Effective education of adults with asthma who are allergic to dust mites

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The effects of supplementary computer instruction in house dust mite–avoidance measures on adherence to implementing measures, on home dust mite–allergen levels, and on symptomatology were investigated in 52 adult patients with mite-associated asthma. Twenty-six patients received conventional instruction (counseling and written instruction) and the other 26 patients received conventional plus 22 minutes of interactive computer-assisted instruction. Instructions were aimed at mite-avoidance measures. Pre- and postinstruction dust samples were collected, and adherence was monitored. All patients kept symptom diaries twice a day. Patients' progress was followed for 12 weeks, and all patients completed the study. Adherence, number of observed and self-reported mite-avoidance measures implemented after visit, was higher for the computer group (p = 0.023). The computer-instructed group achieved significantly lower levels of mite allergen in bedroom carpets (p = 0.004) with mean levels of mite allergen declining from 6.5 ± 7.6 to 2.2 ± 4.3 μg/gm of dust (two-site monoclonal antibody assays), whereas levels for the conventional-instructed group did not change. Moreover, by study weeks 9 and 10, the computer-instructed group was significantly less symptomatic (p = 0.033). Mean symptom scores for this group decreased from 12.4 to 7.7, compared with 16.4 to 14.3. Conventional instruction supplemented with computer instruction is suggested in mite education. (J ALLERGY CLIN IMMUNOL 1992;89:836-43.)

Key words: *Education, computer, asthma, mite allergy, environment, allergen, home visits, symptomatology, avoidance, adherence*

Asthma is a chronic disease affecting fully 5% of the adult population.[1-3] Among adults with asthma younger than age 50 years, dust mite exposure is an important trigger for asthma exacerbations and a cause of chronic airway inflammation.[4-7]

House dust mites and their derivative allergens appear most commonly in bedding, carpeting, and upholstered furniture.[8, 9] Traditional mite-avoidance measures, such as encasement of mattresses and box springs, removal of carpeting, and replacing upholstered furniture, can reduce this allergen burden and alleviate mite-induced asthma.[10-13] However, these avoidance measures are poorly adhered to.[14, 15]

Abbreviations used

D. farinae:	*Dermatophagoides farinae*
D. pteronyssinus:	*Dermatophagoides pteronyssinus*
ASRS:	Avoidance self-rating scale
OCECM:	Observation checklist of environment control measures
Der f I:	Major allergen from *D. farinae*
Der p I:	Major allergen from *D. pteronyssinus*
RH:	Relative humidity

In this study of patient education, our goal was to compare the impact of two instructional methods: (1) conventional physician/nurse counseling with written materials (control group) (2) conventional physician/nurse counseling with written materials plus 22 minutes of interactive instruction by computer (experimental group). Computer instruction has been demonstrated to improve other health-related behaviors.[16, 17] We were particularly interested in whether computer education would result in improved adher-

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ence, decreased mite-allergen burden, decreased symptom scores, and medication usage.

MATERIAL AND METHODS

Experimental design and patients

Fifty-two adult patients with asthma were randomly assigned to either a 26 patient-control group or 26 patient-experimental group. Research was conducted with informed consent under a protocol approved by the Human Use/Institutional Review Boards of Walter Reed Army Medical Center and The Catholic University of America. Patients were selected based on having (1) symptomatic asthma determined by an allergist using standardized criteria according to the method described by Norman[18] and (2) positive epicutaneous skin tests (wheal 5 mm larger than wheal of diluent control) to either *Dermatophagoides farinae* (1:100 Hollister-Stier Laboratories, Spokane, Wash.) or *D. pteronyssinus* (5000 AU/ml, Berkeley Biologicals Co., Berkeley, Calif.), or both. Patients were excluded if they had positive epicutaneous tests to dog, cat, cockroach, mold, or other potentially relevant indoor allergens.

