ALLERGOL. ET IMMUNOPATHOL., 25, 2 (67-72), 1997

Clinical tolerance, parasitological efficacy and enviromental effects of dehumidifiers in stable asthmatics sensitized to house dust mites

T. Chivato*, A. Montoro*, D. Martínez*, P. Gil, J. Zubeldia**, M. De Barrio**, M. L. Baeza**, M. Rubio**** and **R. Laguna***

* Hospital Universitario del Aire. ** Hospital General Universitario "Gregorio Marañón". Madrid.

SUMMARY

Dehumidifiers (DH) are potentially effective appliances as coadjuvant therapy in the treatment of bronchial asthma caused by sensitization to house dust mites.

The aims of this study were to analyze DH tolerance in asthmatic patients, to assess the parasitological effects and to analyze the environmental effects produced by the use of these appliances in the bedrooms of asthmatic patients sensitized to house dust mites.

10 stable asthmatic patients sensitized to house dust mites were studied. DH appliances (CD-300) were installed in their bedrooms. Each patient was given symptom scoring tables and a portable peak expiratory flow (P.E.F.) during a period of 5 months, 1 month before installing the DH and 4 months afterwards. To study the parasitological efficacy of the DHs, we analyzed dust samples from the bedrooms and determined the Der p I, Der f I and Der II allergens by means of a modified ELISA based on monoclonal antibodies. Dust samples were collected before installing the DHs and after they had been working for 2 and 4 months. Dry temperature and relative humidity measurements at three time intervals (7-9, 15-17 and 22-24 h) were carried out. The 1st measurement was done prior to installation of the DHs in the patients' bedrooms and the 2nd and 3rd were achieved 2 and 4 months respectively after the installation. Statistical analysis was done by comparison of paired means.

No significant differences were detected in the patients' symptoms nor in the P.E.F. measurements in the course of the study. Decreases in the house dust mite allergens were observed in 4 bedrooms. A significant decrease in relative humidity in the bedrooms of mite asthma patients after use of dehumidifier appliances was observed ($p < 0.01$).

Significant differences between the measurements of the bedrooms with and without DH were detected ($p < 0.01$).

In summary, DHs were well tolerated by stable asthmatic patients, produced a significant decrease in the relative humidity level and showed some parasitological efficacy.

Key words: Dehumidifier. Asthma. *Dermatophagoides pteronyssinus. Dermatophagoides farinae.*

Allergol et Immunopathol 25, 2 (67-72), 1997.

INTRODUCTION

House dust mites, mainly *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae* (1) in our environment, are responsible for various allergic diseases, among which we may single out extrinsic bronchial asthma (2, 3). These mites require a temperature over 20° C and a relative humidity of over 50% for survival, while the optimum conditions for their development are a temperature of 24-28° C and a relative humidity of 70-80% (4).

The first rung in the enviromental fight against these mites consists of the classic deallergenization measures: to avoid objects that accumulate dust, vacuum cleaning, full ventilating of bedrooms, to wash clothes with hot water,... (5, 6). Secondly to apply acaricides, products which have proved its effectiveness *in vitro* and in *seminatural* conditions (7-9). Mechanical ventilation and electrical heating blankets are another measures used in the control of house dust mites (10, 11).

Finally dehumidifiers are potentially effective appliances as coadjuvant therapy in the treatment of bronchial asthma in patients sensitized to house dust mites (12).

The aims of this study were to examine dehumidifier tolerance, to evaluate the parasitological effects and to determine the enviromental effects caused by the use of these appliances in the houses of asthmatics sensitized to house dust mites.

MATERIAL AND METHODS

Patients

We studied 10 clinically stable asthmatic patients sensitized to house dust mites drawn from outpatient consultations of the Aire and Gregorio Marañón Hospitals, Madrid. Random selection was carried out from patients exhibiting these processes.

Diagnosis was done by means of suggestive anamnesis, positive skin tests using prick technique, and IgE determination by means of *in vitro* technique (RAST or Pharmacia FEIA CAP) with class 2 or above.

