

Mechanisms and patient compliance of dust-mite avoidance regimens in dwellings of mite-allergic rhinitic patients

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Summary

We report on the mechanisms, the environmental changes and patient compliance with regard to conventional and new dust and mite avoidance measures to prevent allergic symptoms caused by mite allergens, taking into account both allergen contamination and the developmental success of pyroglyphid Acari. Twenty patients with persisting rhinitic complaints were selected and matched. Although the patients had performed some conventional dust and mite avoidance measures (patient compliance was 90%), the dwellings proved to be a stimulus for mite development. Moisture problems due to faulty construction and excessive moisture production were common. Since humidity conditions could not be changed at short notice, the 20 homes were subjected to the new variants of mite allergen avoidance based on intensive cleaning without (control) and with an acaricide incorporated (acaricidal cleaner [Acarosan]). After the carrying out of conventional avoidance measures, these patients still had allergic symptoms, and dust from only 23 to 52% of their textile objects was under the proposed guanine (mite faeces indicator) risk level. Only the acaricidal cleaner was able to decrease the allergenic mite load (and the burden of the patients) significantly in this 12 month period. With respect to mite-extermination, acaricidal cleaning was 88% better than intensive cleaning. Reduction of guanine was 38% better in the Acaroson treatment group.

Clinical results have been reported elsewhere. A significant difference in favour of the acaricidal cleaning was seen in both subjective (as regards symptoms) and in objective data (total IgE). Another 50 patients were questioned. About 90% were willing to spend two weekends (70%), or at the most one weekend (20%) per year sanitizing the dwelling by cleaning it with the whole family.

The authors of this report consider acaricidal cleaning to be a significant improvement in the management of mite-allergic diseases, such as rhinitis. Compared with the replacement of home textiles, this treatment is less expensive and more effective. Patient compliance is acceptable, but depends on acceptance by physicians and the initial motivation and consequent burden on the patient.

Clinical and Experimental Allergy, Vol. 22, pp. 681–689. Submitted 17 July 1990; revised 7 November 1991; accepted 11 November 1991.

Introduction

In the case of mite-induced allergy, conventional dust, moisture and mite avoidance is the first means advised in

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causal therapy [1]. This used to mean moving out as much dust-containing textile objects (furniture, carpets, curtains, toys) as possible, combined with regular vacuum cleaning, wet-mopping, the use of synthetic material, as well as increasing ventilation and repairing water leaks. Mite-ridden dust provokes symptoms, and moisture (humidity) is the prime influential factor in the development of the mites [2].

In this Journal we recently reported on a double-blind controlled mite avoidance trial with acaricidal cleaning [3]. Patients were selected by their inability to control allergic problems by conventional mite avoidance methods and so forming an extreme study population, giving the avoidance regimen an extreme test. After one year the health of eight out of 10 rhinitic patients had improved, three of whom became symptom-free. In the control group (intensive cleaning) four out of 10 patients felt better, but none were free from daily symptoms at the end of the trial. In addition, a significant decrease of total IgE ($P=0.0049$) was seen in the acaricidal treatment group and this was not the case in association with the normal intensive cleaning.

We shall now report on other aspects of this avoidance trial: the mechanisms, the toxicology, the environmental changes (acarological and physico-chemical), the practical and economic aspects influencing the compliance of the patients. The biological basis for the clinical success of this study was measured by changes in the offending mite populations and faecal contaminations (guanine) of dust. Physico-chemical aspects were monitored for the determination of the indoor climate, especially of mite supporting moisture levels in the dwellings. In addition, the relative effort and cost of treatment regimens used will be discussed.

Subjects, materials and methods

Twenty Dutch patients (aged 12–35 years; ratio male/female 7:13) living in 20 different dwellings participated in a double-blind mite avoidance trial. Another 50 interested atopics entered the study by answering a questionnaire, but no measurements were taken in their dwellings. General questions were posed as well as questions pertaining to the sanitation method performed until the questionnaire and the willingness to perform mite avoidance through (acaricidal) cleaning.

