

Effect of Air Cleaners on Mold Count in the Air and on the Symptoms of Perennial Rhinitis

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ABSTRACT

Seventy-five children (ages 4 to 14 years) with perennial rhinitis caused by mold allergy (36 had asthma) were enrolled in an air-cleaner study for 2 years. Symptom scores prior to the study were compared with scores 1 and 2 years after placement of air-cleaners in the bedrooms. Forty-two homes were surveyed for mold count in the air in summer and winter, and the results compared with symptom changes. Improvements were found in quality of sleep (96 vs. 99%), sneezing (80 vs. 90%), scratchy throat (75 vs. 80%), night cough (75 vs. 83%), better mood in the morning (65 vs. 80%), postnasal drip (70 vs. 77%), nasal congestion (70 vs. 72%), night wheezing (70 vs. 83%), and sinus infection (50 vs. 55%). Parents reported a decrease in the use of both over-the-counter (76 vs. 80%) and prescription (43 vs. 48%) drugs. When the weekly symptom score sheets were compared, symptom recurrence rates were found to be clustered in the winter. These symptoms were cough (35%), nasal congestion (35%), sinus infection (32%), and postnasal drip (20%). The average mold counts (expressed as colony-forming-units per cubic meter of air) in the filtered bedrooms, in the unfiltered bedrooms, and outdoors were 310, 425, and 927 in the summer, and 689, 762, and 1213 in the winter, respectively. The higher mold count in the winter may explain the increase in symptoms during that season. We observed a significant improvement in respiratory symptoms for 2 years following the installation of air-cleaners in the bedrooms of 75 children with perennial rhinitis due to mold allergy.

INTRODUCTION

PREVIOUSLY WE REPORTED the results of a 12-month study on the effect of air-cleaners on in 90 children with perennial allergic rhinitis due to mold allergy.⁽¹⁾ Since that study was an open study without the benefit of comparison with proper controls, it could be argued that the beneficial effect that we observed could have been in part due to a placebo effect.⁽²⁾ Since our patients were known to be heavily dependent on drug therapy, and this therapy was fully available without expense, we felt that extending the study for another year to show the decline in drug use would prove that our positive results were not due to a placebo effect.

Seventy-five patients from the original study were enrolled in another 12 months of study. The present

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study compares symptom scores between the first and second year. The effects of air-cleaners on respiratory symptoms in the summer and winter months were also compared. Forty-two homes were surveyed for mold count in the air in filtered rooms, in unfiltered rooms, and outside the house in the summer and winter. The effect of air-cleaners on overall symptoms in allergic children and the significant seasonal variation of mold counts in the air of North Central Florida are presented and discussed.

PATIENTS AND METHODS

Seventy-five children with perennial allergic rhinitis, mean age 7.2 (range 4 to 14 years) were enrolled in the study for the full 2 years. All children were skin tested positive ($\geq 2+$) for three or more allergens. They were reactive 2+ or less on a scale of 0 to 4 to other indoor air-borne allergens.

An air-cleaner was placed in each child's bedroom and run continuously. As in the previous study, parents were instructed to fill out the symptom score sheets weekly. Each symptom was rated as follows: 0 = free of symptoms, 1 = slight symptoms, 3 = severe symptoms. The score of the fourth week was chosen

