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Original article

Medical Indoor Environment Counselor (MIEC): role in compliance with advice on mite allergen avoidance and on mite allergen exposure

Background: In order to improve patient compliance in allergen avoidance, a new occupational activity was created: Medical Indoor Environment Counselor (MIEC). The aim of this study was to assess the impact of an MIEC on compliance with advice for mite allergen reduction in patients sensitized and exposed to mite allergens, and on mite allergen levels.
Methods: The study included 378 patients from four centers (Marseilles, Montpellier, Paris, Strasbourg) in a randomized prospective study. Patients in group A received advice from doctors only, and those in group B from doctors and MIEC. Mite allergen levels were measured on mattresses, mattress bases, and floors. Compliance and mite allergen levels were assessed 5 months later.
Results: Compliance for changing the mattress bases, removing or treating the carpets, washing duvets, pillows and stuffed animals were significantly higher in group B than in group A. A significant decrease in mite allergen was obtained for group B in mattress bases (83.8–22.9 μg/g) and in carpets (15.8–6.3 μg/g), but not in group A.
Conclusion: Our results suggest that the home visit by the MIEC 1) increased the compliance to mite reduction methods advised; 2) induced a significant difference in mite reduction levels on mattress bases and on carpets; 3) avoided nonestablished avoidance advice.

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Key words: allergen; compliance; medical indoor environment counselor; mite; reduction method.

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The role of mite allergen exposure in modulating sensitization in atopic people has been demonstrated (1). Moreover, mite allergen exposure is a risk factor for the development of rhinitis and asthma symptoms among mite-sensitized patients (2, 3). Providing advice and recommendations about avoidance to mite-allergic patients therefore seems important.

The effectiveness of mite allergen avoidance has been discussed recently (4). Several published studies have shown that mite measures appear to effectively reduce mite allergen levels and the symptoms among patients with asthma and mite allergy, when several mite reduction measures were carried out together for at least six months (5–7).

An important issue in the success of mite avoidance is patient compliance (8, 9). Only one study has pointed out this difficulty and demonstrated that use of educational home-software increased compliance with mite allergen avoidance methods (9).

Since 1991, the chest diseases department of Strasbourg University Hospital has employed a Medical Indoor Environment Counselor (MIEC) to visit mite-allergic patients. This healthcare professional helps patients and their families to comply with doctors' recommendations by assessing mite allergen exposure in their homes and by giving advice on avoidance measures according to actual exposure.

To assess the utility of this new occupational activity, we performed a multicenter prospective randomized controlled study. This aimed to compare patient compliance with recommendations for mite allergen avoidance either when the advice came from allergists alone, or from allergists plus an MIEC, and the reduction of mite allergens levels in the two groups.

Material and methods

Patients

Patients were selected on the following criteria: aged from 3 to 50 years old. Clinical history of perennial asthma and/or rhinitis with:

1. only intermittent or mild and moderate persistent asthma;
2. rhinitis symptoms regardless of the severity score;
3. positive skin prick test to mite allergen defined by a mean diameter of the wheal ≥66% of the mean diameter of the wheal of the positive control (codeine phosphate 9%);
4. and/or specific IgE to mite allergen ≥ class 2 (with Pharmacia CAP system, Pharmacia Uppsala, Sweden, or DPC Alastat, Paris, France).

Moreover, positive skin test to other aeroallergens was not an exclusion criterion; previous advice on mite avoidance from either a doctor or paramedical was an exclusion criterion; patients were not supposed to have moved within 8 months.

Finally, patients could be included only if they were exposed to mite allergen in their mattress dust with an Acarex Test (Allergo pharma, Joachim Ganzer, Germany) result of ≥ +.

Dust mite allergen measurements

Dust sampling. These were performed on mattresses, mattress bases and floors of the patients' bedrooms. All dust samplings were performed according to the International Consensus (2), using the same vacuum cleaner in all centers (HOOVER TELIOS 1400 W, Pantin, France). In each center, dust sampling was performed by the same MIEC. All the samples were sent to the Allergy Laboratory in Strasbourg, then sieved and stored at −20°C.

Dust mite allergen analysis. An Acarex Test® was performed in the mattress dust only during the first home visit, according to a procedure previously described (10).