Patients were enrolled after a routine scheduled appointment, randomized to instructional groups, and visited for collection of baseline data and dust samples within the next 7 days (to preclude environmental control measures being done before completion of education). An investigator (K. H.) and research assistant visited all patients' homes initially and again 12 weeks later. A 12-week follow-up period was chosen to permit completion of avoidance measures and to allow time for symptomatic improvement to begin. Subjects were enrolled between August and November 1988; follow-up home visits were completed between November 1988 and February 1989.

The research assistant, using a Douglas Hand Vac 6785 (Douglas Products, Walnut Ridge, Ark.) and without knowledge of patient-group assignments, vacuumed dust samples in a standardized way from the same four sites during both initial and follow-up visits.[8, 19] The sites vacuumed were mattresses, bedroom carpets, sofas, and living room carpets. Dust samples from mattresses after 12 weeks were taken from the tops of mattress encasements if this measure had been implemented. Spirometry (Flowmate spirometer model 2500, Spirometrics, Inc., Auburn, Maine), temperature and humidity measurements (Psychron psychrometer, Belfort Instrument Co., Baltimore, Md.), and medication-usage data were obtained at each visit. Patients were not informed of preliminary data, initial temperature and humidity results, or forewarning of dust-sample collection points. Patients self-monitored asthma symptoms twice a day. A focused interview was conducted at the second home visit.

ASRS

This tool was a scaled, subjective, self-report of adherence to recommendations. The tool consisted of 18 items, each with a possible rating of 1 (almost never) to 4 (almost always). Possible scores ranged from 18 to 72 with higher scores indicating better adherence. Internal consistency, determined by Chronbach's alpha, was 0.62.

OCECM

This instrument objectively assessed adherence to avoidance measures (i.e., by two researchers who cross-checked each other, one knowing, the other researcher not knowing patients' group membership status). The checklist contained 13 items requiring a "Yes" or "No" response. A fourteenth item was for temperature/humidity measures. Possible scores ranged from 33 to 66, with higher scores indicating better adherence. Internal consistency (Chronbach's alpha) was 0.82.

Asthma-symptom checklist

Patients recorded symptoms twice a day and mailed in checklists every 2 weeks during the course of their 12 weeks in the study.[20]

Interview guide

The interview guide consisted of 25 open-ended questions that gathered data on adherence behavior of the subjects. The guide identified what measures subjects did or did not implement in the program and why. It described their attitudes about performing avoidance measures.

Medication survey

Patients were asked to write the names of each prescribed medication that they were using, frequency of use, and dosage before and after the study.

Measurements of mite allergens

Dust samples were frozen at $-70°$ C for future weighing and assaying of allergen content. Assays of *Der f* I and *Der p* I were performed with a two-site monoclonal antibody ELISA according to the methods of Chapman et al.[21] Assays were performed in a blinded fashion. The results were expressed in micrograms of total allergen content (*Der f* I plus *Der p* I) per gram of dust; >10 μg/gm of dust was considered a high level; >2 μg/gm, moderate; between 0.40 and 2 μg/gm, low; and <0.40 μg/gm, very low.[15]*

Computer-assisted instruction

The patient, in addition to receiving conventional instruction, also interacted with the computer program, "Avoidance measures in house dust allergy," developed by one of the investigators.[22] It is an interactive self-paced program developed for MS-DOS-compatible computers (Microsoft Corp., Redmond, Wash.) that reviewed the same information that physicians/nurses provided in the conventional instruction program. Measures discussed were (1) encasing mattresses, box springs, and pillows, (2) removing carpeting and upholstered furniture, (3) laundering bedding in hot water (130° F), and (4) controlling indoor temperature ($<70°$ F) and humidity ($<45\%$ RH).

Conventional instruction

Conventional instruction was provided by subjects' physicians/nurses with verbal and written guidance. Written

*Reagents provided by Dr. Martin Chapman, University of Virginia, Charlottesville, Va.

