

Clinical evaluation of a double-blind dust-mite avoidance trial with mite-allergic rhinitic patients

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Summary

Inheritance and allergen exposure are key factors in the development and the course of atopic allergy, expressed as conjunctivitis, rhinitis, asthma or dermatitis. This study concerns the clinical significance of mite and mite-allergen avoidance measures based on intensive cleaning with acaricide (solidified benzylbenzoate) added (10 dwellings), and without biocidal activity (10 other homes) as a control in a double-blind trial with matched pairs. Twenty subjects with persisting rhinitic complaints were selected. They lived in 20 different dwellings and were all sensitized to pyroglyphid mites; 12 of them were also sensitized to stored product mites (*Acarid*). Daily symptoms and medication score, guanine and dust exposure, total and mite-specific IgE in serum, eosinophilia in the blood and in the nasal smear, intracutaneous tests with house dust mite and storage mite extracts were compared in both pairs and groups. Acarological data, physiochemical aspects and exposure assessment are discussed in detail elsewhere. Symptom scores dropped significantly, as did the total IgE and exposure to dust and mite products in the acaricidal cleaner treatment group. After 1 year, the daily symptoms median was 47% ($P=0.025$), total IgE was 38% ($P=0.0049$), and exposure to dust and mite products (guanine exposure) was 53% ($P=0.0449$) better or lower than in the controls. Intensive cleaning, without acaricidal treatment performed twice a year, resulted in clinical improvement in four out of 10 subjects, of whom none became free of complaints. In the Acarosol treatment group (cleaning + benzylbenzoate) eight out of 10 subjects improved, in three cases subjective symptoms disappeared. The conclusion is that mite avoidance in homes can be carried out successfully with a special acaricidal cleaning formulation Acarosol.

Clinical and Experimental Allergy, Vol. 21, pp. 39–47. Submitted 21 March 1990; revised 5 July 1990; accepted 17 July 1990.

Introduction

In atopic allergy an inherited constitution is combined with a sensitization towards inhalant allergens in a long-term extensive allergen exposure. In dwellings, a variety of possible allergens may be formed by mites, pets, fungi, insects, etc. [1]. At least 5% of the population (18 million West-Europeans and 11 million North Americans) suffer from such an illness induced by house dust mites [2,3]. Although chronic rhinitis is sometimes thought to be a trivial illness, the morbidity and economic burdens associated with it are immense [4]. Rhinitis is the most

common of allergic diseases, even more common than asthma, the affliction most investigated in avoidance studies.

Avoidance of allergens by removing home textiles and padded furniture proved an effective solution in some open and a few controlled dust-mite avoidance studies with atopic patients showing signs of conjunctivitis, rhinitis or asthma. This concept (allergological sanitation or dust avoidance) has been used for decades. Its disadvantage is the unwanted change in living comfort [5,6]. Recently, Platts-Mills *et al.* [7] demonstrated a dramatic drop in clinical symptoms after moving asthmatic patients from their dwellings (13 600 ng *Der pI* antigen/g dust) to 'dust free' hospital rooms (240 ng *Der*

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Table 1. Characterization of 20 rhinitic subjects by distribution (ratio) and the median values in the treatment and control group at the start of the experiment