Selection criteria for the 20 patients and their dwellings, as well as a characterization of the patients are described in detail elsewhere [3]. However, all patients had a positive skin test (5 mm weal with erythema) to extract of *Dermatophagoides pteronyssinus* or a RAST-class of ≥ 1

(Pharmacia, Phadebas RAST, range 0–4) to *D. pteronyssinus*, and a long-standing history of mite allergy with perennial rhinitis more evident than asthma or dermatitis. Out of the 60 rhinitic patients initially selected, 10 pairs were formed by matching in age, IgE-level, skin test results, guanine exposure value, severity of complaints, hyperreactivity, type of dwelling, and number of inhabitants per dwelling. The 50 patients who only answered the questions were selected from an address file of patients who had shown interest in mite-avoidance over the last 12 months. Long before the trial, all the patients had received routine instructions for the allergological sanitation of their dwellings [1]. Information on the normal (pre-existed) state of the dwellings (many years after the enforcement of the conventional avoidance regimen) was obtained by questionnaire as well as by visual and technical inspection. Special attention was given to the adherence to ventilation requirements and its use in dwellings (NEN 1087 of the Netherlands Normalization Institute [4]) and constructional humidity parameters, such as rising and penetrating damp, water leaks and surface condensation. Furthermore, information was gathered about heating-, ventilation systems, and material used for curtains and wall-coverings. All of these can play an important role in conventional sanitation regimens.

Indoor climate classification was performed according to Tamme and Vos [5] in order to index humidity in Dutch dwellings. Four classes ranging from very dry (class I) to very humid (IV) can be distinguished for the Netherlands. They are based on long-term indoor and outdoor measurements (vapour pressure and outside temperature), but for practical purposes daily classification measurements were taken during at least one month in the heating season. An indoor weather parameter (modified climate-class) was calculated from in- and outdoor absolute humidity data (1.2 m above ground level) and from the outdoor temperature in a pilot measurement in the period March–April 1989 by using thermohygrometers (Type 252Ua & 253; Lambrecht, Göttingen, Germany) and an electronic temperature/humidity meter (Testotherm/Hygrotest). The difference between P_i (Partial water vapour pressure [Pascal] in the dwelling) and P_e (Partial water vapour pressure [Pascal] outside the dwelling) together with T_e (Outdoor temperature [degree C] Royal Dutch Meteorologic Institute; KNMI, de Bilt, The Netherlands) was used to calculate the indoor weather class [6]. In five dwellings long-term studies were also performed to determine indoor climate classes. The hygienic level for indoor weather in the Netherlands was taken from Schober [7] and set below class III [5].

Mite avoidance data were obtained by questionnaire,

visual inspection and dust sample analysis. Patients were interviewed by questionnaire as to their knowledge of avoidance procedures and the measures actually taken. Mite and dust avoidance measures, but not dehumidifying attempts of the dwellings of the patients were taken into account.

The dwellings concerned were divided into three sections; the living room, the bedroom of the patient and other rooms. In June (after vacuuming) and in December 1988, all textile objects in the 20 dwellings were either treated with a normal cleaning formulation (intensive cleaning = control) or with an acaricidal cleaning formulation (= Acarosan treatment) in a double blind set-up [3]. Both products are available as a foam or as a moist powder. Acarosan is composed of a mite-killing component (adsorbed benzylbenzoate) and cleaning (allergenic dust removing) components [3]. The Acarosan moist powder consists of benzylbenzoate which is adsorbed to zeolith (an anorganic molecular sieve with a relatively high specific weight) and a powder of cellulose fibres with a relatively low specific weight as well as an organic liquid. It is sprinkled on the carpet, brushed in thoroughly, and removed by vacuuming after a drying period of between 1 and 3 hr. The allergen-containing dust components are soluted from the house-dust reservoir by liquid paraffin, and during drying it is adsorbed on the cellulose fibres. After drying, the loaded cellulose fibres are collected by vacuum cleaning, while the smaller particles (2 μm in diameter) and the heavier mite-killing ones sink into the carpet pile. Acarosan foam uses another kind of solidified benzylbenzoate as a mite killer. It is sprayed on a pad, distributed on the textile, and rubbed in. In order for the foam to work efficiently, vacuum cleaning was not performed for one week. The allergenic dust removing effect starts with tensids and water loosening the dirt particles from textile fibres, fixing them afterwards to a polymer film. The film loaded with allergen-containing dust is destroyed by mechanical influences ('use'), and removed by vacuum cleaning (Bischoff, Indoor Medical Research Center, Mainz, Germany, personal communication).