TABLE I. Patients' demographic data

Variable	Computer instruction (N = 26)	Conventional instruction (N = 26)	Total (N = 52)
Age range (yr)	18-75	18-69	18-75
Average age (yr)	43.7	44.5	44.1
M/F	15/11	10/16	25/27
Race white/black	22/3	16/7	38/10
Family income >$30,000	17	20	37
Employed/unemployed or retired	19/7	24/2	43/9
Computer experience			
Yes/No	21/5	20/6	41/11
Cigarette smoking	2	5	7
Asthma severity level			
Mild/moderate	9/17	12/12	21/29
Baseline spirometry			
FEV_1 (L)	2.72	2.29	2.51
FEV_1 as percent predicted	76.9	75.2	76.1
Baseline asthma			
Symptom score*	12.39	16.39	14.39

*Baseline asthma symptom score is the average daily symptom score reading for the first 2-week period of the study.

materials consisted of a two-page standardized handout on house dust mite avoidance supplied by the American College of Allergy and Immunology.

Data analysis

Demographic data were subjected to chi-square analysis to evaluate whether randomization had achieved comparable treatment groups (measures implemented). Yates' correction was applied whenever expected cell frequency was <5. Means, standard deviations, and ranges were computed for the outcome variables of mite allergen levels, adherence variables, and symptom scores/medication usage. Repeated measures analysis of variance with multivariate analysis of variance was used to test whether computer instruction would lead to better adherence, decreasing mite-allergen levels, improved symptom scores, and decreasing medication use.

RESULTS

Sixty patients were approached as candidates for this study. Four patients refused to participate, three failed enrollment criteria, and one patient was about to move. Fifty-two patients were enrolled and completed the study. Patient demographic data are displayed in Table I. Computer and conventional instruction groups did not differ significantly in age, sex, race, marital status, income, educational level, or employment. There were no significant differences in baseline symptom scores or baseline FEV_1 as percent predicted. None of the patients had instituted avoidance measures at the preinstruction visit.

Home demographics are displayed in Table II. Groups did not differ in degree of home ownership or other home characteristics. Baseline mean home-allergen levels were higher in the computer-instructed group than in the conventional-instructed group in the four sites sampled, although these levels did not approach statistical significance. The only measurement for which significant differences were found was that the preinstruction living room and bedroom temperatures were higher in the conventional-instructed group.

Adherence

Based on scores from the ASRS and the OCECM, the computer-instructed group implemented significantly more avoidance measures ($p = 0.023$). Higher postinstruction OCECM scores were noted in 21/26 patients in the computer-instructed group, versus 12/26 in the conventional-instructed group. Postinstruction ASRS scores also rose in 25/26 patients in the computer-instructed group, versus 22/26 in the conventional-instructed group. The two groups are compared on the number of the more aggressive avoidance measures that were implemented and confirmed at home visits in Table IIIA. For each measure, adherence was higher in the computer-instructed group. Overall, the computer-instructed group performed 48 aggressive measures versus 24 for the conventional-instructed group.

Of the two groups, there were no significant differences in the average postinstruction temperature or humidity of the bedroom or living room. However, 14/26 in the computer-instructed group versus 8/26 in the conventional-instructed group had postinstruc-

TABLE II. Home demographics

Variable	Computer instruction (N = 26)	Conventional instruction (N = 26)	Total (N = 52)
Home ownership			
Own/rent	15/11	19/7	34/18
Age of dwelling			
<10 yr	10	11	21
>10 yr	16	15	31
Presence of hardwood floors yes/no	15/11	12/14	27/25
Presence of air conditioning	24	25	49
Presence of humidifier	8	17	25
Presence of dehumidifier	6	5	11
Baseline RH (%)			
Living room	53.30	56.15	54.73
Bedroom	53.50	55.34	54.42
Baseline absolute humidity (gm H_2O/m^3 air)			
Living room	9.96	11.73	10.85
Bedroom	10.17	11.80	10.99
Baseline temperature (F)			
Living room	70.57	73.30*	71.94
Bedroom	71.15	73.96*	72.56
Baseline mite-allergen levels			
Mattress	5.72	3.57	4.65
Bedroom carpet	6.51	3.43	4.97
Sofa	5.55	4.62	5.09
Living room carpet	5.17	2.60	3.89

Allergen levels expressed in micrograms per gram of dust.
*Statistically significant difference, $p < 0.05$.