Subject characteristics	Group 1 (n=10) Acarosan		Group 2 (n=10) Control	
	Median (range)	Ratio of subjects	Median (range)	Ratio of subjects
Age (yr)	19 (14-35)		21.5 (12-29)	
Skin test HDM (signs)	2 (1.5-3.0)	[≤ 1 : > 1]=0:10	2 (1.0-3.0)	[≤ 1 : > 1]=3:7
Skin test STM (signs)	1.75 (0.0-2.5)	[≤ 1 : > 1]=3:7	1.25 (0.5-2.5)	[≤ 1 : > 1]=5:5
Skin test fungi (signs)	0 (0.0-0.0)	[≤ 1 : > 1]=10:0	0 (0.0-0.0)	[≤ 1 : > 1]=10:0
Skin test histamine (signs)	2.25 (1.5-3.0)	[≤ 1 : > 1]=0:10	2.25 (1.5-3.0)	[≤ 1 : > 1]=0:10
Eosinophilia nose (signs)	0.5 (0.0-3.0)	[> 0]=5	0 (0.0-3.0)	[> 0]=4
Eosinophilia blood (number)	116 (11-231)	[> 200]=4	131.5 (11-704)	[> 200]=3
RAST IgE total (PRU/ml)	132.5 (17-600)	[> 150]=4	140 (70-560)	[> 150]=4
RAST IgE specific (HDM) (%)	34.5 (1-43)	[$\leq c1$: > c1]=1:9	32.5 (0.4-47)	[$\leq c1$: > c1]=2:8
RAST HDM $\leq c1$ and skin test HDM ≤ 1	0 subjects		0 subjects	
Eosinophilia nose > 0 and blood > 200	1 subject		3 subjects	
Smoking observed in the home	4 subjects		5 subjects	

HDM = *Dermatophagoides pteronyssinus*

STM = cocktail of *Lepidoglyphus destructor*, *Acarus siro*, *Tyrophagus putrescentiae*.

Fungi = cocktail of *Aspergillus*, *Penicillium*, *Cladosporium*, *Mucor*, *Alternaria*, *Candida albicans*.

Skin test: 1 = wheal of 5 mm with erythem (according to [43]):

HDM: 0.05 ml with 10 PRU/ml (HAL);

STM: 0.05 ml with 100 PRU/ml (Diephuis);

Fungi: 0.05 ml with 0.1% concentration (HAL).

Histamine: 0.05 ml with 0.01% concentration (HAL).

RAST: c1 = class 1 (2-5% activity bound [16]).

Eosinophilia nose: 0 = less than one eosinophil per mm³ in a smear of nose secretion.

Eosinophilia blood: total number of eosinophils counted per mm³ blood.

In no case was a significant difference found between the two groups (Mann-Whitney U-test at $P=0.05$).

pI antigen/g dust). However, as in the case of conventional dust avoidance, living in 'allergen/dust free' hospital rooms is neither a comfortable nor a permanent solution.

In the last few years, new 'household' appliances and products, e.g. MCR nebulizer, wet vacuum cleaning systems, electrically heated blankets, and intensive cleaning combined with acaricidal treatment became available for mite avoidance. Promising clinical trials were reported recently with the MCR nebulizer [8] and with solidified benzylbenzoate incorporated in household cleaning foam and powder [9-13]. These latter trials were uncontrolled and mostly short-term.

This study was undertaken to test the clinical efficacy of the acaricidal cleaning products over a period of 12 months in a double-blind controlled trial with perennial mite-allergic rhinitic patients. In the control group, normal but intensive household cleaning was performed. Exposure assessment, biological and physiochemical effects of treatment and the results of earlier conventional avoidance measures will be reported elsewhere [14].

Subjects and methods

To reduce variability, all dwellings were treated in the same week, and matched pairs were selected.

Selection, matching and characterization

Initially 60 patients were selected from out-patient files. They all showed a long-standing history of mite allergy with house dust mite-induced perennial rhinitis more evident than other allergic symptoms (asthma or dermatitis). All were between 12 and 36 years old. Moderate to severe pollen allergics were excluded. Hyposensitization treatment in the past was allowed. All subjects had received routine instructions as to the conventional allergological sanitation of their homes prior to this trial.

Out of the initial 60 subjects 20 were chosen to form 10 pairs matched by age, house dust mite-specific IgE and skin testing results, guanine exposure value, severity of complaints, hyperreactivity, type of dwelling, and number of inhabitants per dwelling (Table 1). All subjects

Table 2. Evaluation of symptoms and drug consumption after the avoidance measures