An enzyme-linked immunoassay (ELISA) was performed. Dust Der p 1 and Der f 1 allergens were measured by the same technician using a monoclonal ELISA-based assay (Indoor Biotechnologies, Charlottesville, VA) as published previously (11). The intraassay coefficient of variation (CV) was 5% ($n = 25$), and interassay CV was 14% ($n = 16$) for Der p 1 and Der f 1.

Medical Indoor Environment Counselor

Four MIECs were hired by the Association Asthme. They were first trained for 8.5 days in Strasbourg and briefed about mite allergens, clinical symptoms related to mite sensitization, and mite allergen avoidance methods, by the medical staff and an MIEC who has worked in our department since 1991.

The aim of the training was to teach the dust-sampling method of the International Workshop, to perform the Acarex Test®, and to ensure that their advice about mite allergen avoidance was consistent, using the same questionnaires and guides.

At the end of the training, they were each assessed during home visits on four occasions.

Study design (Fig. 1)

We performed a prospective randomized controlled study with parallel groups in four French cities and their surrounding suburbs: Marseilles (MAR) and Montpellier (MON) (Mediterranean climate, mean annual temperature of 15°1C and 14°1C, and relative humidity of 75.7% and 70.8%, respectively), Paris (PAR) (temperate climate, mean annual temperature 11°4C, relative humidity 75.6%) and Strasbourg (STR) (semicontinental climate, mean annual temperature 9°8C, relative humidity 79.1%).

Patients were initially selected by allergists and lung specialists based on their allergy to mites. The doctor then provided each one with a form, on which they circled items from 13 preprinted measures recommended for this patient. These measures included: encasing the mattress; encasing the duvet and pillow; changing the mattress base; washing synthetic pillow and duvet at the highest temperature recommended by the manufacturer every 3 months; dry-cleaning duvets and blankets; removing double curtains and wall fabrics; keeping only one stuffed animal to be washed every three months at the highest temperature allowed; using Acarosan (Allergo pharma, Joachim Ganzer, Germany) or

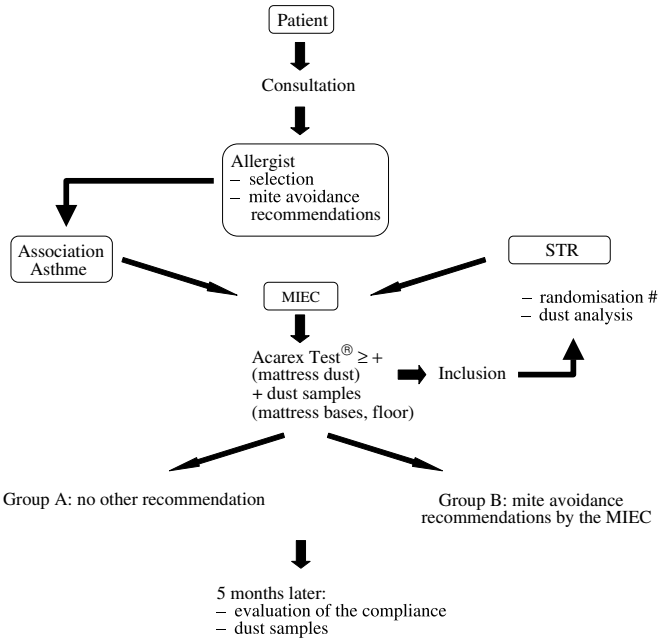

Figure 1. Study design.

tannic acid on carpets following manufacturers' recommendations; removing the carpet according to the Acarex Test® levels.

Every piece of advice was explained by the allergists in their standardized manner. All were free to provide additional information including booklets and videos. The doctor then contacted the Association Asthme, and they in turn contacted the MIEC.

