Clinical evaluation of the effect of anti-allergic mattress covers in patients with moderate to severe asthma and house dust mite allergy: a randomised double blind placebo controlled study

L H M Rijssenbeek-Nouwens, A J Oosting, M S de Bruin-Weller, I Bregman, J G R de Monchy, D S Postma

Background: The use of anti-allergic mattress covers in patients with asthma can result in a large reduction in the level of house dust mite allergen in dust samples. Apart from a reduction in histamine induced bronchial hyperresponsiveness, there are few data on the effect of mattress covers on clinical efficacy and quality of life in patients with moderate to severe asthma.

Methods: Thirty patients with asthma and house dust mite allergy were studied in a randomised, double blind, placebo controlled study. Before and after using anti-allergic covers for 1 year, dust was collected from the mattresses to determine concentrations of Dermatophagoides pteronyssinus (Der p 1), and bronchial hyperresponsiveness and quality of life were measured. The patients scored their symptoms (lungs and nose), morning and evening peak flow values, and rescue medication for 14 days before and after the intervention period.

Results: There was a significant reduction in the concentration of Der p 1 in the dust collected from the mattresses in the actively treated group after 1 year compared with before treatment; no change was found in the placebo group. In both the actively treated and placebo groups there was no significant improvement in PC20 histamine. Quality of life improved similarly in both groups. The symptom score of the lower airways did not significantly change in either group. A significant decrease in nasal symptom score was seen in the actively treated group compared with before treatment, but there was no significant difference between the groups. No changes in morning and evening peak flow values, peak flow variability, nor in the use of rescue medication were found in either group.

Conclusion: The use of anti-allergic mattress covers results in significant reductions in Der p 1 concentrations in carpet-free bedrooms. However, in patients with moderate to severe asthma, airways hyperresponsiveness and clinical parameters are not affected by this effective allergen avoidance.

Reduction of allergen exposure in the bedroom is the primary target of avoidance measures, since the bed is the most important habitat and source of mite allergens to which we are exposed for many hours during nocturnal sleep. The most effective and probably most important avoidance measure is to cover the mattress, pillows, and duvets with mite allergen impermeable covers. Acaricides have been shown to be ineffective, time and energy consuming, and they require repeated application. Carpets are also an important microhabitat for mite colonisation and a possible source from which beds can be reinfested, so this source of mites should also be eliminated. Allergen avoidance measures seem to be more effective in the early stage of the disease. The effects of allergen avoidance measures in more advanced stages of asthma are not known.

A double blind, placebo controlled study was undertaken to investigate whether allergen impermeable covers as a single intervention are of clinical benefit to patients with moderate to severe asthma. Only non-smoking patients with a smooth bedroom floor whose disease had been stable for the previous 6 months were included. Patients with furry pets were admitted if they had no pet allergy. All had moderate to severe asthma and house dust mite allergy, severe bronchial hyperresponsiveness, and relevant exposure to house dust mite allergens. A study period of 1 year was chosen to exclude seasonal variation in exposure to Der p 1.

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METHODS

Patients

Thirty eight patients aged 11-44 years with a history of asthma and house dust mite allergy were recruited from the outpatient department of Asthmacenter Heideheuvel in Hilversum, The Netherlands, from January 1996 to December 1998. Informed consent was obtained from the patients or their parents. The patients were selected on the basis of increased bronchial responsiveness to histamine inhalation (PC_{20}< 4 mg/ml, 30 minute method), positive skin tests and/or raised specific IgE to house dust mite allergen, and relevant HDM exposure on the mattress (>1 µg Der p 1/g dust). All patients had FEV1 values >60% (predicted value). Patients had no history of respiratory tract infections in the previous 6 weeks or severe asthma attacks in the previous 6 months. None had received oral corticosteroids in the previous 6 months.

All patients gave informed consent. The medical ethics committee of Asthmacenter Heideheuvel approved the study.

Study design

The study was of a randomised, placebo controlled, double blind, parallel group design, comparing the effect of allergen impermeable encasings on the mattresses, pillows and bedcovers during 1 year with matching placebo encasings.

At the start of the study a trained respiratory nurse visited the patients to collect dust samples from the mattresses of the patients for Der p 1 measurement and to note the allergen avoidance measures already present in the house. All patients included in the study had smooth bedroom floors. Patients were instructed to wash their sheets each week at 60°C. Apart from the mattress encasings, no other allergen avoidance measures were taken. At the end of the study the same nurse visited the houses again to collect dust from the mattress covers.

The patients were included during the entire year; the inclusion period was 2 years. Pollen allergic patients were tested outside the pollen season.