We made an initial visit to the patients' houses. We offered them a detailed explanation of the project and all patients gave their consent. At that time we gave them record cards, where they had to note down their symptoms and therapeutic needs during the 5 months of the study. The bronchial symptoms included coughing, dyspnea and wheezing. The set of symptoms varied from 0 (asymptomatic), 1 (mild), 2 (moderate) and 3 (severe). Similarly, they had to record the medication used on a daily basis, which was scored as 0 (no drug), 1 (a mast cell membrane stabilizer), 2 (bronchodilator) and 3 (inhaled steroid).

In addition, each patient was given an ASSES brand (Health Scan) peak expiratory flow (P.E.F.) meter. The patients were instructed carefully about its use and they had to make three maximum forced expiration measurements in the morning and in the evening, selecting the best value, in order to monitor respiratory function.

Temperature and environmental relative humidity measurement

We carried out dry temperature and environmental relative humidity measurements. The 1st was done before installation of the dehumidifier appliances, in December, while the 2nd and 3rd were done after the appliances had been in operation for 2 and 4 months, respectively.

The measurements were made at three time intervals: 7-9 h, 15-17 h and 22-24 h. These measurements were performed in the asthma patient's bedroom where the dehumifier was installed and in another bedroom.

Dust samples

Three dust samples were collected: the first in December, prior to the installation of the dehumidifiers, and the second and third 2 and 3 months respectively after the installation of these appliances.

All the samples were collected with an electric vacuum cleaner, which was fitted with a new collection bag beforehand. The samples were obtained from the patients' bedrooms by carefully vacuuming bedspread, carpets, covers, floor, shelves, etc. Collection were done for a period of 5 days. After collection, the bags were sealed and kept at 4° C until their analysis.

Dehumidifier appliance

CD-300 type dehumidifier appliances (Carburos Metálicos. Spain) were installed in the 10 asthma patients' bedrooms. The patients' parents were carefully instructed about their use and maintenance. The appliances were installed at the end of December and they began working in January and continued until May. The appliances have a 6250 cc collection tank, which has to be emptied when it is full.

Preparation of dust samples and immunoassays of allergens (Der p I, Der f I and Der II)

In order to assess the parasitological efficacy of the dehumidifiers, we studied the dust samples from the patients' bedrooms and the Der p I, Der f I and Der II allergens were determined by means of a modified ELISA based on monoclonal antibodies (DEA-test. Alergia e Inmunología Abello. Spain), according to the method of Ventas et al (13).

The results were evaluated according to the different microgram concentrations of antigen per gram

Table I

Patients	P.E.F.		Symptoms		Drugs	
	B	A	B	A	B	A
1	206	203	1	0	1	1
2	151	171	1	0	1	0
3	169	169	0/1	0/1	2	2
4	172	154	2	1	3	2
5	527	546	0	0	3	3
6	451	411	2	1	2	2
7	364	401	0/1	1/2	1	2
8	604	645	0	0	1	1
9	462	474	0/1	0/1	0	0
10	415	418	1/2	2	0	0

Peak expiratory flow (P.E.F.) measurement, symptoms and therapeutic requirements in the course of the study: before dehumidifier installation. (B) and after (A).

of dust analyzed. The exposure levels varied according to the following scale: 0-0.2 µg/gr (weak), 0.2-2.0 (moderate), 2.0-10.0 (high) and more than 10.0 (very high).

Statistical handling of the results

It was done with the SIGMA statistics package, by comparison of paired means.

RESULTS

Table I shows the set of symptoms, the patients' therapeutic requirements and the P.E.F. measurement over the period of the study: prior to and after the installation of the dehumidifiers. Considering the overall results, there are no significant differences as regards the patients' symptoms, P.E.F. measurements and therapeutic requirements between the period prior to the installation of the dehumidifiers and during the next 4 months.

Table II shows the concentrations of Der p I, Der f I and Der II in the 3 dust sample collections that were carried out. Evaluating the overall results, there are no significant differences between the concentrations determined before and after using the dehumidifiers in the asthmatic patients' bedrooms. When we compare the concentrations before the installation of the dehumidifier and 2 and 4 months after the installation, houses 2, 4, 7 and 8 evidenced decreases in the levels of the principal antigens, whereas in homes 1, 5 and 9 we observed an increase in these concentrations comparing the 1st collection with the subsequent ones.