The MIEC visited each patient's home and assessed mite allergen exposure in the mattress dust by performing an Acarex Test®. If this was positive (i.e. ≥ +), patients were submitted for randomization (see statistical methods below) into one of two groups. Group A received nothing more than the avoidance advice previously provided by the allergist; group B received advice from the allergist and the MIEC. In the two groups, the MIEC took extra dust samples from the mattress bases, and the floors of the bedrooms. In group B, after sampling, the MIEC completed a standardized form confirming the advice given. The MIEC revisited all patients 5 months later. At this visit, the MIEC completed a standardized form to assess the allergen reduction measures that had actually been carried out by the patient, and took dust samples from the same locations as in the first visit. The MIECs were also able to note on this form the frequency of inadequate advice given by doctors, such as discrepancies in recommendations givens as they related to the actual characteristics of the patient's home (e.g. to remove carpeting where there was none). To assess the reliability of the compliance results reported by the MIEC, an external control was performed by a technician not involved in the protocol (the same who trained the four MIECs). At the end of the study, this trainer visited four dwellings in each center, two selected randomly from the two groups of patients.

Statistical analysis

After the MIEC had performed the procedures common to both groups, an independent investigator in Strasbourg carried out the randomization procedure by center and the randomization was equilibrated every 6 patients.

All statistical analyses and models were intended to measure the additional effect of an MIEC over that obtained by a physician alone. We did not attempt to measure the effect of advice by the MIEC alone, since this would have required a group in which the physician intentionally gave no advice. Simple comparisons, as well as regression methods, were all adjusted for the centers. Characteristics of the patients and their housing were compared with Student's test or a Chi-square test, depending on whether the variables were continuous or categorical. When necessary, exact nonparametric tests were used. Frequency of advice was analyzed on the basis of multidimensional tables, using either log-linear models or the Mantel–Haenszel statistic. Compliance was analyzed along logistic models; the dependent variable was compliance with a specific recommendation. The independent variables were: the group; the physician made the recommendation; the MIEC gave the advice; both made the recommendation (interaction term); the center. Some odds ratios (OR) could not be determined when the recommendation was made very infrequently or the number of compliant patients was low. This has been indicated in Table 3 as ND (not determined). Mite allergen levels were compared using covariance analysis (ANCOVA). Levels at study entry were taken into account in the analysis.

The P values for multifactorial regression models pertain to global tests. Confidence intervals were also calculated, based on the coefficients and the covariance matrices.

Results

Patient characteristics

Three-hundred and seventy-eight patients were included: 187 in group A and 191 in group B. In total, 89 were asthmatics, 119 rhinitics, and 170 had asthma and rhinitis. The mean age was 19.5 years (SEM = 0.9) in group A, and 20.4 (SEM = 0.92) in group B. No statistical difference in patient characteristics (age, sex, frequency of rhinitis, asthma, rhinitis plus asthma, smoking) was found between the four centers or between group A and group B.

Housing characteristics

Table 1 summarizes the principal significant differences in the characteristics of the homes.

Significant differences were found between the four centers in: the type of building, the mean number of rooms per dwelling, the mean number of inhabitants per room, the age of the building, the presence of central heating, the presence of carpeting, moisture, double glazing, and the presence of soft toys.

However, no difference was found between the centers in: the frequency of slatted bases (mean value 70%), use of pillows and blankets, nature of pillows and duvets, frequency of cleaning bedding, presence of mould, presence of furred pets, and ventilation systems.

Avoidance measures: frequency of recommendations and compliance (Tables 2 and 3)

Encasing the mattress. The most frequent recommendation was for encasement of the mattress and no difference was found between the two groups (Table 2). Mattress encasement in the two groups was not significantly different (Table 3). The frequency of compliance was 30% (range 12–47%) in group A and 36.8% (range 26–45%) in group B. In 24% of cases, mattress covers bought by the patients were not certified as antimite encasing. Covers were also bought more frequently by patients living in one-family homes than by those living in low-cost public housing (i.e. 21.2% and 1.8%, respectively, $P = 0.004$).

Encasing the pillows. This recommendation was offered equally frequently in group B and group A (Table 2), but was complied with more frequently by group B (Table 3) when both the allergist and MIEC recommended it.

Washing the pillows. This method was advised (Table 2) and applied more frequently in group B than in group A, underlining a strong additional effect of the MIEC (Table 3).