Data on non-toxicology, non-mutagenicity and non-allergenicity of the environmental acaricidal cleaning product, as well as its active ingredient are reported [8]. No evidence was found of any side-effects after short or long-term contact with the remaining concentrations of benzylbenzoate present in Acarosan formulations or treated textiles. In accordance with current advice to patients, a living room was considered sanitized when at least the floor coverings or the furniture were non-textile. However, a bedroom only needed synthetic bedding to be rated as sanitized. The group 'other rooms' was sanitized when a non-textile floor covering was used. However,

other avoidance measures like changing the wall coverings and indoor climate may also play an important role in the efficacy of conventional sanitation (see Table 2 and 3). To evaluate the efficacy of the avoidance endeavours, dust samples were taken in June, September, December 1988 and in June 1989 by vacuuming every textile object separately. Non-textile floor coverings were only sampled in June 1989. Sampling intensity was 1 min/ m^2 surface area with a Hoover S2222 (Hayesgate, U.K.) vacuum cleaner. Sampling per object differed from 1 to 55 minutes. Mite numbers (alive, dead and total, expressed per gram of dust) were assessed by a flotation technique [9], with an extraction efficiency of 15–20%. Guanine determinations were made by the Acarex test [10–12] to obtain data on the amount of mite-excrements in vacuumed dust as an indicator of the allergen level [13]. The Acarex test has four upgrading classes (0–3). Sections or surfaces were considered effectively sanitized when mite product levels (Acarex) did not reach risk levels of Acarex = 1 (weakly positive) [14,15]. The mite risk level was set at 100 mites/g dust (furniture and mattresses) [16–18], and 10 mites/g dust (floor coverings) [19,20]. Increase or decrease of mite-numbers after treatment was calculated by the growth rate per month (r) [21]. The numbers of living pyroglyphid mites in June 1988 (N_0) and June 1989 (N_t) were used in this calculation; $r = (\ln N_t - \ln N_0)/t$ (t = time period). A negative r -value indicates a population decrease, whereas a positive value is an indication for an increase. To evaluate the possible burden of mite avoidance in the 20 households studied, the financial effort needed to replace all too highly contaminated textile objects was estimated as well as the time and money needed to perform a selective avoidance. Time and product consumption for selective mite avoidance procedures with Acarosan and normal cleaning formulations in different mite-niches were obtained from manufacturers' information and calculated from vacuum data of our 20 dwellings (Table 1). The writing off period for furnishings was set at 5 years for the carpet and 10 years for the furniture. Default replacement cost for the carpet was set at US\$ 50/ m^2 and for padded furniture US\$ 25/ m^2 [22]. Default treatment frequency was twice in the first year and once in the years thereafter. This adds up to 5 treatments in 5 years (carpets) or 10 treatments in 10 years (furniture). Current German prices (US\$ 2.50/ m^2 for Acarosan foam; US\$ 2.50/ m^2 for Acarosan powder; US\$ 0.30/ m^2 for normal foam and powder cleaning) were used in the calculations.

Data appeared not to have been distributed normally, not even after log-transformation, so only non-parametric statistical tests could be used [23]; the Mann-Whitney U-test was selected to compare the three different treatments. The confidence limit was set at 0.05.

Table 1. Time consumption of selective mite avoidance measures with Acarex/Acarosan in 20 homes of rhinitic patients

	Median	Range
<i>Inventory</i>		
Vacuuming all home textiles	2 hr 50 min	80–287 min
Performing all Acarex-Tests	1 hr 8 min	20–92 min
<i>Treatment with Acarosan</i>		
Bedroom(s)	44 min	7–104 min
Living room	39 min	0–83 min
Other rooms	30 min	0–66 min
<i>Selective mite avoidance: total</i>		
(without drying time of textiles)	5 hr 51 min	107–632 min

Results

Ninety per cent of the patients (18 out of 20) conformed at least partly to the conventional avoidance advice given. Sixteen patients carried out the conventional sanitation according to pamphlets originating from hospitals, industries and the Dutch Asthma Foundation (NAF), the other two were instructed by their physician only.

