergen might require up to 70 prick puncture tests, followed by up to 40 intradermal tests when the prick puncture is negative. Furthermore, they feel that under certain circumstances, a greater number of prick puncture and/or intradermal tests might be appropriate. However, it would appear that these recommendations were based mainly on current practices.^{2,11}

Our study had certain limitations. Most of the extracts used in the study were nonstandardized, which means that their true allergenic strength is unknown. The standardized extracts used included cat dander and house dust mite. These potent extracts, cat 10,000 BAUs, dust mite 30,000 AU/mL, produced relatively frequently positive skin tests (52% for Dp, 41.6% for Df, 30.7% for cat pelt, and 37.2% for cat hair). The grass pollen extracts produced the highest frequency of positive responses with orchard grass reacting in 54% of the tests. The other extracts,

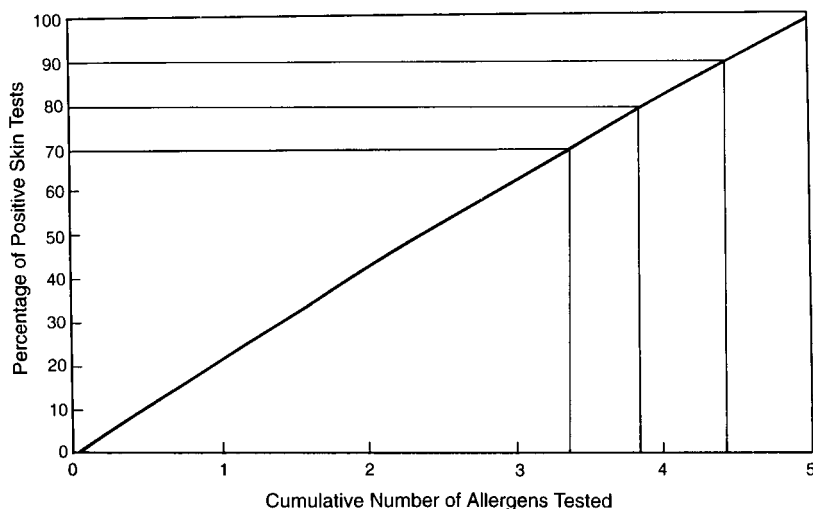


Figure 1. Using a best fit model, frequency curves were established based on the rank order of positive reactions for each allergy category (Tables 2–6). Shown are the number of skin tests required by extrapolation to give 70%, 80%, and 90% of all positive responses to grasses.

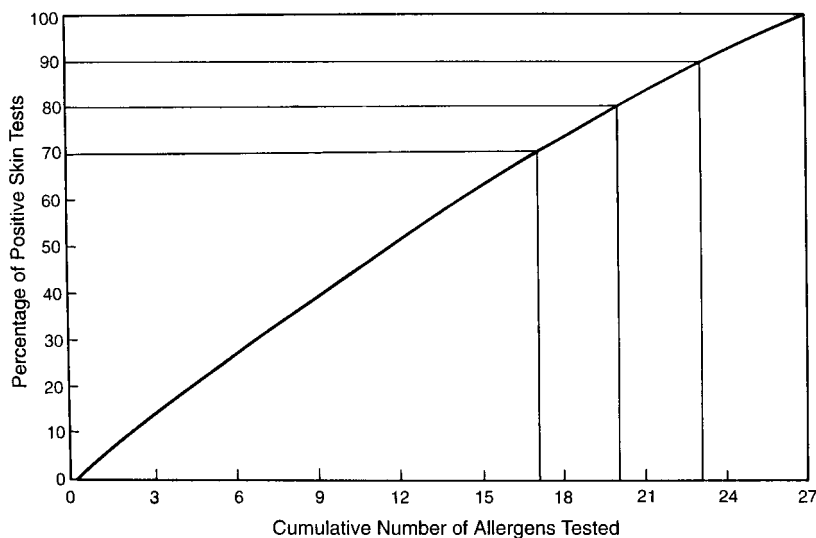


Figure 2. Frequency curve for weeds. For explanation, see legend Figure 1.

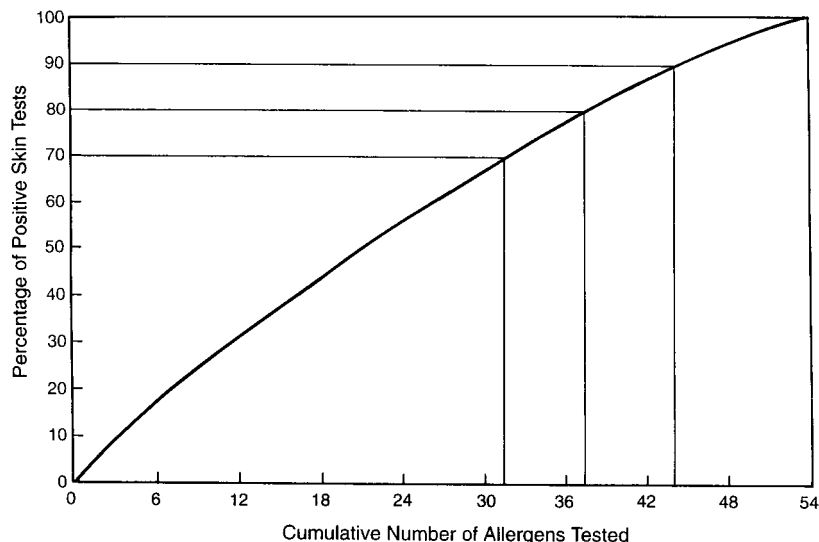


Figure 3. Frequency curve for trees. For explanation, see legend Figure 1.