Table 1. Dwelling characteristics

	Marseilles	Montpellier	Paris	Strasbourg	*P*
Type of building *n* (%)					
Individual house	30 (36)	34 (58)	29 (36)	93 (57)	
Apartment	40 (49)	15 (25)	49 (60)	57 (34)	10^{-5}
Public housing	12 (15)	12 (17)	3 (4)	14 (9)	
Mean number of rooms per dwelling	4	4.7	4	4.6	10^{-4}
Mean number of inhabitants per room	1.02	0.86	1.15	0.86	10^{-4}
Year of building	1957	1973	1949	1955	10^{-2}
Central heating *n* (%)					
Yes	42 (53)	31 (51)	47 (58)	117 (71)	
No	38 (47)	30 (49)	34 (42)	47 (29)	10^{-2}
Non-carpeted floor in bedroom *n* (%)					
Yes	71 (86)	47 (77)	45 (56)	104 (63)	
No	12 (14)	14 (23)	36 (44)	66 (37)	10^{-4}
Carpeted floor in bedroom *n* (%)					
Yes	12 (14)	9 (15)	36 (44)	56 (34)	
No	71 (86)	52 (85)	45 (56)	108 (66)	10^{-5}
Moisture *n* (%)					
Yes	12 (14)	7 (11)	22 (27)	4 (2)	
No	71 (86)	54 (89)	59 (73)	160 (98)	10^{-5}
Double glazing *n* (%)					
Yes	43 (52)	32 (52)	47 (58)	130 (79)	
No	40 (48)	29 (48)	34 (42)	34 (21)	10^{-5}
Stuffed animals *n* (%)					
Yes	19 (23)	14 (23)	34 (42)	63 (38)	
No	64 (77)	47 (77)	47 (58)	101 (62)	10^{-2}

Washing the duvets. Again, this recommendation was made to and complied with more frequently in group B (Table 2). The additional effect of the MIEC on the application of this measure can be seen by the OR of 208.5 (confidence interval CI 25.3–1717) (Table 3).

Changing the mattress base. Compliance was higher in group B (Table 3).

Other measures. Changing pillows, was recommended more often in group B than in group A (Table 2). All the recommendations (except changing duvets) were applied more often in group B than in group A, whether advised by allergist and MIEC, or by MIEC alone (Table 3).

External control. No discrepancy was found between the assessments of the MIEC and those of the training technician who performed external control in each center.

Quality of advice given by the allergists. Discrepancies were found between advice given by the allergist and the characteristics of the home observed by the MIEC. Depending on the centers, carpet removal in homes without carpets was recommended by 29.5–65.8% of the doctors; treatment of the mattress with acaricides was known to be ineffective by 13–75% of allergists giving advice; removal of mattress bases (although they were not upholstered) was recommended by 18.2–40.2% of the allergists.

Table 2. Frequency of each measure advised in the two groups (%)

Measure	Group A ($n = 187$)	Group B* ($n = 191$)	*P*
Encasing mattresses	79.6	99,4	0.06
Encasing pillows	37.9	34	0.4
Encasing duvets	37.9	31.9	0.22
Washing pillows	62	94.2	10^{-4}
Washing duvets	63.1	94.7	10^{-4}
Changing pillows	3.2	9	0.01
Changing duvets	3.2	6.2	0.16
Changing mattresses	3.2	6.8	0.11
Changing mattress bases	18.7	30.8	0.007
Removing carpets	26.2	30.3	0.37
Treating carpets	40.6	48.1	0.14
Washing stuffed animals	44.9	45	0.98
Removing double curtains	24	31.9	0.09
Removing wall fabric	17.1	20.9	0.34

* These values are the sum of the frequency of advice from allergists alone and that from allergists plus the MIEC and MIEC alone.

