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Mite allergen control with acaricide fails

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Abstract

TOP

Background: We compared the effects of an acaricide, benzyl benzoate, with the effects of baking soda control applied to bedroom and living room carpets on house dust mite allergen levels, lung function, and medication use in 12 adult patients with asthma for 12 months.
Methods: This was a randomized, double-blind, placebo-controlled study. Patients were enrolled from the allergy clinic of a large tertiary care center in a metropolitan area. All patients had positive dust mite puncture test results. Six patients used benzyl benzoate, and six used baking soda. Other aggressive mite control measures were implemented uniformly in each group. Subjects were to make two carpet applications, at baseline and at 6 months according to the manufacturer's recommendations. Dust samples were collected in bedroom and living room carpets at 0, 3, 6, 9, and 12 months; and quantities of *Der p* I and *Der f* I allergens were determined. Spirometry was done every 3 months, and peak flow rates were recorded for 10 days after each dust sampling.
Results: There were no significant differences in mean allergen levels between the two groups over time at either site. There were no significant changes in lung function or medication use for either group.
Conclusions: Benzyl benzoate powder applications may not be effective when done according to manufacturer's instructions. Further studies are necessary to test effectiveness when applied more frequently and for longer periods. (J ALLERGY CLIN IMMUNOL 1994;94:27-32.)

FEF_{25-75}	Forced expiratory flow from 25% to 75% of forced vital capacity
FEV_1	Forced expiratory volume in 1 second

PEFRs Peak expiratory flow rates

Key words: Acaricide, mite allergy, asthma, allergen, home visits, avoidance, respiratory status

Performance of aggressive house dust mite avoidance measures by patients with asthma and mite sensitivity has been demonstrated to reduce mites and mite allergens and alleviate asthma symptoms. [1-4] These measures include: (1) encasing mattresses, box springs, and pillows in hypoallergenic covers; (2) removing carpets; (3) replacing upholstered furniture; (4) washing bed linens in hot water; and (5) controlling indoor temperature and humidity.

However, patients with mite-induced asthma do not always carry out aggressive avoidance measures. In a controlled study in which measures implemented after two different types of education were compared, 17 of 52 (33%) subjects encased mattresses and box springs.[5] Only six performed the difficult measure of removing carpets.

An acaricide, benzyl benzoate, is commercially available as a moist powder with which to treat carpets. Results of clinical trials in Europe and the United States have demonstrated reduction in mite numbers and allergen levels in carpets after use.[6-10] However, long-term longitudinal randomized control trials have not been conducted. The purpose of this study was to compare the effects of benzyl benzoate with effects of a control (baking soda) applied to carpets on house dust mite allergen levels, respiratory status, and medication use in adult patients with mite allergy and asthma over a 12-month period.

Methods

Patients

Twelve adult patients with asthma (age range, 25 to 65 years) were randomly assigned to either a six-patient control group or a six-patient experimental group (■Table I). Groups were well matched for age and race. However, there was a significant difference between the groups in sex distribution; the control group included only women, and all four men were in the benzyl benzoate group.

TABLE I. Patients' demographic data

Variable	Control group (*n*= 6)	Benzyl benzoate group (*n*= 6)
Age range (yr)	30-65	25-55
Average age (yr)	45.8	42.3
M/F	0/6*	4/2
Race: white/black/other	5/0/1	5/1/0
Duration of asthma (yr)	5.7	5.0
Cigarette smoking	0	1
Asthma severity level (mild/moderate/severe)	2/4/0†	0/5/1†
Baseline spirometry		
FEV_1 (L)	2.52	2.50

FEV_1% predicted	91.8	65.5
FEF_{25-75}	1.78	1.63
FEF_{25-75}% predicted	58.5	42.8
Morning peak flow	299	340
Evening peak flow	344	434
Percent variability	24.8	34.2

*Statistically significant difference, $p < 0.05$ by *t* test.
†Severity levels determined by physician rating based on pulmonary function tests.

One patient in the benzyl benzoate group smoked fewer than 5 cigarettes per day. Severity of asthma was moderate in most patients. The forced expiratory volume in 1 second (FEV_1) and forced expiratory flow from 25% to 75% of forced vital capacity (FEF_{25-75}), expressed as percent predicted values, were lower for the benzyl benzoate group, although values were not statistically different. The variability in peak expiratory flow rates (PEFRs) was higher for the benzyl benzoate group.

Patients were selected on the basis of having (1) symptomatic asthma, as determined by an allergist using standardized criteria described by Norman[11]; (2) positive epicutaneous skin test results (wheals, 5 mm or larger than 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; and (3) high levels of house dust mite allergens in carpets, as demonstrated by participation in a previous study.[5] Subjects were excluded if they had significant severity to dog, cat, feathers, or other potentially relevant indoor allergens.

Patients had already implemented mite control measures such as encasing mattresses, box springs, and pillows and washing bed linens in hot water but had not removed carpets. Instituting these measures led to amild reduction in symptoms and a slight decrease in the use of inhaled bronchodilators before the study began. However, all patients were still experiencing symptoms.