including weeds, trees and molds, did not produce as many positive reactions as the grasses, cat or mite extracts. Recent data indicate that non-standardized grass pollen extracts at a 1:20 weight by volume dilution are very potent with most batches tested exceeding 100,000 BAUs/mL (personal communication T. Kordash/Bayer Allergy Products). One must ask then whether the frequency of positive responses in this study is truly due to patient sensitivity or due to the fact that certain extracts produce more pos-

itive responses because these extracts are stronger than others. Until more biologically standard extracts are available, this question will not be answerable. In addition, if assumptions regarding crossreactivity made in this study were not correct, the total number of skin tests required for 90% positivity would be considerably higher so that the number 57 total is a minimal number.

Finally, we failed to find a statistically significant correlation between patient reactivity and the geographic

distribution of pollens (data not shown). The difference in reactivity between more distant communities (ie, Northern and Southern California) was no greater than the difference between nearby sites (ie, within Orange County). The reasons for this are not entirely clear, but could include such variables as patient selection, technique and interpretation. Although this was spelled out in the protocol (see Methods Section), it was not rigidly controlled. Furthermore, mobility of the California population is great, and although we specified local residence for at least 2 years, reactivity may have reflected previous exposure. In addition, the number of subjects studied was limited with a disproportionate number of sites in Southern California. A better geographic distribution, a larger number of subjects per site, and more careful monitoring of adherence to the protocol may have revealed a better reflection of local exposure.

CONCLUSIONS

The basic rationale for this study was to establish the relevant allergens currently in California and to determine the number of skin tests which would adequately characterize the clinically symptomatic allergic patient. Using a 90% cutoff point, the number of skin tests required was 57. These included three miscellaneous environmental allergens, nine molds, two grasses, 16 weeds and 27 trees. The 90% cutoff is purely arbitrary and might not reflect the sensitivity of individual patients depending on exposure. If limited to 30 skin tests,¹ however, we estimate at least 50% of relevant allergens would be missed in California patients.

Negative control subjects generally did not react to these aeroallergens except for house dust mite and mesquite indicating good specificity.

There were some unexpected findings. The differences in specific skin test reactivity between more distinct communities, such as Northern and Southern California, were not as great as the differences between nearby communities such as those found in Orange County, so that skin test reac-

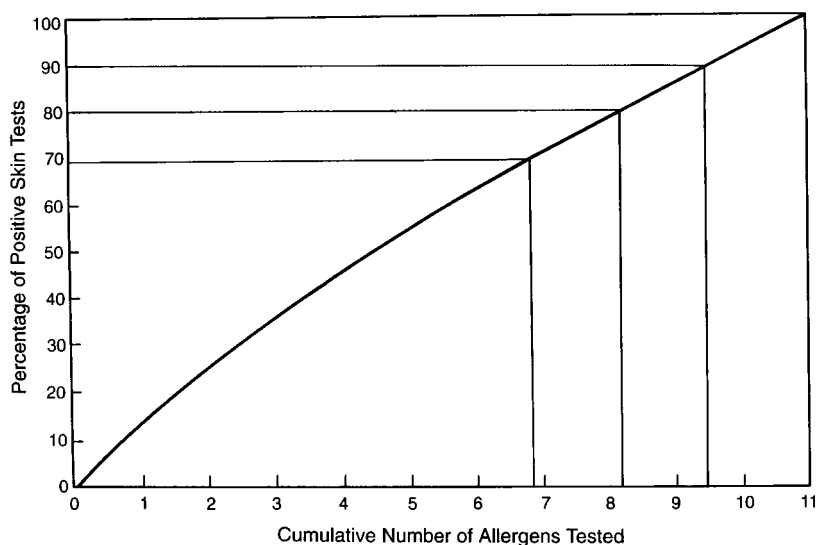


Figure 4. Frequency curve for molds. For explanation, see legend Figure 1.