TABLE IIIA. Comparison of aggressive measures implemented postinstruction for two groups

Aggressive measure	Computer instruction (N = 26)		Conventional instruction (N = 6)	
	No. of patients	% Increase over preinstruction	No. of patients	% Increase over preinstruction
Mattress and box spring encased	10	38.5	7	26.9
Carpets removed (total)	4	15.4	2	7.7
Living room	0	0.0	0	0.0
Bedroom	4	15.4	2	7.7
Upholstered furniture removed	7	26.9	4	15.4
Hot water laundry	9	34.6	1	3.8
Temperature and humidity control	14	53.8	8	30.8

Note: Computer-instructed group instituted more measures ($p = 0.023$).

tion RHs <50% and temperatures <70° F in their homes.

After the twelfth and final study week, interviews by K. H. disclosed that factors contributing to adherence were patients' concern about their health, spouses'/friends' support and encouragement, and physicians' emphasis and follow-up. Factors that acted to deter adherence are listed in Table IIIB. These were (1) cost (e.g., to replace carpets and furniture), (2) altered lifestyle/household issues (discomfort of sleeping on plastic or vinyl, preference for carpet, and subflooring not conducive to carpet removal), (3) insufficient time available to implement measures, (4) limited or no assistance from others (e.g., to put on encasings), (5) lack of spouses' support, and (6) skepticism about relevance of dust mites to their disease.

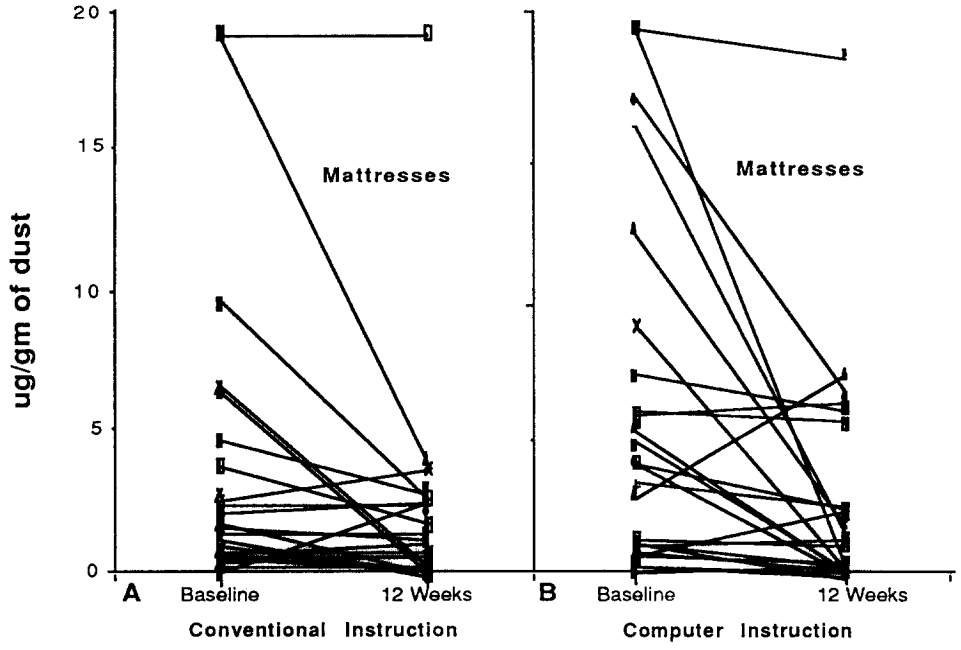

FIG. 1. Mite-allergen levels in mattresses for patients at baseline and week 12. **A,** Patients randomized to conventional instruction. **B,** Patients randomized to computer instruction. Significant decline in mite-allergen levels for both groups ($p = 0.020$) with no differences between groups.