Subject identification	Smoking†	Physicians' evaluation after 12 months	Subjects' evaluation			
			Medication index*	P-value (Δ)	Symptom index	P-value (Δ)
1 Acarosan	No	Better	0.48		0.26	
1 Control	Frequent	Better	0.43	-0.05	0.92	0.66
2 Acarosan	No	Equal	0.11		1.15	
2 Control	Sporadic	Better	1	0.89	0.4	-0.75
3 Acarosan	Frequent	Better	2.5		0.7	
3 Control	No	Better	0.08	-2.42	0.31	-0.39
4 Acarosan	Frequent	Better	1		0.01	
4 Control	No	Equal	1	0	1.3	1.29
5 Acarosan	No	Better	0.17		0.19	
5 Control	Sporadic	Equal	0.00‡	-0.17‡	1.22	1.03
6 Acarosan	No	Better	1		0.47	
6 Control	No	Better	0.84	-0.16	1	0.53
7 Acarosan	No	Better	1		0.76	
7 Control	No	Worse	1	0	0.94	0.18
8 Acarosan	Sporadic	Better	1		0.88	
8 Control	No	Equal	0.5	-0.5	1.57	0.69
9 Acarosan	Frequent	Better	1		0.47	
9 Control	Frequent	Better	1.47	0.47	2.34	1.87
10 Acarosan	No	Equal	1		1.1	
10 Control	Sporadic	Equal	1	0	1.52	0.42

* Differences in normalized medians of scores (0-3 months versus 9-12 months): < 1 = improvement; 1 = no change; and > 1 = worsening.

† Smoking allowed in dwelling?: no = no smoking; sporadic = smoking less than once a month; and frequent = smoking more or less frequent (> once a month).

‡ Not reliable; patient stopped drug consumption in week 45 (November 1988), although symptoms had not diminished.

lived in dwellings with at least one object (floor covering, furniture, mattress, children's soft toy) with an increased guanine level [15]. In total, 65% of the objects were found to be above the hygienic limit (36% of bedroom objects, 12% in the living room, and 17% in other spaces).

All subjects completed the experiment. Two subjects (control group) moved during the course of the trial. One of these (control 7) rented an identical dwelling next door and took all textile objects to the new lodging. The other subject (control 1) left only her wall-to-wall carpeting in the old dwelling, moving all other home textiles.

Serum IgE (both total and specific against *Dermatophagoides pteronyssinus*) was measured with the Phadebas RAST method (Pharmacia, Uppsala, Sweden). Results of total IgE are expressed in PRU/ml, whereas specific IgE is expressed as a percentage of inhibition [16]. Intracutaneous tests with pollen, animal dander, mould cocktail (*Aspergillus*, *Penicillium*, *Cladosporium*, *Mucor*, *Alter-*

naria, *Candida albicans*), and *D. pteronyssinus* (HAL, Haarlem, The Netherlands), and storage mite cocktail (Diephuis, The Netherlands; *Lepidoglyphus destructor*, *Tyrophagus putrescentiae* and *Acarus siro*) were executed, together with phosphate-buffered saline solution (HAL) and phosphate-histamine as controls. Eosinophil counts in blood samples and in nose secretion were performed [17,18]. One subject (Acarosan 4) had received hypo-sensitization treatment in the past.

The intensity of smoking in the dwellings ranged from non-smoking, via sporadic smoking (less than once a month) to regular/frequent smoking (at least once a month). Eleven homes were inhabited by non-smokers only, six of these belonging to the acaricidal cleaner group. In four homes (three in the control group) sporadic smoking was observed. Two 'controls' and three subjects of the acaricidal cleaner group allowed regular smoking in their dwellings (Table 2).

Study protocol

Subjects were examined at regular intervals (at the start, after 2 weeks, 3, 6 and 12 months) at the Allergological Department of the University Hospital, Utrecht, The Netherlands. Physical examinations were performed at the start and end of the trial. Eosinophil counting in nose secretion and in blood was repeated 3 and 6 months after the start of the experiment.