Asthma medications including aerosolized β-agonists, inhaled steroids, cromolyn, and ipratropium had previously been optimized. Five patients took oral steroids during the study, three in the treatment group and one in the control group. The highest dosage was 15 mg per day. All patients, except one in the control group, used inhaled steroids and/or sodium cromolyn.

All patients gave informed consent before entering the study. The research was conducted under a protocol approved by the Human Use/Institutional Review Board of Walter Reed Army Medical Center.

Study design

The trial was a randomized double-blind placebo-controlled design. Twelve patients were enrolled and assigned to groups randomly by lot. Blinding was performed by a physician not involved in the study. The same investigator and research assistant visited homes initially and every 3 months for 1 year. Home visits took place between October 1990 and November 1991. All bedroom and living room carpets were treated at baseline and at 6 months.

The experimental and control groups were supplied with either benzyl benzoate powder (Acarosan; Fisons Corp., Rochester, N.Y.; manufactured by Werner & Mertz GmbH, Germany) or masked baking soda. Treatment materials were applied at 75 gm/m^2. The investigator, research assistant, and patients were blinded as to which compound was being applied to the carpet. Instructions on use were given verbally and by showing the supplier's educational videotape. In addition, patients received a copy of the manufacturer's written directions for application. Instructions specified that subjects thoroughly brush the material into carpets and let it dry for 4 hours before vacuuming.

The research assistant, using a 2.2 A Douglas Hand Vac 6785 with a filter (Douglas Products, Walnut Ridge, Ark.), vacuumed dust samples in a standardized way from bedroom and living room carpets during both

initial and follow-up visits.[12] A 1 m [2] area of carpet was vacuumed for 2 minutes. Sequential sampling was done from the same places.

Dust samples were frozen at –70° C for future weighing and assay of allergen content. Patients were instructed to vacuum their carpets weekly. Previous testing with baking soda applied to other carpets showed no changes in allergen levels, indicating that baking soda was an adequate control material.

Spirometry (Flowmate spirometer model 2500; Spirometrics, Inc., Auburn, Maine), temperature, and relative humidity measurements (Psychron psychrometer; Belfort Instrument Co., Baltimore, Md.), and medication usage data were obtained at each visit. Patients measured PEFRs twice daily for 10 days after each visit with an Assess peak flow meter (Healthscan Products, Inc., Cedar Ridge, N.J.) and recorded results in a diary. Measurements were performed in the morning and evening before inhaled bronchodilators were used. A focused interview was conducted at the end of the study.

Interview guide

The interview guide consisted of 27 questions that gathered data on subjects' adherence behavior. The guide identified feelings patients had about applying the material and asked whether they believed it helped them.

Measurement of mite allergens

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.[13] All of the collected dust was used in the assay. The baseline results were expressed in concentrations (micrograms per gram of dust). Subsequent results were expressed in total micrograms of allergen content (absolute values) to avoid confounding from the increase in weight of dust from the carpet treatments.

Data analysis

Demographic data were subjected to *t* tests or chi square analysis, as appropriate, to determine whether randomization had created comparable treatment groups. Means, standard deviations, and ranges were computed for the outcome variables — mite allergen levels, spirometry parameters, and PEFRs. Repeated measures analysis of variance was used to determine whether treatment of carpets would reduce allergen levels and improve respiratory status. A comparison of medications used was done before and after the study.

Results

Twelve patients entered the study and completed the 1-year trial. Home data are displayed in Table II. Initial bedroom and living room relative humidities and temperatures were comparable for each group. Baseline mean home allergen levels were higher in the benzyl benzoate group in the two sites sampled, although not statistically significant.

TABLE II. Home demographics

Variable	Control group (*n = 6)*	*Benzyl benzoate group (n*= 6)
Baseline relative humidity (%)		
Bedroom	47.0	54.0
Living room	45.5	56.7
Baseline temperature (° F)		

Bedroom	71.8	71.7
Living room	71.7	70.3
Baseline mite allergen levels*		
Bedroom carpet	2.75	6.28
Living room carpet	2.69	8.21

*Baseline allergen levels expressed in concentration, micrograms of group I allergen per gram of dust.

Allergen levels

Both groups failed to show significant alterations in allergen content in bedroom ($p = 0.274$) or living room carpets ($p = 0.070$) (Figs. 1 and 2). The control group showed consistently lower allergen content than the benzyl benzoate group for both sites for the 12 months. Pooled data for all 12 patients showed no significant differences in allergen levels across the five periods ($p = 0.392$ for bedrooms and $p = 0.565$ for living rooms). There was also no interaction between treatment type and time.

FIG. 1. Total mite allergen levels in bedroom carpets for patients at baseline and for each 3-month interval during the study. **Top:** Patients randomized to control group using baking soda. **Bottom,** Patients randomized to benzyl benzoate group. There were no significant differences between the groups.

FIG. 2. Total mite allergen levels in living room carpets for patients at baseline and for each 3-month interval during the study. **Top:** Patients randomized to control group using baking soda. **Bottom:** Patients randomized to benzyl benzoate group. There were no significant differences between the groups.

