The effects of a single treatment of an acaricide, Acarosan, and a detergent, Metsan, on Der p 1 allergen levels in the carpets and mattresses of asthmatic children

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Abstract **Baseline levels of the house-dust mite allergen, Der p 1, were measured on the carpets and mattresses of 60 pure-mite-sensitive asthmatic children in the Cape Peninsula, by means of an enzyme-linked immunosorbent assay (ELISA). High levels of mite allergens were recorded (range 2 - 50 μg Der p 1/g dust). In order to investigate the efficacy of the application of acaricides to carpets and bedding, 3 groups of 20 children were studied. Carpets and mattresses in group A were treated with a detergent, Metsan (Snowchem), and in group B with Metsan combined with the acaricide, Acarosan (Noristan). Group C was a control group in which no treatment was applied. The level of airway hyperreactivity (PC20) to histamine was measured at the beginning of the study and again 3 months after acaricide treatment.**

Significant reductions in carpet Der p 1 levels were achieved in group A (22,83 v. 13,26 μg Der p 1/g dust; $P = 0,04$) and group B (21,76 v. 13,26 μg Der p 1/g dust; $P = 0,01$), but mite levels were not reduced in any of the mattresses treated. There was also no improvement in airway hyperreactivity in any of the groups.

This study clearly demonstrates that at present it is not possible to reduce Der p 1 antigen levels in mattresses in the Cape Peninsula with the available acaricides, even when one of these is combined with a detergent solution.

Until strategies are developed which will significantly reduce Der p 1 levels in the bedding of sensitive individuals, a reduction in ongoing airway inflammation and airway hyperreactivity cannot be expected.

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Allergy to house-dust mites occurs in 67 - 80% of children with allergic disease in the Cape Peninsula.[1,2] Chronic exposure to perennial allergens, such as the house-dust mite, results in an inflammatory process in the airways[3,4] which in turn increases the airway nonspecific reactivity to cold air, exercise, tobacco smoke and specific allergen challenge. Mite-allergic asthmatic patients, when placed in a mite-free environment, experience a significant reduction in nonspecific bronchial hyperreactivity and in their symptoms.[5] Furthermore, their requirements for anti-inflammatory treatment with steroids or cromoglycate are reduced.

Although it has been known since 1955 that house-dust mites are found in the coastal regions of South Africa,[6] immunochemical determination of the allergen level of house-dust mite, *Dermatophagoides pteronyssinus* (Der p 1), has not previously been undertaken. The recent availability of such assays for Der p1 antigen[7] has made it possible to quantify and evaluate objectively the protocols currently recommended to reduce house-dust mite levels in patients' homes.

Several acaricides have been found to kill mites effectively under laboratory conditions.[8] Their acaricidal effects on mites in patients' homes are influenced by factors such as the age of the house, the level of mite infestation, the ambient humidity and temperature, the presence or absence of carpets and the nutrient supply for the mites.

We report the results of a prospective study which documents the levels of Der p 1 in the carpets and

mattresses of 60 asthmatic children in Cape Town and evaluates the efficacy of an acaricide, containing benzyl benzoate (Acarosan; Noristan), and a detergent (Metsan; Snowchem), in reducing Der p 1 levels 3 months after a single application.

Methods

Patients

Sixty children between the ages of 5 and 12 years were studied. The children were known asthmatics, familiar with the use of a peak flow meter, or Vitallograph. All children had strongly positive skin tests or radioallergosorbent tests (RASTs) for house-dust mite (Der p 1) and negative RASTs or skin tests for other aeroallergens (including fungi, dogs, cats, feathers, grass and tree pollens). All patients lived in the Cape Peninsula. Patients were matched according to age, asthma treatment and sex and then randomised via a system of random numbers into 3 groups of 20 patients, A, B and C. None of the children had any history of recurrent bronchitis and none of them was a smoker. None of the patients was on oral steroids. Several were on inhaled steroids and these were evenly spread among the members of the 3 groups when they were matched for treatment and severity.