TABLE IIIB. Deterrents to implementing measures as indicated by interview after instruction

Variable	Computer instruction (N = 26)		Conventional instruction (N = 26)		Overall (N = 52)	
	f	%	f	%	f	%
Cost	13	50.0	12	46.2	25	48.1
Altered lifestyle/household	10	38.5	10	38.5	20	38.5
Time	6	23.1	3	11.5	9	17.3
Assistance	13	50.0	12	46.2	25	48.1
Spouse support	13	50.0	12	46.2	25	48.1
Mite significance*	4	15.4	7	26.9	11	21.2

f, Frequencies; the number of patients that mentioned the particular variable as a deterrent to implementing measures.
*Patients doubt the significance of mites as a cause of asthma.

Allergen levels

After instruction, both groups demonstrated statistically significant declines in mattress mite-allergen levels (Fig. 1). The experimental group decidedly diminished dust mite–allergen concentrations on bedroom carpets and floors ($p = 0.004$) (Fig. 2). Samples of dust from these areas demonstrated that mean levels of mite allergen decreased from 6.5 ± 7.6 to 2.2 ± 4.3 μg/gm of dust, whereas levels for the conventional-instructed group, at 3.14 μg/gm, did not change. However, both groups failed to significantly alter allergen levels in living room carpets or sofas (data not presented). The prevalent mite was *D. farinae*, dominant in 36 homes.

For the mattress site, 15 subjects achieved a tenfold or higher decrease in allergen levels from pre- to postinstruction, 10 in the experimental and five in the conventional-instructed group. Tenfold decreases in allergen level have been mentioned as being a significant change.[19] All except two of these subjects had encased their mattresses. Of the two subjects who did not encase and yet achieved a tenfold reduction, one slept on a water bed and one subject had changed the mattress.

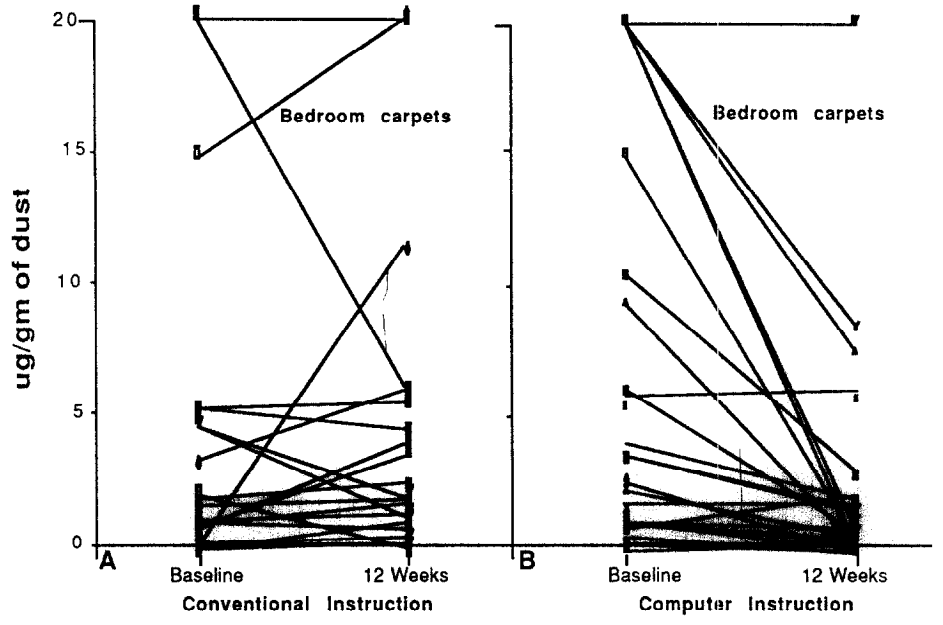

FIG. 2. Mite-allergen levels in bedroom carpets for patients at baseline and week 12. **A,** Patients randomized to conventional instruction. **B,** Patients randomized to computer instruction. Significant decline in mite-allergen levels for computer-instructed group compared with conventional-instructed group ($p = 0.004$).