Spirometry and peak expiratory flow

Neither group had a significantly different change in spirometry parameters after treatment (FEV_1, FEV_1 expressed as a percent of predicted value, FEF_{25-75}, or FEF_{25-75} expressed as a percent of predicted value). There were no significant differences in morning or evening peak flow rates between the treatment groups over time. There was a significant difference in morning peak flow rates across the five periods without regard for group $p = 0.0008$. In peak expiratory flow variability, both groups showed considerable variations in peak flows compatible with asthma. Values were usually over 20% and sometimes as high as 36%.

Relative humidities and temperatures

There were no significant differences in bedroom or living room relative humidities and temperatures between the two groups over the course of the study.

Interviews

After the fifth and final study visit, interviews were conducted concerning patients experiences with applying the acaricide and time considerations (Table III). On average, it took patients 45 minutes to apply the

material and 1 hour to vacuum it up. Although the timing of the applications was not always precisely as directed, all carpets did receive two treatments, except for one in the control group, which did not receive any.

TABLE III. Interview data for all patients concerning carpet applications (*N*= 12)

Variable	No. of patients	Percent
Made both applications	11	92
Required assistance to apply	3	25
Read labeling	11	92
Hesitant to apply	6	50
Left on for directed time (4 hr)	12	100
Difficult to vacuum	9	75
Felt adverse effects	0	0
Felt improved asthma (yes/no/unsure)	4/2/6	33/17/50
Would use again if effective	11	92
Would use a service next time	6	50

Subjects in both groups indicated that use of this mite control measure was difficult (i.e., application and vacuuming). However, 11 (92%) stated that they would apply the material again if treatments were found to be effective in reducing levels of mite allergen. No adverse effects were reported.

Medication use

By study visit 5, medication use per day in the benzyl benzoate group was not significantly different from that of the control group. All subjects required regular drug treatment for asthma.

Discussion

In this randomized, controlled, 1-year study, we did not find any significant differences between benzyl benzoate and control groups on bedroom and living room carpet allergen content when measured every 3 months. Furthermore, there were no significant changes in respiratory status, as determined by spirometry and PEFRs, or in medication use.

Because of the small number of subjects in each group, one must be careful about generalizing these results to a larger population. These results are in agreement with those of Hayden et al.[14] who treated seven carpets for 4 hours each and showed only modest decreases in mite levels at 1 and 2 months after treatment. These investigators found that the time of application had to be extended to 12 hours to be effective in reducing mite allergen levels.

Our findings conflict with those of others who have demonstrated benefits of benzyl benzoate.[6-10] There may be several reasons for the differences in outcomes.

First, patients may have applied the benzyl benzoate incorrectly or not at all. We found adherence to the study protocol less than ideal in timing of carpet applications. However, interviews revealed that 8 of 12 patients applied the treatments within a month of home visits and 3 of 12 within 3 months. All 11 patients who applied the material stated that they left it on the carpet for approximately 4 hours before vacuuming it off. Nonadherence to instructions did not appear to be the reason for lack of treatment effect.

Second, group differences may have contributed to the findings. The control group had significantly more women than the benzyl benzoate group. These subjects may have adhered to the protocol more than the men. However, interviews revealed that patients in both groups applied treatments to carpets with similar frequencies. In some cases men carried out treatment recommendations more fastidiously than women.

Third, techniques of carpet applications may be significant factors for effectiveness of the acaricide. In a controlled short-term study of the effects of benzyl benzoate applied to carpets, Lau-Schadendorf et al.[8] found significantly lower total mite allergen levels in the treated group on days 30 and 60. The material was applied twice, on days 0 and 10. The duration that the material was left on carpets was similar to that in our study. Hayden et al.[14] and Platts-Mills[15] found that benzyl benzoate should be left on carpets a minimum of 12 hours and brushed in twice to be effective. These investigators demonstrated that benzyl benzoate was effective on ventilated carpets on wood floors when used in this manner but not on carpets on concrete slabs.[14] We followed the manufacturer's suggestions, treating carpets once every 6 months and leaving the benzyl benzoate on for 4 hours.

Fourth, the baseline allergen level exposure of patients may not have been sufficient to cause significant symptoms. Thus the enrolled patients with asthma may have received the benefits of mite allergen avoidance before the study, with further reductions not leading to more improvement. However, baseline allergen levels were in the moderate range for both study groups, which put them at risk for symptoms of asthma if not for acute exacerbations. [16] Baseline levels were higher for the benzyl benzoate group, making an acaricidal effect more likely to be detected. Yet there was no evidence that benzyl benzoate decreased allergen levels significantly or improved respiratory status for this group.

This long-term study has shown that a relatively expensive “mite-killing” powder, widely touted as effective, may not work any better than baking soda when used by patients as directed. Benzyl benzoate powders may not be effective when applied according to manufacturer's instructions but may be effective when applied more frequently and for longer periods. Further studies on benzyl benzoate and also on tannic acid, which denatures the allergen but does not kill mites, are indicated.

Presently, we believe that the ideal treatment for patients with mite allergy, with regard to carpets, is removal. If this is not possible, then weekly vacuuming and control of temperature and humidity in homes is advised.[16]

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Articles with References to this Article

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