Der p 1 analysis

Baseline dust samples were collected from the carpets and mattresses in the children's bedrooms with a Vorwerk vacuum cleaner fitted with a paper bag. An area of 1 m^2 of the floor beside the bed and 2 m^2 of the upper surface of the mattress was vacuumed for 2 minutes and the dust sample sieved through a 0,3 mm mesh to obtain fine dust. The dust was stored at –20°C until extracted with borate-buffered saline. Dust samples were collected again after 3 months and Der p 1 levels determined by ELISA according to the method of Luczynska *et al.*[7] (i.e. with the monoclonal antibody clone 5H8 C12D9; University of Virginia, Charlottesville).

Application of acaricides

Acarosan or Metsan was applied to the carpets or mattresses (60 g/m^2) after baseline dust samples were collected. Group A patients had their carpets and mattresses treated with Metsan. Group B had theirs treated with a combination of Metsan and Acarosan, and group C's underwent no treatment.

Metsan is a water-based mixture of alcohol, detergents and antimicrobial substances (mainly fungicides) in an amino plastic foam carrier, and is available at local supermarkets as a foam and powder formulation for application to mattresses and carpets respectively. Acarosan foam contains benzyl benzoate, methacrylate copolymerisate, tensides (sodium lauryl sulphate and olepine sulphate), fatty acids, sodium hydroxide, 1,2 benzisothiazoline, propane/butane and water. The powder also contains cellulose, paraffin, sodium aluminium silicate and silicone dioxide.

Histamine challenge

Histamine challenges were conducted on all patients according to the method of Yan *et al.*[9] and the PC20 was calculated by means of a linear algebraic formula.[10] A baseline histamine level of PC20 was determined before the application of Metsan or Acarosan, and again at 3 months. Before bronchial challenge tests were conducted, inhaled steroids were discontinued for 1 week and β_2-agonists, antihistamines and sodium cromoglycate were continued for 3 days.

Statistical analysis

Analysis of the data was undertaken by the South African Medical Research Council, Parowvallei, CP; the Mann-Whitney U-test and the signed rank test were used.

Permission to perform the study was obtained from the Ethics and Research Committee of the Medical School of the University of Cape Town, and informed consent was obtained from the parents of the children in the study.

Results

Fifty-nine patients completed the study. There was no significant difference between groups A, B and C in respect of age and sex distribution. The mean age of the children was 9,6 years.

Mean baseline Der p 1 levels were above 22,8 μg/g dust in group A, 21,7 μg/g dust in group B and 16,65 μg/g dust in group C. Although the mean baseline Der p 1 level on the carpets was apparently lower in the control group, the difference was not significant. Baseline Der p 1 levels on the mattresses were markedly higher than on the carpets in all 3 groups.

Three months after application of Metsan or Metsan plus Acarosan, a significant reduction in baseline Der p 1 levels on the carpets was observed in groups A (P = 0,04) and B (P = 0,01) but not in the control group C (Table I). There was no significant reduction in the level of Der p 1 antigens in the mattresses 3 months after application of the Metsan or Metsan plus Acarosan.

TABLE I.
Mean levels of Der p 1 (μg/g dust)

	Carpet		Mattress	
Group	Baseline	3 months	Baseline	3 months
A	22,8	13,2*	34,5	29,7
B	21,7	9,6†	26,4	24,7
Control	16,65	16,7	33,8	33,8

* P = 0,04
† P = 0,01

Results of the histamine challenge tests are shown in Table II. Baseline median PC20 levels were not significantly different in the 3 groups. There was no improvement in the histamine sensitivity of any of the groups at 3 months. In fact, both groups B and C showed a significant deterioration in their bronchial hyperreactivity to histamine (signed rank test: group B — P = 0,02; group C — P = 0,05).