Table III shows the humidity (%) and temperature (° C) measurements in the 10 houses and in the 3 stages performed: before installation (1st) and 2 (2nd) and 4 (3rd) months, respectively, after the humidifier appliance had been set in operation. All the variables studied conformed to a distribution normal.

Significant differences were obtained comparing the relative humidity means before installation of the dehumidifiers and after 2 and 4 months in operation ($p < 0.01$).

Similarly, we observed significant differences between the measurements in bedrooms with and without dehumidifier ($p < 0.01$).

Table IV gives the amounts of water collected in the course of the days studied.

Table II

House	1st Col.			2nd Col.			3rd Col.		
	1	2	3	1	2	3	1	2	3
1	0.05	0.05	0.05	0.09	0.11	0.20	0.05	0.07	0.13
2	0.59	0.05	0.23	0.20	0.40	0.16	0.72	0.05	0.8
3	NP	NP	NP	0.05	0.10	0.05	0.05	0.05	0.07
4	0.39	0.67	0.08	0.11	0.30	0.07	0.34	0.33	0.34
5	0.05	0.05	0.05	0.08	0.18	0.08	0.05	0.06	0.05
6	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.12
7	0.06	0.18	0.05	0.10	0.10	0.20	0.05	0.05	0.05
8	0.05	0.34	0.05	0.05	0.11	0.05	0.05	0.06	0.11
9	4.32	0.06	5.06	NP	NP	NP	20.8	0.05	10.2
10	0.05	0.05	0.05	NP	NP	NP	0.05	0.14	0.06

Der p I (1), Der f I (2) and Der II (3) concentrations in micrograms per gram of dust (µg/gr) in the course of the study: 1st, 2nd and 3rd determinations. NP = determinations not performed, minimal samples, imposible to analyse by the laboratory.

DISCUSSION

The growth of house dust mites depends largely on the relative humidity of the patients' homes (10, 14). Theoretically, reducing environmental humidity is a useful method for controlling the mite population.

In this study we have analysed the tolerance of stable asthmatic patients sensitized to house dust mite to dehumidifier appliances.

We observed that patients showed good tolerance to the drop in environmental relative humidity. All the parameters controlled (symptoms, therapeutic requirements and P.E.F. measurements)

Table III

House	Col.		7-9 h.		15-17 h.		22-24 h.	
			T	H	T	H	T	H
1	1st		16.5	69.5	16.5	74.5	19.5	67
	2nd		20	48	22	43	21	49
	3rd	W	25	41	25	38	25.5	38.5
		WO	24.5	50.5	24.5	44	24.5	44
2	1st		17.5	70.5	20	60	20.5	60
	2nd		19.5	51	21.5	42	21	46
	3rd	W	22	54	23	45	23	42
		WO	22	62	22.5	51.5	23	56
3	1st		16	59	20	56	21	49
	2nd		16	50	21	34	23	41
	3rd	W	17	56	18	45	18	45
		WO	18	57	18.5	54	19	55
4	1st		20	56	20	44	20	44
	2nd		21.5	60	22	40	21	49
	3rd	W	24	33	22	37	22	47
		WO	21	53	21	60	21.5	57
5	1st		22	51	16	79	16	69
	2nd		22	57	17	60	19	55
	3rd	W	25	45	25	35	25	48
		WO	24	53	25	48	27	50
6	1st		19	47	23	45	23	45
	2nd		21	49	22	51	22	51
	3rd	W	24	39	25	21	26	30
		WO	22	51	25	29	25	29
7	1st		17	70	15	62	17	60
	2nd		19	55	18	45	19	55
	3rd	W	24	33	24	46	25	41
		WO	24	53	25	61	26	56
8	1st		17.5	60.5	18	53	18	53
	2nd		19	55	19	42	19.5	42
	3rd	W	20.5	48.5	20.5	41.5	21	34
		WO	19.5	55.5	19.5	55.5	20	56
9	1st		21	57	16	69	19	55
	2nd		16	79	18	71	15	67
	3rd	W	23.5	42	23	45	24.5	79.5
		WO	24		24		24	
10	1st		16	46	16	41	21	27
	2nd		16	55	17	34	18	37
	3rd	W	25	48	28	28	26	42
		WO	26	42	26	48	26	48

Dry temperature (T) and relative humidity (H) at the homes in the different collections (col) at the 3 times intervals (7-9, 15-17 and 22-24) with (W) and without (WO) dehumidifier.