Table 3. Odd ratios for compliance with each measure in both groups

	Group A		Group B					
Measure	Allergist only OR (95% CI)	*n*	Allergist only OR (95% CI)	*n*	Allergist and MIEC OR (95% CI)	*n*	MIEC alone OR (95% CI)	*n*
Encasing mattresses	3.6 (1.3–10.0)	138	5.9 (0.4–95.9)	2	5.4 (1.9–15.1)	136	4.2 (1.3–13.4)	41
Encasing pillows	4.5 (1.8–11.5)	68	3.8 (1.0–14.5)	45	7.8 (1.5–39.6)	8	ND*	6
Encasing duvets	4.4 (0.9–21.2)	68	4.6 (0.4–51.5)	46	ND*	6	ND*	3
Washing pillows	65.6 (8.5–510.0)	31	19.0 (1.4–266.0)	8	191.5 (24.3–1508.0)†	100	123.0 (15.3–995.0)†	62
Washing duvets	81.6 (10.1–661.0)	109	5.1 (0.3–100.2)	10	208.5 (25.3–1717.0)	94	127.3 (15.2–1066.0)	67
Removing pillows	7.3 (1.2–45.9)	5	14.0 (1.7–115.5)	1	ND*	2	29.5 (7.6–113.9)†	13
Changing duvets	6.0 (0.6–64.9)	5	19.3 (1.2–315.3)	1	ND*	1	8.8 (1.4–55.9)	10
Changing mattresses	10.2 (2.03–50.8)	6	14.6 (2.1–102.3)	2	ND*	0	197.3 (16.6–2343.0)‡	8
Change mattress bases	10.2 (2.9–35.7)	33	9.3 (1.6–55.3)	24	38.7 (7.8–191.6)†	12	109.4 (21.4–560.0)†	17
Removing carpets	11.7 (2.1–65.2)	49	8.2 (0.8–87.6)	34	40.6 (5.2–319.0)†	10	23.7 (2.6–216.0)‡	11
Treating carpets	15.7 (3.1–78.8)	73	8.3 (0.7–104.0)	31	51.9 (9.3–291.0)†	26	54.5 (9.8–302.0)†	29
Washing stuffed animals	49.1 (6.3–386.0)	79	8.2 (0.6–111.0)	33	177.5 (20.3–1552.0)	28	123.6 (13.1–1166.0)†	17
Removing double curtain	10.4 (0.8–142.0)	43	10.0 (0.4–272.0)	46	79.2 (5.0–1266.0)	6	246.8 (10.9–5581.0)§	4
Removing wall fabric	ND*	30	ND*	35	ND*	0	ND*	2

* This could not be assessed because too few patients applied this measure.
† $P = 10^{-5}$.
‡ $P = 10^{-4}$.
§ $P = 10^{-3}$.

Table 4. Initial and final levels of group 1 mite allergens (μg/g)

	Group A levels (mean (SEM))		Group B levels (mean (SEM))	
	Initial	Final	Initial	Final
Mattresses	67.7 (24.8)	46.3 (14.75)*	44.9 (5.9)§	20.5 (2.8)*
Mattress bases	107 (26.3)	106.5 (25.2)	83.8 (6.1)§	22.9 (4.2)†
Floors	14.5 (0.4)	12.2 (0.7)‡	15.8 (0.3)§	6.3 (0.2)

* Difference between initial and final dust-mite allergen levels in group A or in group B ($P = 10^{-5}$).
† Difference in dust mite allergen levels between group A and B of upholstered mattress bases ($P = 10^{-5}$).
‡ No significant difference between initial and final levels in group A and significant in group B ($P = 10^{-3}$).
§ No significant difference was found between initial mite allergen levels between group A and B in mattresses, mattress bases and floors.

Mite allergen levels in mattress, mattress base and carpet

At study entry, that is, at the first home visit by the MIEC, dust levels of group 1 mite allergens did not differ between the centers or study groups A and B for mattresses, mattress-bases or carpets (Table 4). Mite allergen levels decreased significantly after mite avoidance measures in groups A and B for mattresses, and mattress bases. After the mattresses were covered, the reduction in group B was higher than in group A, but not significantly so (Table 4). For mattress bases a significant decrease was found in group B. For carpets, a significant decrease was obtained in group B only.

Discussion

By international consensus, avoidance is recommended for mite-allergic people and the different methods are clearly stated (2,15). It has been shown that a dramatic reduction in mite exposure is possible only when several of these avoidance measures are combined (16). Adequate patient education and prevention requires, we think, adjustment for actual mite exposure levels and home characteristics. This can be achieved by home visits from a trained counselor, an MIEC. Our multicentre prospective study has shown that when this advice is combined with that of a doctor, there are positive effects on compliance and mite allergen exposure levels in dust from mattresses, upholstered mattress bases and carpets.