About half of the patients had altered the living room, 15 out of 20 (75%) had attempted to sanitize the bedroom, while eight (40%) had also taken avoidance measures in other rooms. Only five (25%) patients sanitized all rooms. In spite of these avoidance attempts all the dwellings had breeding places for mites, and most had a fungal problem. The amount of textile floor coverings ranged from 3–107 m²/dwelling (median 54 m²/dwelling), and of padded furniture from 17–159 m²/dwelling (median 54.5 m²/dwelling). Curtains were made of natural fibres in 10 out of 20 bedrooms of the patients (50%) and three living rooms (15%). Paper or textile, as possible breeding places for, e.g. storage mites [24], were present on the majority of walls and room partitions (Table 2). One measure advocated in conventional sanitation, using hard floor coverings instead of textiles, appeared effective in decreasing living mite numbers (median 0.2; range 0–16.7 mites/g dust versus median 80; range 0–92 mites/g dust). As for Acarex values hard floors always scored 0 (negative), while floor textiles ranged from 0 to 3 (strongly positive).

With regard to the indoor climate, especially the moisture level, 17 out of 20 homes (85%) were considered humid. In the majority of cases (13) this could be attributed to inadequate construction of the building or the heating/ventilation systems (moisture problems A, B, C and D2a of Table 3); in nine cases (45% of dwellings) household activities presumably led to an increased moisture production (moisture problems D1 of Table 3).

Indoor climatic measurements, although not complete, indicate a weather class III or higher (which is optimal for mites), in 50% of the homes. Inhabitants were given advice as to how to dehumidify their dwellings. Changes in life style (2 ×) or construction (5 ×) or a combination of both (10 ×) were advocated. The results and the patient compliance of these interventions can only be measured in the long-term over a number of years, and are not further taken into account in this publication. Apparently dwellings had a sufficiently high moisture level to support the population growth of house-dust mites even in the three cases (15% of the dwellings) where no technical moisture problems were apparent. There appeared to be a large range of mite-counts (0–1995 mites/g dust) and all Acarex-classes were present. In two houses excessive contamination with mites was observed (code 4 & 10 Acarosan, both > 1300 mites/g). In total 19 089 mites were identified in June 1988. About 87% belonged to the family Pyroglyphidae (house dust mites), with *D. pteronyssinus* (Trouessart 1897) being the most abundant species. Stored food mites represented 5% of the mite fauna on home textiles, and—as was determined later [24]—21% on walls. In this group the families Glycyphagidae and Acaridae were noted for their abundant occurrence.

All 20 patients entered this study because of long-lasting allergic problems, allegedly in spite of conventional sanitation (16 out of 20 dwellings proved sanitized). Inside the rooms no correlation was noted between conventional sanitation, mite numbers and guanine values; values below risk levels were found in both conventionally sanitized and not sanitized sections of the dwelling.

After the execution of conventional avoidance measures in 18 dwellings, 48–77% of vacuumed textile objects still possessed an increased risk level based on guanine values (Fig. 1). Also 53% (padded furniture) to 77% (floor coverings) of textile objects were above the proposed risk level based on total mite numbers. One year after intensive cleaning (2 ×) of home textiles with control powder and foam, the number of objects with an increased guanine risk-level had diminished. However, 38–65% of textile objects needed an additional or rather a more effective treatment. The effect of the acaricidal cleaning with Acarosan exceeded the effect of intensive cleaning by up to 50% (Fig. 1). The Acarex-step-reducing effect was higher in acaricidal cleaning (Acarosan) as compared to the intensive cleaning (all textile objects $P=0.004$). Although the acaricidal cleaning treatment was generally better than both conventional mite avoidance and intensive cleaning, in the case of mattresses 17 out of 31 (55%) remained above risk level. These mattresses were all more than 10-years-old. Mean growth

Table 2. Characterization of conventional mite avoidance attempts in the dwellings of 20 rhinitis patients