Table IV

House	Total water collected (litres)	cc/day collected
1	31.250	31.250/130 = 240
2	100.000	100.000/131 = 760
3	31.250	31.250/117 = 270
4	62.500	62.500/128 = 490
5	81.250	81.250/139 = 590
6	18.750	18.750/134 = 140
7	31.250	31.250/144 = 220
8	50.000	50.000/121 = 410
9	50.000	50.000/123 = 410
10	18.750	18.750/134 = 140

Water collected in litres at the different houses in the course of the study. The cc/day column shows the days when the dehumidifier was in operation in each bedroom and the number of cc/day is obtained from the total water/number of days quiotient.

remained constant over the 4 months' duration of the study.

In order to study the possible parasitological efficacy of these dehumidifier appliances, we performed periodic determinations of the Der p I, Der f I and Der II concentrations. The mite antigen concentrations were low in general. In the course of the study, decreases in the concentrations were detected in 4 houses.

In this study we have analysed the environmental effects caused by installing dehumidifier appliances in the bedrooms of asthmatic patients sensitized to dust house mites.

Evaluating the results obtained, we observed significant differences in the measurements of the relative humidity level before and after the installation of these appliances. In addition, we detected significant differences between the humidity measurements in each house when comparing the results between different bedrooms, one with dehumidifier and the other without.

These results clearly indicate that the installation of dehumidifier appliances in the bedrooms of asthmatic patients produces a significant decrease in the environmental relative humidity level, to the extent that figures of lower than 50% are reached, which are therefore, in theory, incompatible with the growth of mites.

There are few previous studies with dehumidifiers. Harving et al (5) performed a study in Denmark with 3 asthmatics and the results were negatives in relation with clinical improvement and house dust mite reduction. An important adverse effect detected in that study was the temperature increase. In our study no significant variation in temperature was found.

Medina et al (12) carried out a study in Sevilla (Spain) with 9 patients with significant reduction in relative humidity as well as a significant decrease in concentrations of Der p I.

Reduction in relative humidity did not result in a significant reduction in mite concentration, maybe because mite concentration was always very low, with most values in the mild and moderate ranges. There is a natural background level of mites whitch survive in any enviromental conditions; mites living in those limit conditions get easily adapted to slight reductions in relative humidity, as those produced by the dehumidifiers in this study. As a consequence, relative humidity reduction is not an efficient way of controlling mites proliferation in places where humidity is already low, as it is the case in Madrid.

The results obtained allow us to assert that dehumidifiers installed in bedrooms are well tolerated by clinically stable asthma patients. The dehumidifiers displayed some parasitological efficacy. To confirm this efficacy in the parasitological control of mites, it would be of interest to carry out studies in areas in which the mite concentrations were higher. In the event of confirming this parasitological efficacy, we would have a new coadjuvant therapeutic option open to us in the treatment of allergic diseases caused by house dust mites.

RESUMEN

Los ácaros del polvo doméstico precisan un grado de humedad relativa ambiental entre el 50% y 80% para su crecimiento. Los deshumidificadores (DH) son aparatos potencialmente coadyuvantes en la terapéutica del asma bronquial por sensibilización a los ácaros del polvo doméstico. En el presente trabajo hemos estudiado la tolerancia de los DH en pacientes asmáticos, y se han evaluado los efectos parasitológicos y ambientales de estos aparatos.