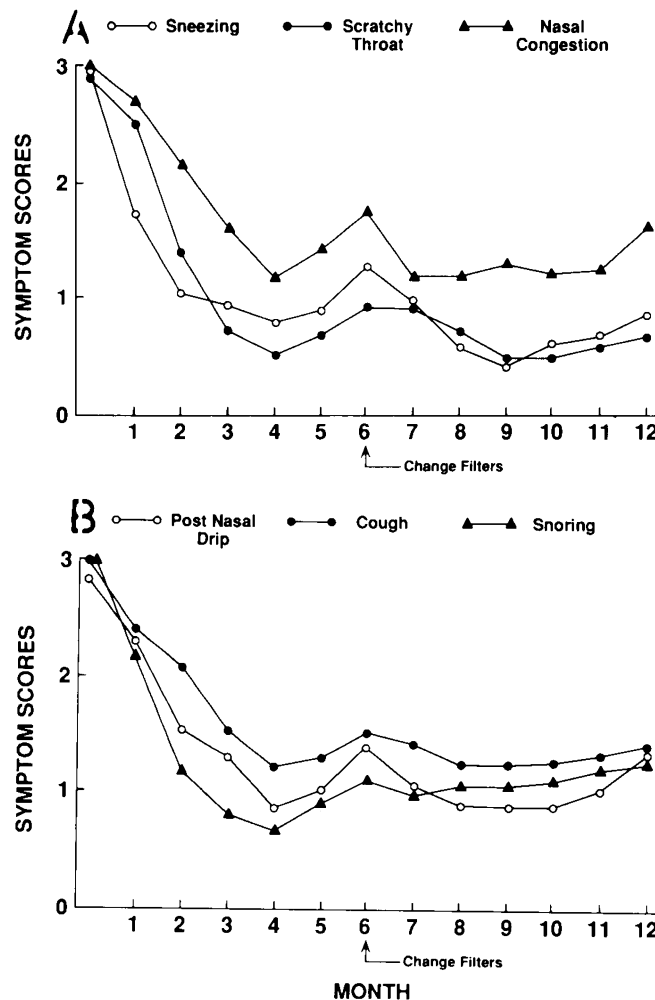


FIG. 1. (A,B) The sequential changes in respiratory symptoms in 75 pediatric patients with perennial rhinitis due to mold allergy during the first 12 months with the air-cleaners used continuously. Each point represents the mean of the symptoms score of 75 patients at the beginning and the fourth week of each month during the study.

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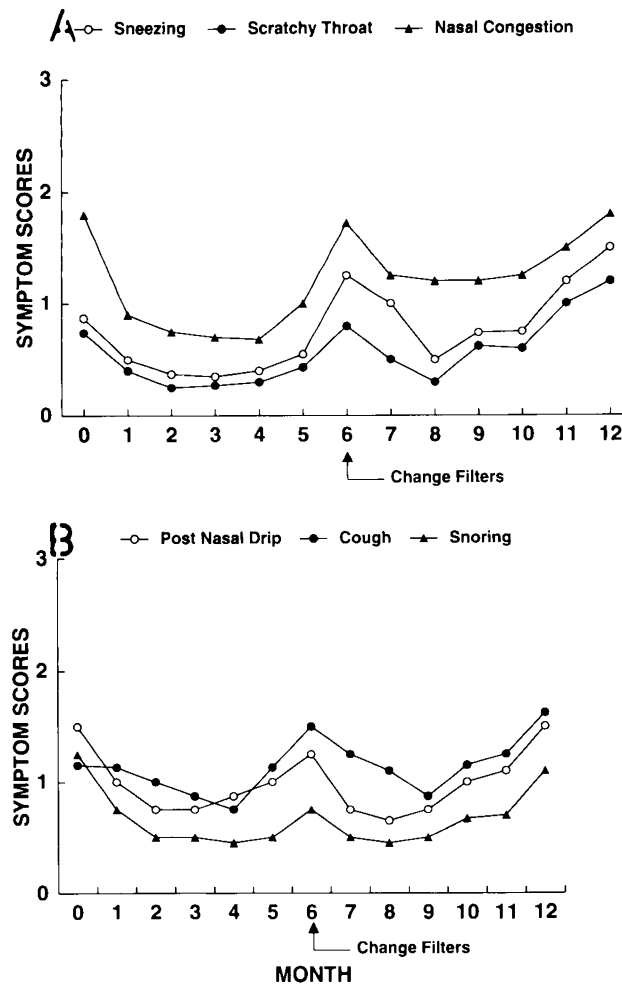


FIG. 2. (A,B). The sequential changes in respiratory symptoms in 75 pediatric patients with perennial rhinitis due to mold allergy during the second 12 months with the air-cleaners used continuously.

to represent the month. The symptoms were compared between the first and second year and between the summer and winter months.

The air inside and outside 42 homes was sampled with an air sampling device in the summer and winter months. The filters from the sampling device were the source of cultures for the molds. The molds were identified and the concentration expressed as colony-forming units per cubic meter of air (CFU/m³). Mold counts in the different seasons in the filtered room were compared with those outside of the home.

RESULTS

As shown in Figures 1 and 2 and in Table 1, there was a continued trend of improvement in respiratory symptoms in the second year compared with the first year in those children who continued to use air-cleaners. We also observed that the quality of life continued to improve (Table 2). When we compared the seasons, we noticed that there was a significant increase in respiratory symptoms in the winter months compared with the summer months in at least one-third of the patients, despite the use of air-cleaners (Table 3).