House code	Floor area (m ²)		Surface area of padded furniture (m ²)	Sanitized			Curtain material		Wall-covering	
	A textile	B non-textile		Living room	Bedroom	Other rooms	Living room	Bedroom	Living room	Bedroom
1 Acarosan	65	4	33	Yes	Yes	Yes	*	*	Paper	Paper
1 Control	52	12	147	No	Yes	No	*	*	Stucco(s)	Paper
2 Acarosan	71	9	33	No	No	No	*	Velvet	Jute	Paper
2 Control	26	70	68	Yes	Yes	Yes	*	*	Stucco(r)	Paper
3 Acarosan	81	15	50	Yes	Yes	Yes	Wool	PVC	Stucco(r)	Wood
3 Control	63	13	78	No	Yes	No	PVC	*	Mineral	Mineral
4 Acarosan	107	4	159	No	Yes	No	Velvet	Wool	Paper	Paper
4 Control	60	40	104	No	Yes	No	Velvet	*	Paper	Paper
5 Acarosan	23	74	66	Yes	Yes	No	*	Cotton	Stucco(r)	Paper
5 Control	53	27	68	No	No	Yes	*	Cotton	Paper	Paper
6 Acarosan	28	20	28	Yes	Yes	No	*	Cotton	Stucco(s)	Paper
6 Control	51	24	63	Yes	Yes	No	PVC	PVC	Paper	Painted
7 Acarosan	55	47	59	Yes	No	No	PVC	Cotton	Stucco(r)	Paper
7 Control	41	8	46	No	No	No	None	Cotton	Stucco(s)	Stucco(s)
8 Acarosan	48	3	28	Yes	Yes	Yes	PVC	*	Paper	Paper
8 Control	80	34	50	No	Yes	Yes	*	Cotton	Stucco(s)	Stucco(s)
9 Acarosan	41	35	17	Yes	Yes	No	None	Cotton	Stucco(r)	Paper
9 Control	3	74	63	Yes	Yes	Yes	*	Cotton	Jute	Paper
10 Acarosan	84	20	82	No	Yes	No	*	*	Paper	Jute
10 Control	16	3	23	No	No	Yes	*	*	Paper	Paper

PVC, poly vinyl chloride.

*, Lamella.

(r), rough.

(s), smooth.

rate per month (*r*-value) decreased in all acaricidal cleaning (Acarosan) 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 $0.001 < P < 0.01$). The change in house-dust mite population 12 months after acaricidal treatment, expressed as mean *r*-value was -0.53 (range: -2.43 to $+0.18$) in case of floor coverings, -1.56 (range: -2.45 to $+1.16$) in case of padded furniture and -1.22 (range: -6.31 to $+1.61$) in case of mattresses. For intensive cleaning mean *r*-values were $+0.21$ (range: -1.39 to $+3.75$) for floor coverings, -0.34 (range: -0.73 to $+1.18$) for furniture and $+0.13$ (range: -1.03 to $+0.88$) for mattresses (Fig. 2).

Selective mite avoidance (intensive cleaning and acaricidal treatment) takes 5 hr 51 min (median value) per treatment (range 107–632 min). The treatment as well as the allergen inventory by Acarex test is included in these values, but not the drying of the cleansing agent. Costs for

replacement, household cleaning and acaricidal treatment differ strongly for individual dwellings; replacement-costs range from US\$150 to US\$5600, costs for household cleaning range from US\$50 to US\$600, and acaricidal treatment ranges from US\$110 to US\$2100. For individual patients money saving over a 5-year-period ranged from US\$0 to US\$3948 (median value US\$924), when replacement and acaricidal treatment is compared (Fig. 3). Eighty-nine per cent of the patients (50) questioned are willing to perform selective avoidance as far as only time consumption is evaluated. The most frequently stated restriction was that the measures must have the expected effect on patients' complaints. The current price was acceptable to 44% of the patients.