Se han estudiado 10 pacientes asmáticos estables por ácaros. Se instalaron DH CD-300 en sus dormitorios durante cinco meses. Se realizaron registros de sintomatología y requerimientos terapéuticos, mediciones de *peak flow* (tabla I), cuantificaciones de Der p I, Der f I y Der II (tabla II), mediciones de temperatura seca y humedad relativa ambiental (tabla III).

Se realizó estudio estadístico de los resultados obtenidos. No se observaron diferencias significativas en la sintomatología de los pacientes, mediciones de *peak flow* ni en las concentrations de alérgenos de ácaros, aunque se observaron descensos puntuales en cuatro de los domicilios estudiados. Se

obtuvieron diferencias significativas al comparar las mediciones de humedad relativa antes y después de la instalación de los DH ($p < 0,01$) e igualmente se observaron diferencias en los dormitorios con y sin DH ($p < 0,01$).

En resumen, podemos afirmar que los DH fueron bien tolerados por pacientes asmáticos estables, demostraron cierta eficacia parasitológica y disminuyeron significativamente la humedad relativa ambiental en los dormitorios de estos pacientes.

Palabras clave: Deshumidificadora. Asma bronquial. *Dermatophagoides pteronyssinus. D. farinae.*

REFERENCES

1. Barber D, Chamorro J, Carpizo J, Cortés C, Rico P *et al.* Valoración de la presión alergénica ambiental. Interés de esta determinación en la prevención, diagnóstico y tratamiento de las enfermedades alérgicas. Rev Esp Alergol Inmunol Clin 1990;5 (3):125-32.
2. Pollart SM, Platts-Mills TA. Mites and mite allergy as risk for asthma. Annals of Allergy 1989;63:364-5.
3. Sporik R, Holgate S, Platts-Mills TA, Cogswell J. Exposure to house dust mites and the development of asthma in chilhood. N Engl J Med 1990;323:502-7.
4. Browswijk JE. House dust biology for allergist and mitologist. Zeist, The Netherlands: N.I.B. Publishers, 1981:316.
5. Charpin D, Birnbaum J, Haddi E, N'Guyen A, Fondarai J, Vervloet D. Evaluation de l'efficacité d'un acaricide, Acardust, dans le traitement d'allergie aux acariens. Rev Fr Allergol 1990;30:149-55.
6. Wharton GW. House dust mites. J Med Entomol 1976;12:557-621.
7. Harving H, Korsgaard J, Dahl R. Mechanical ventilation in dwellings as preventive measure in mite asthma. Allergy Proc 1988;9:283.
8. Jean-Pastor MJ, Vervloet D, Thibaudon M, Belaube P. Destruction des acariens de la poussière de maison: efficacité et tolérance d'un nouvel acaricide en aérosol. Rev Fr Allergol 1986;26(3):125-9.
9. Mulcahy R, Jean-Pastor MJ, Maunder JW. Efficacité d'Acardust sur les acariens de la poussi'ère de maison dans des conditions seminaturelles. Comptes rendus de thérapeutique et de Pharmacologie. Chinique. Tomo VI, n 60:3-9.
10. Harving H, Hansen LG, Korsgaard J *et al.* House dust mite allergy and anti-mite measures in the indoor environment. Allergy 1991;46,Suppl 11:33-8.
11. Mosbech H, Korsgaard J, Lind P. Control of house dust mite by electrical heating blankets. J Allergy Clin Immunol 1988; 81:706-10.
12. Medina JF, Castillo J, Capote F *et al.* Utilidad de los dispositivos deshumidificadores en la reducción de la concentración de ácaros. Arch Bronconeumol 1994;30:287-90.
13. Ventas P, Lombardero M, Gualteri O, Carreira J. Cuantificación de los alérgenos Der p I y Der f I de los ácaros del polvo doméstico y Fel d I de gato mediante un ELISA en fase sólida. Rev Esp Alergol Immunol Clin 1990;5(2):71-5.
14. Korsgaard J. Preventive measures in house dust allergy. Am Rev Respir Dis 1982;125:80-4.

Correspondence:

Tomás Chivato Pérez.
Servicio de Inmunología y Alergia.
Hospital Universitario del Aire.
Arturo Soria, 82.
28027 Madrid. SPAIN.