Symptoms were scored by the patients daily, using presence and duration of the following symptoms: itching of eye and nose, sneezing, nose secretion, nose bleeding, eye irritation, and nasal blockage. The time during which each symptom showed itself in every 8-hr period was divided into four classes: no symptoms perceived (rated 0), symptoms present for 0–0.5 hr (rated 1), 0.5–2 hr (rated 2) or more than 2 hr (rated 3). All scores for one day were first added and then divided by 3 to obtain the daily scores. Daily scores were added to obtain 2-weekly scores. A minimum 2-weekly score of 0, and a maximum of 252 could be reached. A subject was considered to have no subjective symptoms when in a period of 3 months the 2-weekly score never surpassed 10 and no more than three of the six 2-weekly scores were above 5. The consumption of medicine (medication was used by 50% of the subjects) was quantified on the basis of daily intake. All scores for one day were added to obtain daily scores. Daily scores were added to obtain 2-weekly scores. Three medication types were scored: nasal spray type A (Beconase, Rhinocort and Syntaris—containing corticosteroids, beclomethasone, budesonide and flunisolide, respectively), nasal spray type B (Lumusol and Rynacrom—containing cromoglycate), and tablets (Triludan—containing the antihistamine, terfenadine). The 3-month median of values of all 2-week periods both for symptoms and medication was used for statistical analysis. No statistical differences (Mann–Whitney *U*-test at $P=0.05$) were found for symptom scores between the two groups after the first period of 3 months, nor was this the case within each group when the first 6 weeks were compared to the last 6 weeks of this period. The physicians' evaluation, based on the subjects' medical dossiers, took place at the end of the study (June 1989), and was divided into better, equal or worse. Non-worsening (equal or better) was compared with worsening (worse).

From each subject group, one member was arbitrarily allocated to acaricidal cleaning treatment and the other to control treatment. This allocation was unknown to both experimenters and subjects until the end of the study. At the beginning of the trial, no significant differences between the two groups (treatment/control) were apparent for any of the variables studied (Table 1).

In both groups, all textile objects in subjects' homes (carpets, padded furniture, mattresses, stuffed animals) were vacuumed (Hoover S2222) for 1 min/m² at the start of the trial (June 1988). Directly afterwards, treatment with acaricidal cleaning or control treatment (both Werner & Mertz, Mainz, Germany) took place. A second treatment was undertaken 6 months later (December 1988), directly after the third collection of dust samples. Acarosan foam consists of benzyl benzoate (2.6%), acrylat-copolymer (3.1%), anionic tensids+sodium soap+n-dodecanol (1.1%), perfume (0.04%), and water (80.1%); the control foam consists of: tensids (sodium soap) (1.00%), perfume (0.03%), and water (86%) (foam uses 13% butane/propane as propellant). Acarosan powder consists of: benzyl benzoate (5.0%), sodium chloride (1.8%), paraffin (8.1%), sodium-aluminium-silicate (4.0%), amorph SiO₂ (1.0%), cellulose fibres (40.5%) and water (39.6%); the control powder consists of cellulose fibres (45%) and water (55%).

Acarosan foam was sprayed onto a pad and distributed evenly on the textile (upholstery, mattresses, stuffed animals). The foam was rubbed in until it was no longer visible. Afterwards, the treated material was not cleaned for 7 days. The powder was sprinkled on to the carpet or rug and distributed evenly and thoroughly with a scrubbing brush. A drying period of 1–3 hr was required. After drying, the powder was removed by vacuum cleaning.

Dust samples of home textiles were taken in June, September and December 1988, as well as in June 1989 (non-textile floor coverings and humid walls included in June 1989 only) by vacuuming all textile objects and non-textile floor coverings in subjects' dwellings. Mite numbers were assessed by a flotation technique [1]. Mites were identified and rated as alive ('whole mite bodies') or dead ('damaged specimens'). Walls and non-textile floor coverings were not cleaned or treated.

The Acarex-test was used for guanine assessment [19–21]. The Acarex test (Werner & Mertz, Mainz) assesses guanine as a measure for mite allergen [15]. Acarex values were transformed to guanine amounts/g dust (mean values) according to Bischoff and Schirmacher [22].