Discussion

Despite the fact that the majority of the dwellings selected were conventionally sanitized by the inhabitants in the past, risk levels for allergen and mite exposure were

Table 3. Indoor climate characterization of the dwellings of 20 rhinitis patients

Code of dwelling	Main heating system in home*	Ventilation type†	Moisture problems‡							Vapour pressure difference (Pi-Pe)	Temperature outdoor (Te)	Weather class level§	Climate class level
			A	B	C	D	D1	D2a	D2b				
1 Aca	Gas	Nat.	No	No	Pr.	Yes	Yes	Yes	No	312	5	No	ND
1 Con	Central	Nat. + mech.	No	No	Pr.	Pr.	No	Pr.	No	542	9,5	Yes	ND
2 Aca	Fan	Mech.	No	No	No	No	No	No	No	112	9,5	No	ND
2 Con	Central	Nat. + mech.	No	No	No	Yes	No	No	No	152	12,5	No	No
3 Aca	Gas	Nat. + mech.	No	No	No	Pr.	No	Yes	No	193	12,1	No	ND
3 Con	Fan	Mech.	No	No	No	Yes	Yes	Yes	No	610	8,5	Yes	ND
4 Aca	Gas	Nat.	No	No	Pr.	Yes	Yes	Yes	Yes	610	8,5	Yes	Yes
4 Con	Central	Nat.	No	No	No	Pr.	No	Yes	No	153	10	No	ND
5 Aca	Gas	Nat. + mech.	No	Pr.	No	Pr.	Yes	No	No	90	13,2	No	ND
5 Con	Central	Nat. + mech.	No	No	No	Pr.	Yes	No	Yes	552	7,9	Yes	ND
6 Aca	Gas	Nat.	No	No	Pr.	Pr.	No	Yes	No	168	6	No	ND
6 Con	Central	Nat. + mech.	No	No	No	Pr.	Yes	Yes	No	438	11,4	Yes	ND
7 Aca	Central	Nat.	No	No	No	No	No	Yes	No	270	6,6	No	ND
7 Con	Gas	Nat.	Yes	No	Yes	Yes	Yes	Yes	Yes	ND	ND	ND	ND
8 Aca	Gas	Nat.	No	No	No	Yes	Yes	Yes	No	396	10,5	Yes	ND
8 Con	Central	Nat.	No	Pr.	No	Yes	No	Pr.	No	294	10,5	Yes	ND
9 Aca	Central	Nat. + mech.	No	No	No	No	No	No	No	20	12	No	ND
9 Con	Central	Nat.	No	Pr.	Pr.	No	No	No	No	111	11,5	No	Yes
10 Aca	Central	Nat.	Pr.	No	Pr.	Yes	Yes	Yes	No	112	9,5	No	Yes
10 Con	Electric	Nat.	No	No	No	Pr.	No	No	Yes	348	8,5	Yes	Yes

ND, not done.

* Central, central heating through a hot water system; gas, one heater/room using natural gas; fan, central heating system by means of hot air.

† Nat, natural ventilation; Mech, mechanical ventilation; Nat. + mech., both types of ventilation.

‡ A, water leak; B, rising damp; C, penetrating damp; D, surface condensation (D1, probably enhanced moisture production; D2, probably inadequate moisture removal; D2a, NEN 1087 regulations not met; D2b, NEN 1087 regulations met); Pr. probably present.

§ Yes, level (weather-class II) exceeded; No, level (weather-class II) not exceeded.

|| Yes, level (climate-class II) exceeded; No, level (climate-class II) not exceeded.

generally exceeded. These findings are not surprising since all the houses were inhabited by patients with allergic symptoms resisting current therapy.

There are few clinical studies in which differences in mite and mite products have been also determined. The limited clinical success of conventional mite-avoidance in such a set-up in dwellings has been repeatedly reported (summarized in [25]). Only one positive case-study (14 patients) was reported [26], while only two of the four controlled studies had a positive impact [17,27]. Apparently the removal of textiles, changing the mattresses and regular vacuuming are neither practical nor financially acceptable under mite-prone (damp) and comfortable home conditions [28]. For Acaroson four positive case studies (71 patients), and one positive double-blind (20 patients), as well as two other controlled studies (as yet not published; only as abstracts) are known. Clinical field

studies with other chemical treatments in which acarological variates were measured, include Tymasil (natamycin and benzalkonium-chlorid) [29], Paragerm (benzoic acid terpineol, chlorophenol and thymol) [30,31], and liquid nitrogen [32]. Other trials are in progress, but only well performed controlled studies are acceptable. Furthermore it is crucial that new acaricidal products are submitted to a proper scientific scrutiny to an extent comparable to drug licensing.