At the first visit patients underwent clinical evaluation. FEV1, and vital capacity (VC) values were measured, skin tests performed, and a PC_{20} histamine was assessed. Medication was withheld before the study period: inhaled steroids and long acting β2 adrenergic agents, long acting inhaled β2 adrenergic agents, and anti-histamines for 6 hours before the tests.

The nebuliser was mounted on a valve box with an aerosol filter. The nebulisation time was 30 seconds, during which the patient was instructed to breath quietly. The test was started with inhalation of a phosphate buffer aerosol. Before inhalation three measurements of VC and FEV1, were performed (Jaeger Masterscreen). FEV1 was measured after each concentration. PC_{20} histamine was derived by linear interpolation.

Mattress encasings

Mattresses, pillows, and bedding in the intervention group were encased with covers supplied by Cara C’air (Allergy Control AC btm Velselbroek, Netherlands). The matched placebo covers were made by the same company. The encasings were placed in position by a research nurse and left in situ for 1 year.

Quality of life

Quality of life was assessed by the Quality of Life for Respiratory Illness Questionnaire (QoL-RIQ).

Clinical parameters

During the 14 day period before the intervention and at the end of the 12 month intervention period the patients were...
asked to keep diary cards in which asthma and nasal symptoms, peak flow values, and medication use were recorded twice daily. Asthma symptoms included dyspnoea, cough, expectoration, and wheezing. Nasal symptoms included nasal blockage, rhinorrhoea, sneezing, and itching. Each item was scored on a scale from 0 (no symptoms) to 4 (severe symptoms).

The patients were trained in performing peak flow manoeuvres with the mini-Wright meter. They were instructed to perform three readings and to record the highest value in the morning when waking and in the evening before sleeping.

Patients were asked to continue their normal inhalation medication and to record extra rescue medication in case they needed it.

### Data analysis

Statistical analyses were performed with SPSS. Comparisons within groups (before and after intervention) were made with the Wilcoxon signed rank test. Logarithmic data were analysed using the sign test. The Mann–Whitney U test was used for between group comparisons. p values of <0.05 were considered significant.

### Table 1 Clinical characteristics of study patients

<table>
<thead>
<tr>
<th>Placebo group</th>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>FEV1 (% pred)</th>
<th>PC20 Hist (mg/ml)</th>
<th>Skin test</th>
<th>Rhinitis</th>
<th>Medication asthma</th>
<th>Medication rhinitis</th>
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<td>98</td>
<td>F</td>
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<td>+</td>
<td>SB</td>
<td>-</td>
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<td>100</td>
<td>M</td>
<td>2.90</td>
<td>1.5</td>
<td>-</td>
<td>B, SB</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Mean** 25 89 1.75 1.6

**SD** 10 20 1.21 0.4

**Active group**

| 1             | 25      | F   | 99  | 1.19          | 1.5               | +         | B, SB    | -                | -                 |
| 2             | 29      | M   | 99  | 0.95          | 1.6               | -         | B        | -                | -                 |
| 3             | 41      | M   | 67  | 3.79          | 2.2               | +         | B, SB    | -                | -                 |
| 4             | 24      | F   | 86  | 2.00          | 1.8               | +         | B, SB    | -                | -                 |
| 5             | 31      | M   | 81  | 1.22          | 1.5               | -         | -        | -                | -                 |
| 6             | 24      | M   | 80  | 0.55          | 1.1               | +         | B, SB    | B                | -                 |
| 7             | 22      | F   | 104 | 2.67          | 1.4               | +         | B        | -                | -                 |
| 8             | 51      | F   | 70  | 0.45          | 1.2               | +         | B, SB    | B                | -                 |
| 9             | 32      | M   | 68  | 0.42          | 1.1               | -         | B, SM    | -                | -                 |
| 10            | 36      | F   | 103 | 0.35          | 1.8               | +         | SB       | B                | -                 |
| 11            | 42      | M   | 75  | 0.42          | 1.2               | -         | B, SM    | -                | -                 |
| 12            | 18      | F   | 103 | 2.35          | 1.2               | +         | F, SM    | F                | -                 |
| 13            | 40      | F   | 98  | 0.86          | 1.6               | +         | B, SB    | -                | -                 |
| 14            | 30      | F   | 107 | 1.16          | 1.9               | +         | F, SB    | F                | -                 |
| 15            | 41      | F   | 97  | 0.98          | 1.1               | -         | B, SM    | -                | -                 |
| 16            | 37      | M   | 76  | 0.91          | 1.3               | -         | SB       | -                | -                 |

**Mean** 33 88 1.27 1.5

**SD** 9 14 0.97 0.3

*X times histamine reaction.