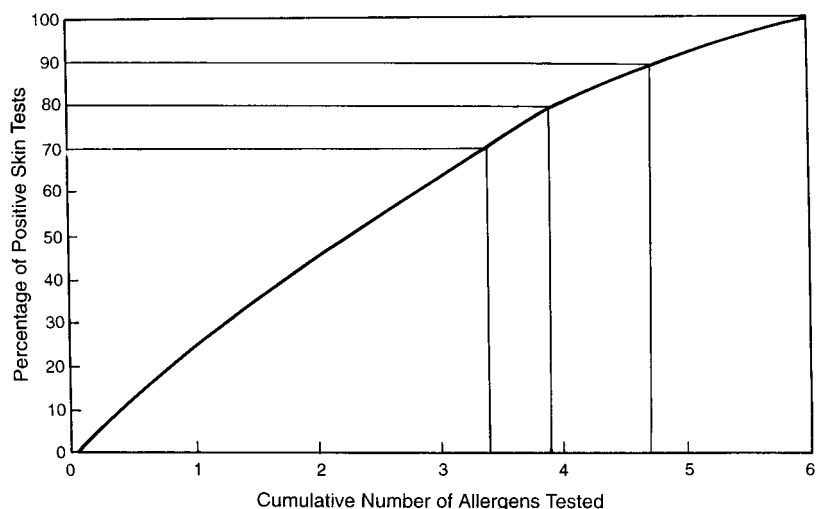


Figure 5. Frequency curve for miscellaneous group. For explanation, see legend Figure 1.

tivity was not strictly related to local flora. For example, plants like Palo Verde and castor bean, which are uncommon in Northern California, showed equal or higher reactivity in Northern California as compared to Southern California. In addition, several aeroallergens not generally considered important showed a high prevalence, while others usually tested for by the allergist gave a lower yield. Since the landscape of America has changed dramatically with urbanization over the past 25 years, a new anal-

ysis of relevant allergens would appear critical.

Many questions remain after this pilot study including the relevance of skin test responses to clinical disease, crossreactivity at the species level, and need for intradermal testing. Using our model, we were unable to establish the cross-reactivity within the genus. More definitive methodologies such as RAST inhibition will be required to sort out the question of cross-reactivity.

It is not clear what intradermal testing would add to the validity of our

data.¹⁴ It was excluded in this study because it was thought the risks in this pilot study might outweigh the benefit. Finally, it is hoped that this model will form the foundation for determining the number and types of aeroallergens required to evaluate the patient's respiratory allergy. However, one must still consider the individual patient's clinical experience and the local environment in which he lives. A closer relationship between the botanist and the practicing allergist must be established to achieve these goals.

APPENDIX

We appreciate the following individuals for their significant contribution. Consultants: Terry Kordash, Bayer, Director of Clinical Research; Jim Thompson, Bayer Botanist; Lester Freshwaters, Statistician; and Arlene Lantz, Bayer facilitator.

REFERENCES

1. Van Arsdel PP Jr, Larson EB. Diagnostic tests for patients with suspected allergic disease. *Ann Intern Med* 1989; 110:304-312.
2. Sokol WN, Galant SP, Kanter L, et al. Allergy diagnostic practice patterns in California. *Immunol Allergy Pract* 1992;14:395-408.
3. Lewis WH, Vinay P, Zenger BE. Airborne and allergenic pollen of North America. Baltimore: John Hopkins University Press, 1983.
4. Bousquet J. In vivo methods for study of allergy: skin test techniques and interpretation. In: Middleton E, ed. *Allergy and immunology principles in practice*. St. Louis: C.V. Mosby Company, 1988:419-436.
5. Adenoff AD, Rosloniec DM, McCall LL, et al. Comparison of six epicutaneous devices in the performance of immediate hypersensitivity skin testing. *J Allergy Clin Immunol* 1989;84: 168-174.
6. Shapiro GG. Diagnostic methods for assessing the patient with possible allergic disease. In: Bierman and Pearlman, eds. *Allergic diseases from infancy to adulthood*. Philadelphia: WB Saunders Co, 1988:224-239.
7. Engler DB, Garnet DE, Jarnatt AC, et al. Comparison of the sensitivity and

-
- precision of four skin test devices. *J Allergy Clin Immunol* 1992;90:985-991.
8. Ellis MH, Gallup J. Aeroallergens of Southern California. *Immunol Allergy Clin North Am* 1989;9:365-380.
9. Malling HJ, Andersen CE, Boas MB, et al. The allergy pricker. *Allergy* 1982;37:563-567.
10. Jergen PJ, Turkeltaub PC. The Association of individual allergen reactivity with respiratory disease, a national sample: data from the Second National Health and Nutrition Examination Survey 1976-80. *J Allergy Clin Immunol* 1992;90:579-88.
11. Lucas SK, Buckley III CF. Quantitative studies of cutaneous hypersensitivity: the prevalence of epicutaneous flare reaction to allergenic pollen extracts. *J Allergy Clin Immunol* 1989;84:465-74.
12. Hagy GW, Settiple GA. Prognosis of positive allergy skin tests in an asymptomatic population. *J Allergy Clin Immunol* 1971;48:200-211.
13. Bernstein IL, Storms WW. Practice parameters for Allergy Diagnostic Testing. *Ann Allergy Asthma Immunol* 1995;75:554-560 part 2.
14. Nelson HS, Oppenheimer J, Buchmeier A, et al. An assessment of the role of intradermal skin testing in the diagnosis of clinically relevant allergy to timothy grass. *J Allergy Clin Immunol* 1996;97:1193-1201.
- Request for reprints should be addressed to:*
Stanley P Galant, MD
1201 W. La Veta, Suite 501
Orange, CA 92868
-