A relative humidity of 70–85% in a dwelling is optimal for mite growth [2,7]. Construction faults were common in patients' dwellings. Surface condensation was the most frequent problem. Increased water vapour production originating from household activities (indoor drying of textiles or cooking without exhausting) or insufficient moisture removal due to incompetent ventilation systems or suboptimal use of ventilation equipment were the main

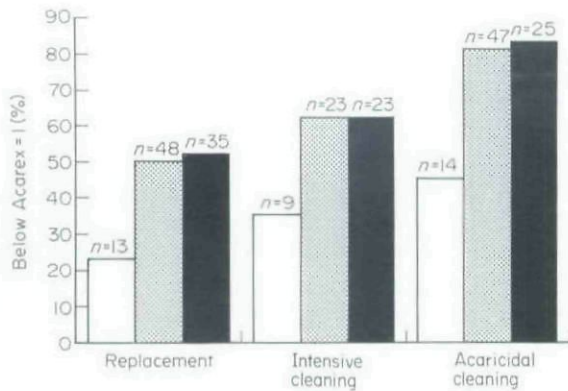


Fig. 1. Number of textile objects below risk level of Acarex = 1 (safe exposure), after the application of three different avoidance procedures: at the start of the experiment for the replacement group ($n = 10 + 10'$ homes; 219 textile objects), 12 months after intensive cleaning ($n = 10$ homes; 100 objects), and 12 months after acaricidal cleaning ($n = 10'$ homes; 119 objects). □, mattress. ▨, floor. ■, furniture.

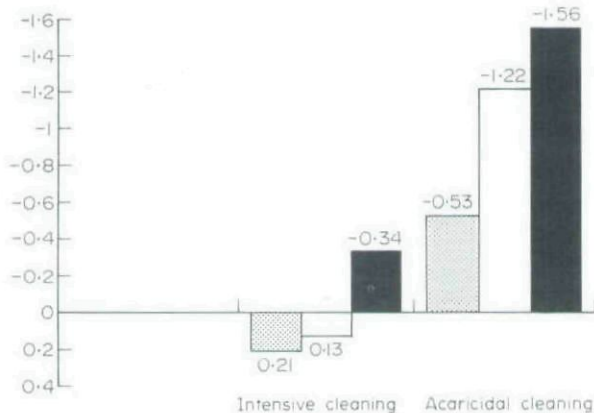


Fig. 2. Mean growth rate (r) during a 12 month period as a measure of the mite-reducing effect of two different mite avoidance procedures; intensive cleaning ($n = 10$ homes; 100 textile objects) and acaricidal cleaning ($n = 10'$ homes; 119 textile objects). □, mattress. ▨, floor. ■, furniture.

causes of surface condensation. Lowering the moisture level called for (unacceptable) changes in life habits or was economically not feasible. However, even if these improvements were realized, no positive effects are to be expected within 3 months, according to Korsgaard [17]. Whether dehumidifying is a practical solution for mite problems should be the subject of further long-term studies of 1–3 year's duration. Effective management of the mite-problem (house-dust and storage mites) in dwellings and a subsequent improvement of patients'

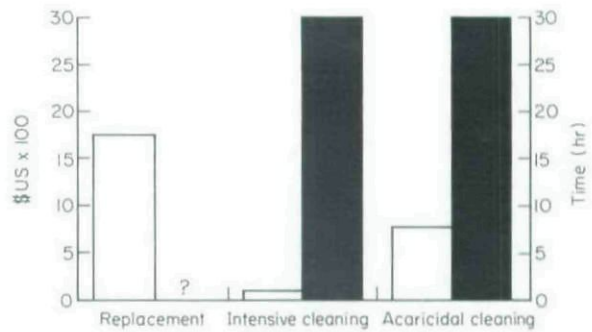


Fig. 3. Cost in money (US\$) and time (hours) calculated over a 5-year period in order to perform three different types of mite avoidance regimens: replacement of home textiles (US\$ 50/m² carpet; US\$ 20/m² furniture, writing-off periods 5 and 10 years respectively), intensive cleaning (5 times in 5 years), Acarosan treatment (5 times in 5 years). □, money. ■, time.

complaints may be achieved by infestation prevention, extermination of the mites and the removal of the allergen produced. The Acarex/Acarosan concept [25,33] came up as allowing for an effective, both safe and practical method of home sanitation against house dust mites and their allergens, with significant clinical amelioration of patients' health within a few months [3]. Although in this study the selective concept was not performed as such (since all textile objects were treated), we may conclude from literature data [34,35] that selective avoidance with Acarosan is just as effective as our 'complete' treatment.