TABLE II.
Histamine challenge tests (median values PC20 (μmol))

	Baseline PC20	3-month PC20	2 dilution shift	Signed rank test
Group A	0,41	0,26	No	NS
Group B	0,30	0,08	Yes	P = 0,02
Group C	0,19	0,04	Yes	P = 0,05

Discussion

This is the first study in Africa in which Der p 1 antigen levels have been recorded by means of an ELISA. Our studies have shown that levels of the house-dust mite,

Der p 1 in the Cape Peninsula were uniformly much higher than the levels regarded as safe for asthmatics (i.e. < 2 μg/g dust) in the homes of all the children studied. The range of allergen levels we observed is similar to elevated levels reported from Brazil and Sydney, Australia,[11] but are higher than those reported by Sporik *et al.*[12] in the UK.

Our study has shown that a single application of Metsan significantly reduced Der p 1 levels in carpets and that this reduction was further improved by the addition of Acarosan. This is, to our knowledge, the first study in which the enhancing effect of a detergent (Metsan) on Der p 1 reduction by an acaricide has been demonstrated in carpets, and this has practical implications for mite control in carpets. Disappointingly, we did not significantly reduce mite allergen levels on the patients' beds. We also failed to demonstrate any improvement in the bronchial hyperreactivity in any of the asthmatic children studied.

Failure to achieve a significant reduction in Der p 1 levels in the bedding has recently been alluded to by others.[13] There may be several reasons for this. In the first instance, the mattresses probably contain a large reservoir of accumulated Der p 1 allergens from the faecal pellets of mites which cannot be removed by vacuuming; secondly, it is probably also necessary to treat bed covers, duvets and pillows with acaricides to remove the live mites which would recolonise the mattresses.

Although we achieved a statistically significant reduction in Der p 1 levels in the carpets, they were not reduced to a level which would prevent further allergic sensitisation. A recent study suggests that an application of Acarosan for 12 hours instead of the manufacturer's recommended 4 - 6 hours may be more effective in reducing mite population in carpets.[14]

The lack of clinical benefit in this study from acaricides, which are highly effective in the laboratory, is disappointing. In order to improve the efficacy of the acaricides it is probably necessary to treat the entire house (in addition to the bedroom), and to use additional measures which do not favour recolonisation or proliferation of the mites, such as reduction of the humidity to less than 50% with air-conditioning systems, or the application of liquid nitrogen. These measures are unfortunately expensive and not practicable for most of our patients.

A two-fold deterioration in the PC20 values in groups B and C was observed. Deterioration occurred in the control group as well as a test group. Our study was conducted during the winter months and the apparent deterioration in PC20 values may reflect the worsening of the overall clinical status which we often observe in our asthmatic patients in the winter months, when intercurrent viral infections are common. Furthermore, without a significant reduction in mattress levels of Der p 1, a deterioration in PC20 is hardly unexpected, since airway inflammation and hyperreactivity are likely to deteriorate in the presence of ongoing allergen exposure.

Our studies confirm that both Metsan and Acarosan are useful reagents for reducing house-dust mite levels in carpets. Six-monthly applications are recommended by the manufacturers. It is likely that more frequent and longer applications of these substances would further reduce the Der p 1 levels in carpets, but complete removal of carpets would be best for patients.

Our study clearly shows how difficult it is to eliminate mites from bed mattresses in a coastal city like Cape Town, and emphasises the futility of simply treating mattresses with the acaricides on the market without checking to see if one has achieved a reduction in the allergen level. The failure to achieve any reduction in mite levels on bedding indicates that alternative strategies must be sought. Bed covers, duvets, pillows and soft toys present an often unrecognised source of mites and these should be removed or hot-washed often. Recent evidence suggests that plastic-coated mattress covers may prevent mite faecal pellets, produced by colonies deep within the fabric of the mattress, from being inhaled by the patients.

Until mite control measures achieve significant reductions of Der p 1 allergens in bedding, an improvement in the bronchial hyperreactivity and clinical status of the patients cannot be expected. Strategies directed specifically at mite control in the bedding need to be explored in the future.

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