In both the summer and in the winter, the mold count in the air was significantly higher outside than inside most of the homes surveyed (Table 4). When the mold count was compared between the two seasons,

TABLE 1. IMPROVEMENTS IN ALLERGY-RELATED RESPIRATORY SYMPTOMS DURING A 2-YEAR AIR-CLEANER STUDY IN PEDIATRIC PATIENTS WITH MOLD ALLERGY

	<i>First year</i>			<i>Second year</i>		
	<i>Number</i>	<i>N</i>	<i>% of N</i>	<i>Number</i>	<i>N</i>	<i>% of N</i>
Ability to sleep	86.00	90	96.00	74.00	75	99.00
Sneezing	72.00	90	80.00	68.00	75	90.00
Scratchy throat	68.00	90	75.00	56.00	75	75.00
Nocturnal cough	68.00	90	75.00	62.00	75	83.00
Postnasal drip	63.00	90	70.00	58.00	75	77.00
Nasal congestion	63.00	90	70.00	54.00	75	72.00
Mood in morning	59.00	90	65.00	60.00	75	80.00
Itchy eyes	60.00	65	92.00	49.00	52	95.00
Nocturnal wheezing	30.00	43	70.00	30.00	36	83.00
Sinus infection	32.00	65	50.00	34.00	52	65.00

TABLE 2. IMPROVEMENTS IN QUALITY OF LIFE DURING A 2-YEAR AIR-CLEANER STUDY IN PEDIATRIC PATIENTS WITH MOLD ALLERGY

	<i>Percent of patients reporting improvement</i>	
	<i>First year (N = 90)</i>	<i>Second year (N = 75)</i>
Fewer workdays missed (parent)	72.00	80.00
Fewer schooldays missed (child)	43.00	70.00
Fewer clinic visits (allergy-related)	63.00	65.00
Fewer over-the-counter drugs used	76.00	80.00
Fewer prescription drugs used	43.00	48.00

TABLE 3. COMPARISON OF RESPIRATORY SYMPTOM SCORES IN THE WINTER MONTHS (DECEMBER THROUGH FEBRUARY) WITH THE SUMMER MONTHS (MAY THROUGH AUGUST) IN PEDIATRIC PATIENTS WITH MOLD ALLERGY

<i>Symptom</i>	<i>Summer</i>	<i>Winter</i>	<i>Increase in winter (%)</i>
Cough	1.27	2.15	35
Nasal congestion	1.25	2.35	35
Sinus infection	0.55	2.15	32
Postnasal drip	0.74	1.75	20

we observed that in the winter it increased inside in nearly half of the homes (Table 4). We also found that the mold count inside mobile homes ($n = 15$) was significantly higher than that in conventional homes ($n = 27$) ($p < 0.05$). The mold count was also higher in those homes under the heavy shade of trees. Overall, the filtered rooms had a significantly lower mold count than the unfiltered rooms ($p < 0.05$), except in the month of January (Fig. 3). Furthermore, the molds isolated in our study (both indoors and outdoors) were those commonly found to be the cause of respiratory allergy (Table 5).

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TABLE 4. RESULTS OF MOLD COUNT IN THE AIR IN A FILTERED ROOM, IN AN UNFILTERED ROOM, AND OUTSIDE OF 42 HOUSES, EXPRESSED IN COLONY-FORMING UNITS PER CUBIC METER

<i>Months</i>	<i>Filtered room</i>	<i>Unfiltered room</i>	<i>Outside</i>
May–June	514 (141–887) ^a	671 (283–1059)	1830 (458–8053)
July–August	315 (35–595)	665 (70–1260)	1102 (140–2275)
September–October	542 (105–980)	885 (185–1584)	1120 (210–2030)
January	1032 (420–1645)	893 (245–1540)	2607 (105–5110)
February	770 (140–1400)	945 (280–1610)	2380 (105–4655)

^aRange shown in parentheses.

DISCUSSION

Our earlier air-cleaner study involved 90 children and was an open study without controls. It showed a dramatic decrease in respiratory symptoms with the use of air-cleaners,⁽¹⁾ but the question remained as to how much of that improvement might be attributable to a placebo effect. We intended to follow up on all 90 patients, but were only able to enroll 75 (the other patients had since relocated). Three parents returned the air-cleaners, two because the patients had been free of symptoms for so long that they did not feel the need to continue, and one wanted to exchange the original air-cleaner for a larger one.

Our second 12-month study convinced us that the placebo effect could not explain the continued improvement in symptoms. The Children's Medical Service would have provided the patients with free medication if they had requested it. The fact that their need for medication, both over-the-counter and prescription, decreased throughout the 24 months of the study is a strong argument that the air-cleaner alone was responsible for the improvement in respiratory symptoms.