Subjects' dwellings were divided into three sections; the bedroom, living room and other rooms. The measurement of subject exposure (guanine exposure value) was based on the amount (mg) of guanine removed with the collected dust. The dust exposure value was based on the amount of dust collected by vacuuming. The guanine exposure was calculated as: $3 \times (\text{mg guanine/g dust} \times \text{collected dust (g)})$ for every textile object from the bedroom + $2 \times (\text{mg guanine/g dust} \times \text{collected dust (g)})$ for every textile object from the living room + $1 \times (\text{mg$

guanine/g dust $\times$ collected dust (g) for every textile object in the other rooms).

Dust exposure was expressed in the same way, but based on the amount of collected dust (g).

Statistical analysis

Missing values in medication or symptom score were treated as 'not changed' and the score of the previous day was taken. Periods of 2 weeks or longer that were not spent in the dwelling (e.g. during holidays) were exchanged with the summed daily score of the previous 2-week period. Missing values for guanine exposure were set at the calculated median Acarex value of that particular dwelling and object group.

Data on total IgE, mite-specific IgE, eosinophilia in blood and nose mucus, intracutaneous tests, guanine and dust exposure were normalized by dividing by the values of June 1988 (start of the experiment). Medication and symptom scores (3-month periods) were normalized by dividing by the median value of the first 3 months of the experiment. Before normalizing, scores of medication and symptoms were transformed as 'median value + 1', whereas observed nose eosinophilia values were transformed as ' $\bar{x} + 0.1$ ', to remove 0-values.

The data were not distributed normally, not even after log transformation. Only non-parametric statistics could be used [23]: randomization test for matched pairs; Mann-Whitney *U*-test to compare the two groups (both with normalized data); McNemar test for the significance of changes; and the binomial test. Physicians' evaluation was in essence a nominal measurement, which did not permit more sophisticated statistics. In the Academic Hospital, Utrecht, The Netherlands, in spring 1988 fewer allergic patients as well as fewer allergic complaints were seen as compared to 1989. Therefore, worsening versus non-worsening was tested. Changes in time within the two groups were studied with the Mann-Whitney *U*-test and the binomial test (for exposure variables only) with non-normalized data. Spearman correlations were computed with non-normalized data at the start and the end of the experiment as well as with the differences between the normalized end values. The confidence limit was set at $P \leq 0.05$.

Results

None of the subjects reported any toxic or irritant effect of acaricidal cleaner or control treatment, except for some annoyance caused by the lavender/citrus smell (present in the acaricidal cleaner as well as in the control), which was removed from the products by the manufacturer after the trial.

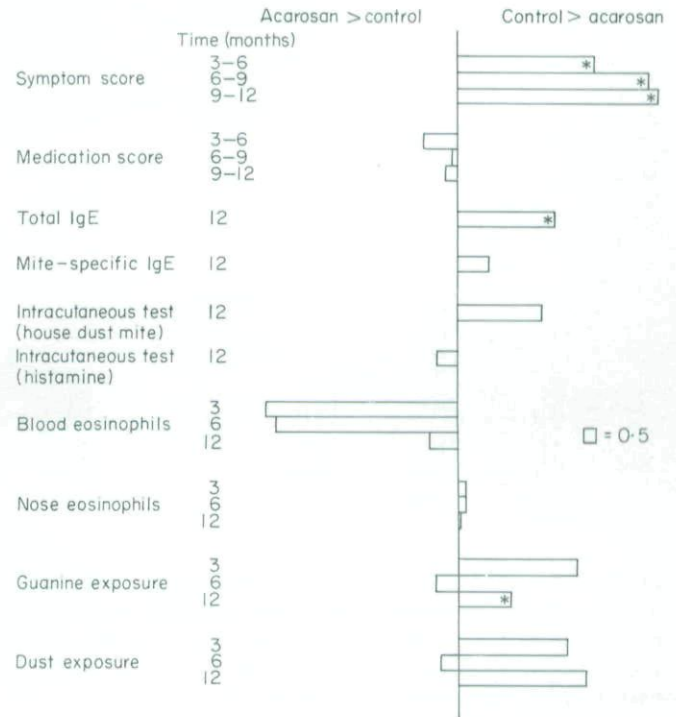


Fig. 1. Median values of the differences of normalized variates (Control - Acarosan) in acaricidal cleaning treatment and control group (10 matched pairs) during a 12-month observation period. * Indicates significant differences (randomization test for matched pairs at $P < 0.05$).