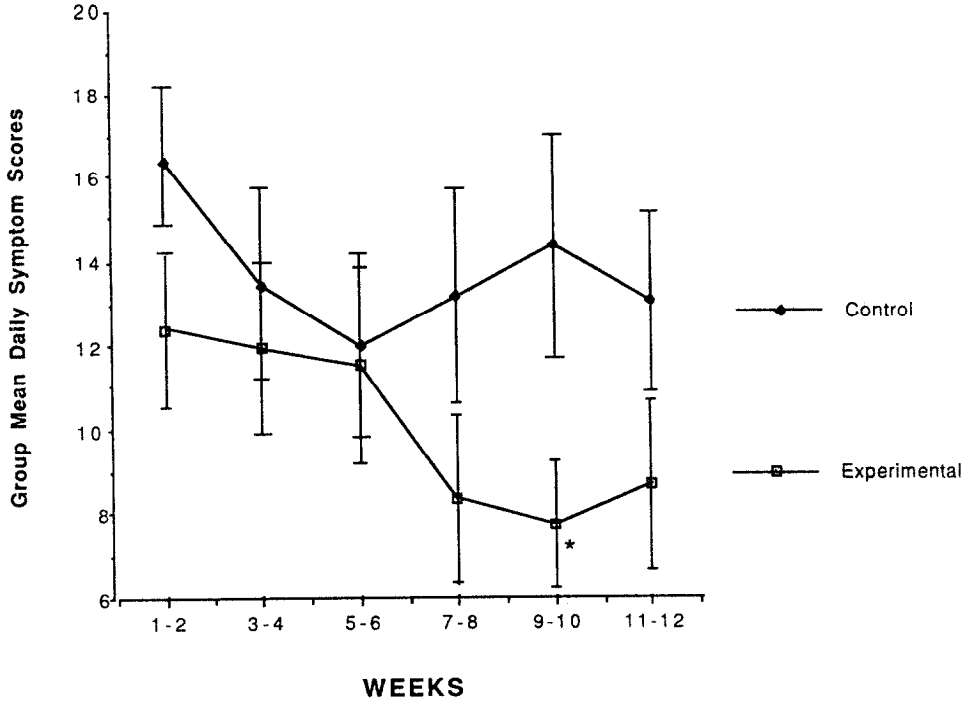

FIG. 3. Mean symptom scores decreased for both groups during 12-week study. Significant difference between groups occurred at weeks 9 to 10. *Error bars* indicate ±SEM; *$p = 0.033$.

Symptomatology

Between the start of the study (weeks 1 to 2) and the end of the study (weeks 11 to 12), both groups failed to demonstrate a statistically significant difference in symptomatic improvement (Fig. 3). Mean symptom scores for both groups decreased by 26%. Only in weeks 9 and 10 did the symptomatic improvement of the computer-instructed group sig-

TABLE IV. Comparison of inhaled bronchodilator use for two groups

	Computer instruction (N = 26)		Conventional instruction (N = 26)		
Use (sprays/day)	**Mean**	**SD**	**Mean**	**SD**	***p***
Preinstruction	6.12	3.69	5.62	3.58	
Postinstruction	4.38	3.71	5.23	3.79	0.023

Inhaled bronchodilator use (sprays per day) decreased for the computer-instructed group from preinstruction to postinstruction ($p = 0.023$).

nificantly surpass that of the conventional-group ($p = 0.033$). However, for each 2-week interval, the experimental group had a lower average asthma-symptom checklist score than the comparison group. By study weeks 11 and 12, the inhaled bronchodilator use per day of the computer-instructed group significantly decreased below that of the conventional-instructed group ($p = 0.023$) (Table IV). Mean FEV_1 as percent predicted did not change significantly during the study or differ between groups.