No difference could be seen in the recommendations of the physicians for the two groups. This underlines the homogeneity of the physicians' conduct during the study. Moreover, the MIECs and the physicians made a similar number of recommendations, probably because the physicians who agreed to participate in the study took interest in allergen avoidance, and because a list of avoidance recommendations was proposed to them. Both of these factors may bias the findings towards the null hypothesis (i.e. that the MIECs had no supplemental affect). Thus, it is possible that had we used a group of doctors less involved in mite allergen avoidance, the effect of the MIEC would have been stronger. For each separate recommendation, the doctor's recommendation alone had a strong effect, although it was lower when combined with that of the MIEC. This was suggested by a previous study, which found that doctors had a significant effect on compliance, particularly for mattress encasement (9). French doctors do not appear, however, to give advice about mite allergen avoidance very frequently, at least according to a recent French study showing that only 8% of 334 mite-allergic children had mattress covers (Neukirch, personal communication). It

appears that French allergists and lung specialists should spend more time educating their patients about control in the home environment.

The role of the MIEC was shown effective in this study. However, when a measure such as mattress encasement was already strongly recommended by the physician, recommendation from the MIEC had no significant additional effect. Nonetheless, although covering the mattress is known to be of major importance in mite avoidance, it is clinically ineffective when employed alone (17). The importance of the MIEC was proved in the other methods of mite reduction that were recommended less often by the physicians. By visiting patients' homes, MIECs were able to assess house-dust mite exposure and to adapt avoidance measures according to actual mite exposure and the potential reservoir of allergen. This avoids a mismatch between the allergen avoidance measures advised and the real conditions of the patients' homes. This was confirmed by the very high frequency of inadequate advice given by doctors for mattresses, carpets, and mattress bases, ranging from 13% to 74%. We found no discrepancy between the finding of the MIECs and those of the external control. Nor was there any "center effect" for any particular recommendation by MIECs. These findings confirm the homogenous approach of the four MIECs and the efficacy of their training.

Compliance was low in both groups and was similar to the compliance of asthmatics with inhaled medication (22.6% in group A and 27.7% in group B) (18). Our study also suggests that compliance with allergen avoidance depends on socioeconomic status, particularly for mattress encasement. Only 1.8% of the low-income patients living in public housing followed this advice compared with 21.2% of those living in one-family houses. This confirms data found in the USA indicating that parents with an income higher than $40 000 bought mattress covers more frequently than those with an income below $10 000 (19). These results underline the need for private or national health insurance to cover mite-reduction measures, which should be considered as preventive medicine.

Our second criterion for assessing the effect of the MIEC on mite exposure was the level of mite exposure. House-dust mite allergen exposure was measured in the mattress, which is known to be the main reservoir of allergen (5). Other dust samples were taken in the bedrooms if other reservoirs, such as mattress bases and carpets, were identified. We used an Acarex test result $\geq +$ as a screening tool for exposure. Guanine has been found to correlate well with mite allergen levels (20). Using this threshold, we always found mite allergen levels ≥ 2 μg/g. We confirmed previous findings showing that upholstered mattress bases contain higher levels of mite allergen than mattresses (21). While the levels of group 1 mite allergens in mattress dust fell in both groups, we noted a tendency towards a greater reduction in group B. Since the MIECs had a significant impact on compliance for mattress bases, the decrease in mite allergens levels was significantly higher in group B than group A. This result points out the importance of MIECs when allergen avoidance measures are proposed by doctors, since advising a change from upholstered mattress bases is frequently omitted or inadequately advised (from 18 to 40%). This point may explain the negative results in some mite-avoidance studies (17). Compliance about carpets with MIECs was 25% higher than with doctors alone, probably because the recommendation about carpeting was based on its actual presence and on a significant mite infestation (i.e. Acarex test $\geq +$). Doctors' recommendations about carpets were quite often inappropriate or unnecessary (from 29.5% to 65.8% of the recommendations) suggesting the necessity of a MIECs visit for the removal of a carpet.

In conclusion, our multicentre prospective study has shown that use of MIECs, acting together with the doctor, increased compliance with mite allergen avoidance measures and decreased mite allergen exposure from mattresses, upholstered mattress bases and carpets. Lung specialists and allergists, who are not necessarily aware of the patients' domestic environment, very often give inadequate advice about allergen avoidance. Practitioners of this new occupational activity can effectively improve mite allergen avoidance.

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