Any new concept should address safety, efficacy and practicality of its treatment products, comparable to drug licensing. The safety (non-toxicity, non-mutagenicity and non-allergenicity) of the active ingredient, as well as the formulated product has been tested in detail, and although the active ingredient can be harmful if used in high doses, no short or long-term effects are known from the concentrations used in carpets, furniture or mattresses (Manufacturers' data; [8,36]).

Efficacy of Acarosan is tested as a reduction of the reproductive potential of the producer of the mite allergen (house dust mites), and of guanine as a marker for mite-allergen. Measuring specific allergen levels in settled or airborne dust was another possibility. Unfortunately only a few monoclonal antibodies to mites are available. No commercial tests to counter minor house dust mite and storage mite allergens are available yet. Further studies to find optimal ways of expressing the efficacy of the avoidance performed, other than measuring any clinical improvement, are therefore necessary before the monoclonals can be used in checking large scale avoidance endeavours.

In vitro, as well as under semi-natural conditions, the acaricidal cleaning product can achieve reductions of living mites of up to 100% [37,38]. A more rigorous way of testing the efficacy of acaricides is the performance of well-designed controlled clinical trials, where the measure of success is translated into clinical improvement. Such results have been presented elsewhere [3]. In this study, the levels for both mite and guanine contents were generally below risk levels after the use of acaricidal treatment. This effect is due to the interruption of allergen production by the mites and the removal of allergenic dust by cleaning.

In this study practicality and convenience of the new treatment was based on the outcome of questionnaires, as well as on the experiences of the experimentors. This new treatment is based on killing the allergen producers, and on the removal effect of cleaning. Cleaning is time-consuming and therefore it is executed only when the need arises, e.g. an unpleasant sight, a wish to fight pests, a medical indication for diminishing allergens, or just by force of habit. Modern cleaning uses technical equipment so as to save time. Not only the time consumed by cleaning, but also the costs involved are an important aspect in evaluating practicality.

Depending on the variable studied and the strictness of definition, patient compliance ranges from 5 to 85% [39]. The cause for non-compliance may be due to patients-, medication- or disease-factors, such as the fear of adverse effects, loss of independence, and unpleasant taste or smell. However, physicians for instance can improve patient compliance by making a correct diagnosis, designing a simple therapeutic regimen, and maintaining good communication with the patient. If we compare the evaluation of selective mite avoidance with the process of drug licensing, an additional complicating factor appears. The concept is based on a complex body of non-medical data from the ecological and technical sciences and pertains to the dwelling, and not to the patient. This extends not only to the pre-clinical test phases, but even up to phase 4; evaluation of post-marketing surveillance of drug use. If this is not well understood, the acceptance of the concepts by physicians may be low, thus further diminishing patient compliance.

Acarosan, an acaricidal cleaning agent, formulated as a foam or a moist powder may be used on home textiles. It is safe and effective. Although the time investment in this type of mite avoidance is high, most atopic patients are willing to perform such measures when there are good chances of success. The effect of Acarosan in our study was superior in the sense of mite population reduction as well as in clinical outcome. Therefore this treatment can be added to the existing therapeutic arsenal used against house dust mite allergies.

Acknowledgments

We are grateful to all patients for their cooperation; to Drs L. G. H. Koren, H. S. M. Kort and G. Schober for sampling and analysis of dust samples; to the student employment agency (SUSA) and its students for their assistance in collecting the dust samples; to Dr A. M. Iken for correcting; to Werner & Mertz, Mainz, Germany for the Acarex/Acarosan products; to the Gesellschaft für hausbiologische Forschung, Mainz, Germany and Stichting Minibiologisch Onderzoek, Utrecht, the Netherlands for financial support.

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