Although most of the respiratory symptoms reported by the parents showed steady improvement, the rhinometer study showed a marginal improvement compared with the year before (not shown). This suggests that the chronic inflammation that underlies rhinitis is difficult to overcome. The increase in respiratory symptoms in the winter months coincides with the increase in mold counts during this time of year. The surprising increase in mold counts inside the homes in the winter could be due to an increase in the num-

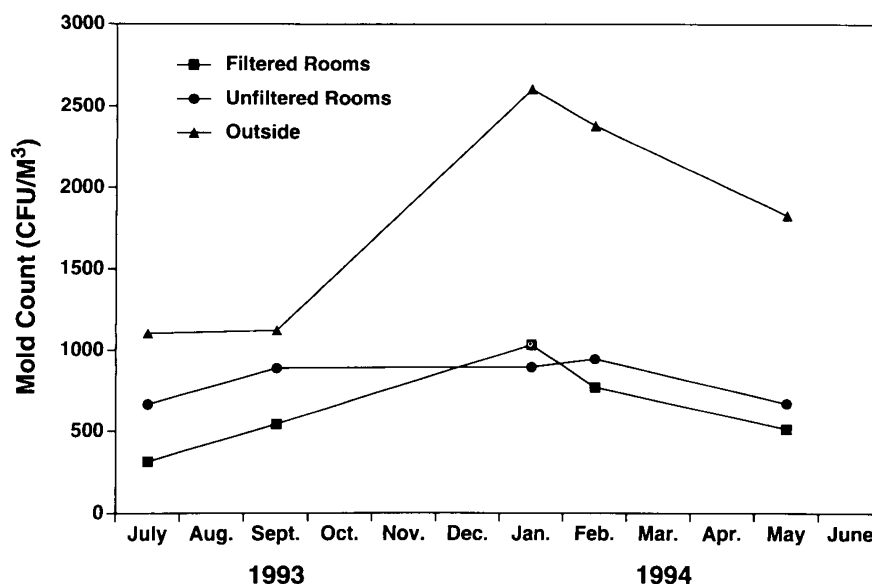


FIG. 3. The mold count in the air sampled from inside and outside 42 homes throughout the 24-month study period.

TABLE 5. COMMONLY ISOLATED FUNGAL STRAINS FROM A FILTERED ROOM, AN UNFILTERED ROOM, AND OUTSIDE OF 42 HOUSES

<i>Filtered rooms</i>	<i>Unfiltered rooms</i>	<i>Outside the house</i>
<i>Cladosporium</i>	<i>Cladosporium</i>	<i>Cladosporium</i>
<i>Penicillium</i>	<i>Penicillium</i>	<i>Penicillium</i>
<i>Fusarium</i>	<i>Curvularia</i>	<i>Epicoccum</i>
<i>Epicoccum</i>	<i>Epicoccum</i>	<i>Fusarium</i>
<i>Alternaria</i>	<i>Alternaria</i>	<i>Curvularia</i>
<i>Paecilomyces</i>	<i>Paecilomyces</i>	<i>Aspergillus</i>
<i>Mucor</i>	<i>Aureobasidium</i>	<i>Alternaria</i>
<i>Curvularia</i>	<i>Botrytis</i>	<i>Drechlera</i>
	<i>Trichoderma</i>	<i>Phyllosticta</i>
		<i>Trichoderma</i>

ber of people and the activity inside the home during the winter, to an increase in recreational activities or eating in the bedrooms, or to an increase in humidity due to elaborate insulation for energy-savings. Based on the mold count outside in the winter months, we feel that it is the dampness rather than the temperature that serves as a favorable environment for the excessive growth of molds. Further evidence of this is the higher mold counts in those homes under the shade of large trees. It is important, therefore, to control humidity when adjusting the indoor environment for those patients with mold allergy.

The discovery of a higher mold count in the winter carries with it important implications. Clinicians are often impressed with the significant increase in cold symptoms in the winter and often attribute it to viral infections. However, although epidemiologically it is true that respiratory tract infection is common in the winter, viral illness cannot explain a prolonged course of cold symptoms without fever. Our study is perhaps the first to demonstrate the significance of mold allergy as the cause of the symptoms observed in many children in the winter months.

We observed that the respiratory symptoms increased as the air-cleaner filters approached 6 months of usage (Figs. 1 and 2). This trend became more apparent with the higher indoor mold counts in the winter time. Therefore, we conclude that the use of an air-cleaner in the bedroom should be considered as part of the comprehensive treatment plan for perennial allergic rhinitis in those patients with an established mold allergy. We also recommend that in order to achieve a better air-cleaning effect, the filter should be changed every 4 months rather than every 6 months as currently recommended by the manufacturer.

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