DISCUSSION

The conventional approach to educating allergic patients with asthma in minimizing exposure to dust mite allergens includes counseling and furnishing of relevant printed material. In our 3-month study, the benefits of this approach were suboptimal. Only seven of 26 patients with asthma, provided with conventional instruction, encased mattresses and box springs. The sum of the measures taken were insufficient to diminish symptoms, improve lung function, or lower requirements for inhaled β-agonist medication. A more useful approach to ensuring adherence to mite-avoidance measures is needed.

During the same 3-month period, patients with asthma, educated with computer-assisted instruction, implemented more control measures and reduced household levels of dust mite allergen, often at several locations. More computer-educated patients also experienced symptomatic improvement and needed less medication. Computer-assisted instruction appears more effective with respect to asthma outcomes. There were no differences between the groups (age, income, education, disease severity, or initial allergen levels) that could explain these improvements. The postinstruction visits did come at a colder time of the year (November to January) than the initial visits. However, mite-allergen levels remain high from August to January[8] and remained high at all sites for the conventional group. Thus, reduction in symptoms for the computer-instructed group was likely from the reduction in mite allergens.

Because the content of the computer-assisted instruction was so similar to the written materials issued to the control group, content alone could not have accounted for the differences in outcomes between the groups. There was no selective or corrective coaching in either group. Possible explanations for the superiority of computer-assisted instruction include greater clarity, the opportunity for self-paced instruction, greater emphasis on certain aspects of allergen avoidance, and the interactive format. The benefits of computer-assisted instruction appeared by weeks 9 to 10, when patients had significantly less asthma. This difference, occurring as soon as it did, was particularly impressive to us, given that both implementation of avoidance measures and beneficial effect of reduced allergen exposure on bronchial reactivity each typically require time periods measured in months.[23, 24] Although allergen-induced bronchial hyperreactivity may diminish in 6 weeks, in practice, mite-avoidance measures often fail to elicit a significant symptomatic benefit until 1 year later.[12]

Patients in the computer-instructed group did a significantly better job of reducing mean allergen levels on bedroom floors. Dust samples collected there, usually from carpeting, not from bare floors, were significantly lower in allergen content. Too few patients had removed bedroom carpets (six in all patients) for carpet removal alone to have accounted for the difference observed at this site. Vacuuming for longer periods, or more frequently, and/or better control of bedroom temperature and humidity could have accounted for this difference.

Computer-assisted instruction also had limitations. Only 17 patients (10 computer-instructed and seven from control group) encased mattresses and box springs, a measure demonstrated to have a high impact and therefore to warrant the highest priority.[10] In the living room, expensive measures were taken even less often. Few patients removed upholstered furniture, and none removed carpeting. Emphasis on less radical measures in the living room to include use of a 3% tannic acid preparation to degrade allergen or an acaricide to kill mites may well improve environmental control there.

In practice, seldom do nurses or allergists learn conclusively what has been implemented in the home

in relation to what has been recommended in the office. In our study, when patients were asked what measures were implemented, they stated they did more than they actually did. That patients overstate adherence has been reported before.[25] Therefore, if mite-avoidance measures are to be successful, especially for patients not responding to treatment, we recommend the following: (1) emphasis on just one or two high priority measures; we found that patients tended to implement measures one at a time, rather than multiple measures concurrently, (2) confirmation that recommended measures have been understood and that the wherewithal to perform them exists, (3) a home visit with a standardized checklist to verify adherence objectively, (4) collection of dust samples to measure mite-allergen burden and level of risk of asthma,[19] and (5) home temperature and humidity measurements to determine changes needed in indoor climate.

Assessing environmental risk and modifying the home is a safe and effective treatment for patients with dust mite allergy and asthma. But without adequate follow-up, physicians and nurses may mistakenly presume that prescribed measures will be, or have been, accomplished. Our observations suggest that computer-assisted instruction and home visits with direct monitoring of mite-allergen levels may confer added benefit on allergic patients with asthma who demonstrate suboptimal response to therapy.

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