One year after initial treatment, daily symptom scores had diminished in the acaricidal cleaner group as compared to the control group (matched pairs: $P = 0.025$; groups $0.025 > P > 0.01$). Eight out of 10 subjects in the acaricidal cleaner treatment group improved more than their control; three lost their symptoms (Table 2). In the acaricidal cleaner group 80%, and in the control group 40% of subjects improved (Table 2). No subject from the control group was free from complaints at any time during the trial. The improvement in the acaricidal cleaner group started about 3 months after the initial treatment and continued until the end of the experiment (comparison start-end: $P = 0.05$) (Fig. 1). Evaluation by the physician showed 'non-worsening' in the acaricidal cleaner group ($P = 0.02$), but not in the control group ($P = 0.22$). Comparison of physicians' assessment in the matched pairs did not show any changes (Table 2).

In the acaricidal cleaner group, four subjects used medication daily. In the control group this occurred in six cases. After 5 months, one subject in the control group suddenly stopped medication because she did not perceive any benefit; her symptom score rose dramatically

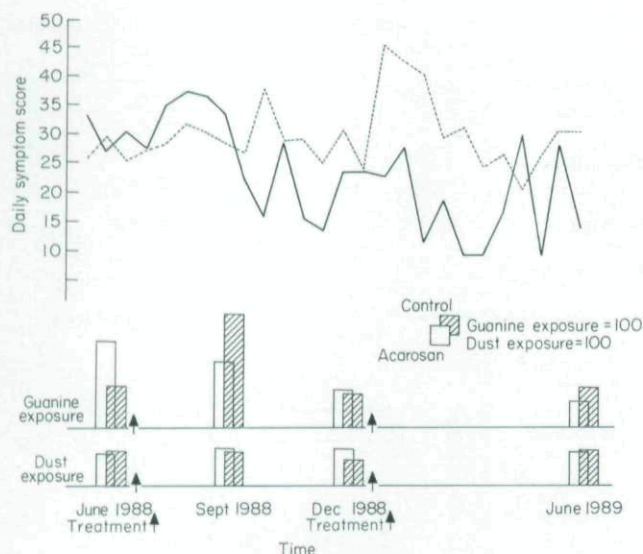


Fig. 2. Daily symptom scores and exposure to guanine and dust. Symptom scores are shown as the median value for all members of one group for a total of 2 weeks of daily symptoms. Exposure values are indicated by histograms of the median value of all participants of one group (acaricidal cleaning treatment (—) and control (---)).

afterwards. Although three out of 10 subjects who initially used medication (two treatment groups and one control group) were free of drugs by the end of the experiment, no overall differences were found in the matched pairs or between the groups (Table 2, Fig. 1).

Total IgE dropped in the acaricidal cleaner group as compared to the control group (matched pairs: $P=0.0049$; groups: $0.050 > P > 0.025$). The maximum fall of total IgE 12 months after the first treatment was 47% (with a mean of 38%) of the initial level in the acaricidal cleaner group. The total IgE level in the control group did not change. Specific IgE against *D. pteronyssinus*, eosinophil counts (blood and nose), as well as intracutaneous tests with *D. pteronyssinus* and histamine stayed at the same level (Fig. 1). At the start of the experiment, elevated eosinophil levels in the blood were present in four subjects of the acaricidal treatment group and in three subjects of the control group. After 1 year, the increased eosinophil level in the blood serum of all four subjects who received acaricidal cleaner treatment fell below the value of 200, in the control group this occurred in one (out of three) subjects.

Guanine exposure dropped (matched pairs $P=0.0449$; between groups $0.025 < P < 0.05$) when comparing start and end values (Fig. 1). Dust exposure did not change (Fig. 2). The mite-killing effect was apparent in all acaricidal cleaning groups as compared to the intensive

cleaning group (all textile objects $0.01 < P < 0.025$; all padded furniture $0.01 < P < 0.025$; textile floor coverings as well as mattresses $0.025 < P < 0.05$; upholstery $0.001 < P < 0.01$) [14].