B=beclomethasone or budesonide; F=fluticasone; SB=salbutamol; SM=salmeterol; FO=formeterol.

**Figure 2** Log values of mean Der p 1 levels (µg/g dust) before and after 1 year of intervention (treated: 0.97 v 0.03; placebo: 0.73 v 0.61).

**Figure 3** Logarithmic PC20 histamine values before and after 1 year of intervention (treated: –0.11 v 0.28 mg/ml; placebo: 0.48 v 0.33 mg/ml). The geometric mean values of the groups are represented by horizontal lines.
considered significant. Values are expressed as mean (SE) or as median (range).

Power calculations were performed. We expected a 20% increase in the PC20 histamine level. Based on the mean PC20 of the complete group of 1.59 (0.38) mg/ml, an increase to 1.91 (0.38) was expected. With a power of 99% of achieving a significant result at the 5% level, the calculated sample size was 29.3 patients. As 30 patients completed the study, a 20% change in PC20 histamine would have a probability of 99% of being noticed.

RESULTS

Thirty eight atopic non-smoking patients with asthma and house dust mite allergy entered the study. Eight patients did not finish the study, five from the placebo group and three from the treated group. In the placebo group three dropped out because of asthma instability, one because of moving to another city, and one because the recording of symptoms, peak flow and rescue medication was not sufficient to make an accurate analysis. In the treated group one individual dropped out because the study was too much of a burden, and two because of insufficient diary keeping. Drop out due to disease instability was significantly higher in the placebo group. 30 patients completed the entire study, 16 in the treated group and 14 in the placebo group (fig 1). The clinical characteristics of these patients are presented in table 1.

Although both groups had severe hyperresponsiveness (geometric mean values of PC20 histamine 1.75 and 1.27 mg/ml in the placebo and treated groups, respectively), three patients in each group did not regularly use inhaled steroids. The demographic characteristics of the two treatment groups were similar (table 1). There were no significant differences between the two groups in PC20 histamine, FEV1, PEF, and medication used.

Der p 1 concentrations on mattresses

Figure 2 shows mean log Der p 1 concentrations on the mattresses before and 12 months after the start of the study in both groups. In the treated group Der p 1 concentrations on the mattresses were significantly lower after 1 year (26.19 (8.58) µg/g fine dust, p=0.004). In the placebo group there was no significant reduction in Der p 1 (25.11 (11.98) µg/g fine dust, p=0.18). A significant difference in the treatment induced change in Der p 1 concentration was seen between the two groups (p=0.04). The significant reduction in the Der p 1 concentration was present after 4 months and persisted throughout the year.

Histamine challenge

At the start of the study the mean PC20 histamine was 1.45 (0.44) mg/ml and after 1 year this had risen to 1.66 (0.35) mg/ml in the treated group; this difference was not significant (p=0.64, fig 3). In the placebo group there was no significant change in mean PC20 over 1 year (from 1.75

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Symptom score before and after intervention (median values of 14 days of registration)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Placebo group</td>
</tr>
<tr>
<td></td>
<td>Patient Before</td>
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<tr>
<td>Pulmonary symptoms</td>
<td>1  1.50 0.21</td>
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<td>2  1.33 5.20</td>
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<tr>
<td>Median</td>
<td>1.27 0.36</td>
</tr>
<tr>
<td>Range</td>
<td>(00–8.35) (00–10.92)</td>
</tr>
</tbody>
</table>

Median 1.93 1.43

Range (00–11.16) (00–10.92) (00–6.57) (00–5.21)

*In the treated group significant difference after 1 year compared with before the intervention (p=0.04).
Quality of life
Overall quality of life scores were comparable at baseline in the placebo and in the treated group. The same was true for the subdomains. Clinically relevant improvements (difference >0.5) were seen in breathing problems, physical problems related to chest problems, triggering/enhancing circumstances, and total score in both the treated and the placebo groups. Although the size of the improvements did not significantly differ between the two groups, improvements within the treated group were significant.

Clinical parameters
Baseline values of asthma symptom scores showed no significant differences between the groups (table 2). The median pulmonary symptom score did not change significantly over 1 year in either group. There was a significant decrease in the nasal symptom score in the actively treated group (p=0.04) but not in the placebo group; the difference between the two groups was not significant. Baseline PEF values (morning and evening) were comparable for both groups (table 3). No significant changes in morning and evening PEF, peak flow variability, or the use of rescue medication occurred in either group following the 1 year intervention.