Guanine exposure decreased constantly in the acaricidal cleaner group, reaching 70% of the start value at the end of the experiment (binomial test $P=0.001$). In the control group the reduction was a mere 3%. Guanine exposure (in the control group) showed a seasonal fluctuation with the exposure peak in late summer (September), a low value in winter (December) and a return almost to the start value in June (Fig. 2).

An acaricidal treatment (Acarosan) may influence the existing ecosystem (house dust) and this may affect variables as well as their interrelations. Using start values, significant ($P \leq 0.05$) Spearman rank correlations were seen among the exposure variables. At the end of the experiment these correlations vanished in the control group. Guanine exposure and daily symptoms showed no relation at the start of the experiment. After 12 months a negative correlation appeared in the acaricidal cleaner group. At the start of the experiment total IgE is related to specific IgE towards house dust mites in the acaricidal cleaner group only, indicating non-homogeneity towards this variable. Twelve months later this relation was not apparent. However, changes in both variables (total IgE and specific IgE) were positively correlated in the control group only. Other significant correlations concerned the blood eosinophilia and IgE. For total IgE the relationship apparently weakened during the experiment and became negative for the correlation of changes. Specific IgE on the other hand showed a positive correlation with blood eosinophilia in the control group at the end of the trial, but correlations of changes were not significant.

Stored food mites, as well as house dust mites were present on seven humid walls of the control group (numbers 1, 3, 5, 6, 7, 8 and 9) as well as on four humid walls of the acaricidal cleaner group (numbers 2, 3, 8 and 10) [24]. Furthermore, one house in the acaricidal cleaner group (number 7) was infested with cockroaches.

Discussion

In this mite-avoidance study the use of an acaricidal cleaner in homes of perennial rhinitis subjects led to a diminishing of daily symptoms, of guanine exposure, and of total IgE. In contrast, the control group with intensive cleaning 'only' showed no such effects.

In view of the erratic distribution of highly mite-infested home textiles it is essential that the allergen levels are monitored with (semi-) quantitative assays in the whole personal environment of subjects. Our exposure values are based on this observation, and on the proposed mite (allergen) standard [15]. The correlations of guanine

and dust exposure variables at the start of the experiment vanished in time, except in the control group. We conclude that the quantitative relation of removable guanine and dust has been changed by the avoidance measures in the acaricidal cleaner group. Two factors may have influenced this process. First, guanine production decreased after the mite control. Secondly, guanine is removed more efficiently with the acaricidal cleaner than by normal intensive cleaning. The dust-binding capacity of the two acaricidal cleaning formulations differs from the control formulations in the use of acrylat-copolymer (acaricidal foam) or paraffin (acaricidal powder).

Non-specific factors, such as irritating dust, fumes, smoke and gasses, humidity, cold air and strong odours may provoke symptoms in rhinitic subjects. These non-specific factors, combined with specific allergens (e.g. stored food mites, cockroaches, animal danders), are generally neglected in clinical efficacy studies. In spite of the fact that in the acaricidal cleaner group 40% of subjects' homes were regularly visited/occupied by smokers, and the findings (during the course of the trial) of other allergen sources offensive to subjects, such as stored food mites and cockroaches, this study shows a decrease of rhinitic symptoms of mite-allergic subjects.

Eosinophilia changes in blood as well as in the nose secretion in allergic rhinitis may be related to the symptoms experienced by the subjects [25]. In this study the counting of eosinophilia in nose secretion and blood serum gave no additional information. However, it is known that many variables may influence determination of numbers of eosinophils, especially in nose secretion. Objective improvement in allergic rhinitis was shown in the acaricidal cleaner group by significant reduction of total IgE, but not in specific IgE to *D. pteronyssinus*. In most mite-avoidance studies it was expected that serum levels of specific IgE to the house dust mite would fall after a period of successful avoidance. However, decreases were also observed [8-13; 26-30; 32-40].

Previous avoidance studies in mite-allergic patients have been successful in reducing asthmatic, rhinitic or conjunctivitic symptoms [7-13, 26-32] and in reducing total IgE [7, 27, 28, 31]. Others were unsuccessful [33-40]. The decrease in total IgE after successful avoidance is not caused by a fall of specific IgE. Any effect from seasonal factors appears equally unlikely, because measurements were performed with an interval of exactly 1 year. As a result of a long-term epidemiological study in the FRG, Hallauer *et al.* [41] found a positive correlation between the degree of outdoor pollution and total IgE concentration in serum. In our experiment, we found a negative correlation between the changes from start to end of trial in total IgE and dust exposure (which is in fact the collectable/removable dust). Dust exposure did not change in time (12 months) in the acaricidal group and

total IgE fell. The conclusion remains that the avoidance measures taken had a positive impact on guanine exposure, and were responsible for these total IgE falls.

Three successful avoidance studies involved removal of carpets and stuffed toys, covering mattresses with plastic, or washing bedding regularly [27-29]. In three other studies asthmatic symptoms were improved by relocating patients from their own houses to 'mite (allergen)-low' places/rooms [7, 26, 31]. Blanc and Boutin [8] concluded that improvement of asthmatic symptoms on the basis of patients' opinion was possible in 92% of 133 cases, using the MCR nebulizer with paragerm AK, followed by intensive cleaning of the complete dwelling. Only one author mentions rhinitic symptoms [10]. In his uncontrolled experiment, improvement was 71%. He too used the acaricidal Acarosan.

Saint Georges-Grèdelet *et al.* [42] published data on efficacy and safety of most of the available acaricides in Europe. Acarosan foam and powder was shown to be efficient and safe.

Improvement in the health of asthmatics (children and adults) has been reported previously after treatment with acaricidal cleaner [9-13]. A decrease of live mites and of Acarex values, as well as a reduction of medication and an increase of peak-flow values were seen in four out of five subjects [11, 12]. Elixmann *et al.* [13], who treated five dwellings with acaricidal cleaner once, no longer found living mites in carpets and in most furnishings 1 year after treatment. The changes in mite population of this trial have been reported elsewhere [14].

Instead of counting mites, Kersten *et al.* [9] as well as Gessinger [10] assessed Acarex values. Without exception, the Acarex test values decreased and significant lung function improvement and reduced anti-asthma medication were seen in a group of 49 patients after 3 months [9]. Thirty-nine of these patients were followed for 1 year [10]: Acarex values stayed low, improvement of lung-function, asthmatic, rhinitic and conjunctivitic symptoms remained for about 7 months after treatment. A second treatment of acaricidal cleaner after 8 months was recommended. A decrease of guanine and of asthmatic symptoms was seen in seven out of 12 French patients [32]. These promising clinical results were reported in uncontrolled, mostly short-term studies. Our 12-month double-blind trial supports the previously reported clinical improvements after mite avoidance with the acaricidal cleaner Acarosan. The acaricidal cleaner method proved to be an effective and safe instrument in reducing mites and allergenic dust, and benefits mite-allergic patients.

Acknowledgments

First of all we want to thank our subjects for their cooperation. Furthermore, we are grateful to Mrs A. de

Haas, Mrs H. E. Korte, Mrs P. A. C. van Wijk and Mrs E. M. M. Zwart-Hezemans for intracutaneous testing; L. G. H. Koren, J. Scharringa and G. Schober for sampling and analysis of dust; Mrs J. Schotanus-Felkers for subject logistics; A. M. Iken for correcting and editing of the English. We would also like to thank the student employment agency (SUSA) and their 'vacuum-students' for assistance; J. A. J. Faber (Center for Biostatistics, Utrecht, The Netherlands) for statistical help; Werner & Mertz, Mainz, FRG for the Acarex/Acarosan products; Gesellschaft für hausbiologische Forschung, Mainz, FRG and Stichting Minibiologisch Onderzoek, Utrecht, The Netherlands for financial support.

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