DISCUSSION
This study was performed to investigate the effect of anti-allergic mattress encasings in carpet free bedrooms on Der p 1 exposure in the bed and on clinical parameters in patients with moderate to severe asthma with allergy to house dust mite. We found a significant reduction in Der p 1 concentration in the dust collected from the mattresses in the actively treated group compared with the placebo group. PC_{20} histamine did not improve during the 1 year intervention period. Although a significant improvement in nasal symptoms and quality of life was observed only in the actively treated group, we found no significant difference between the placebo and actively treated groups in the change in pulmonary and nasal symptoms, quality of life, peak flow values, and use of rescue medication.

Earlier studies using several different types of mattress encasings have also shown a reduction in Der p 1 exposure on top of the mattress (table 4). However, other studies did not show a reduction in Der p 1 concentrations and, remarkably, the carpets in the bedroom were not removed in these studies. We excluded the problem of Der p 1 contamination from the floor by including only patients who had uncarpeted floors in their bedroom. This may have contributed to the fact that we could reach a significant reduction in the actively treated group even though we had higher baseline Der p 1 concentrations than other studies. The reduction in allergen concentration was reached after 4 months and remained during the whole study period.
Although Der p 1 concentrations were significantly reduced in the actively treated group compared with the placebo group, we did not find a significant reduction in bronchial hyperresponsiveness. Other studies have also failed to demonstrate an improvement in bronchial hyperresponsiveness. Two studies did not find a substantial reduction in allergen concentrations in dust, which explains the lack of improvement in bronchial hyperresponsiveness. Frederick et al. stated that all patients were reasonably controlled on regular prophylactic treatment, so little or no change in clinical parameters could be expected. Even Cloosterman and coworkers, who tried to avoid this treatment effect by including only patients who either did not use inhaled steroids or were able to stop them, did not find a significant improvement in bronchial hyperresponsiveness in any of the clinical parameters used such as symptom score, PEF variability, and reversibility of FEV1.

How can we reconcile these observations? Patients participating in our study had severe hyperresponsiveness despite relatively high doses of inhaled corticosteroids of > 800 µg (for comparison, PC20 < 4 mg/ml using the 30 minute method is comparable to 1 mg/ml in the 2 minute method). Thus, despite suppression of airway inflammation by use of inhaled steroids for years, severe hyperresponsiveness remained. Airway inflammation and bronchial hyperresponsiveness are induced by repeated inhalation of low doses of allergen. However, a 1 year reduction in exposure to HDM might be too short in patients with a life time exposure before the intervention. One can hypothesise that the persistence of severe hyperresponsiveness is related to airway remodelling, the structural changes in bronchial architecture as a result of chronic airways inflammation. No further improvement can therefore be expected with allergen reduction that most probably affects acute inflammation in this stage of already established disease.

Until now there have been no data available on the effect of allergen avoidance measures on quality of life. Clinically relevant improvements in quality of life were found in both groups. The instrument we used is a questionnaire specific for rhinitis symptoms in the treated group, although the difference between the two groups was not significant. The nose parameters. This lack of effect may be due to the chronic stage of the asthma and/or limiting the avoidance measures to the lower airways. A controlled trial of avoidance measures in patients with mild asthma, and one studied allergic patients who had not yet developed asthma (subclinical). Other studies, even in children, did not find a reduction in symptoms. PEF was recorded in seven studies; in two a significant increase in PEF occurred in patients with mild and preclinical asthma while in five there was no significant increase in PEF. Medication was recorded in one study without a positive result. Taken together, the data suggest that the contribution of allergen avoidance measures is ineffective in patients with moderate to severe asthma. The severity of the clinical manifestation is influenced by more factors such as other allergens, viruses and air pollution, which are not influenced by the avoidance measures.

Surprisingly, there are no published reports of controlled trials of the effects of allergen avoidance on nasal symptoms. In our study rhinitis symptoms were scored in addition to asthma symptoms and we found a significant improvement in nasal symptoms in the treated group, although the difference between the two groups was not significant. The nose therefore seems to be more responsive to avoidance measures than the lower airways. A controlled trial of avoidance measures in patients with rhinitis using subjective and objective parameters might be of interest.

In conclusion, the use of anti-allergic mattress covers results in a reduction in Der p 1 concentrations in carpet-free bedrooms. In patients with moderate to severe asthma no change occurred in airways hyperresponsiveness and clinical parameters. This lack of effect may be due to the chronic stage of the asthma and/or limiting the avoidance measures to the bedroom. Future studies should explore whether night time and daytime avoidance measures in the early stages of the disease are more effective.

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REFERENCES

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