

THE EFFECTS OF CENTRAL AIR CONDITIONING ON POLLEN, MOLD, AND BACTERIAL CONCENTRATIONS

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In the past thirty years, intermittent published reports have appeared concerning the efficacy of air-conditioning units in lowering pollen, mold, and bacterial counts in enclosed spaces.¹⁻⁵ It has been stated that removal of air contaminants alleviates many major symptoms in patients who suffer from inhalant allergies. These previously published reports, for the most part, have dealt with units which had the capacity to "air condition" one or two rooms at the most. In addition, these studies were usually conducted over short periods of time. Few, if any, reports have appeared concerning similar effects by central air-conditioning systems, although it would be expected that such units should be as good or even better than individual room air conditioners. In the past ten years central air conditioning has become rather common and is no longer considered a novelty. Such equipment is widely used in warm and temperate climates. Besides office buildings, stores, hotels, hospitals, restaurants, and other public places, private residences and apartments are also frequently being equipped with central air conditioners.

The aim of this study was to analyze quantitatively the differences in pollen, mold, and bacterial contaminants within an air-conditioned home, a home that is not air conditioned, and the outdoors. Simultaneously, the clinical symptomatology of highly allergic individuals residing in these residences was evaluated. Whereas our previous studies were conducted in closed unoccupied rooms, this study was conducted in occupied homes which had a normal flow of traffic.

METHODS AND MATERIALS

A six-room, split-level, single home of approximately 15,000 cubic foot capacity was equipped with a commercial central air-conditioning unit of 36,000 BTU capacity.* It was estimated that the air flow rate was 1,200 cubic feet per minute with 10 per cent of the air drawn in from the outside, the remainder being recirculated. Thermostatic control was available to maintain a level temperature. An identical dwelling adjacent to the test home, but not air conditioned, was used as a control. The air-conditioned home was closed at all

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*Carrier Air Conditioning Corporation, Syracuse, N. Y., Model 38BA004, condensing unit with Model 28AA004 evaporator coil.

times, except when the doors were opened as necessary for entry or exit. In the home that was not air conditioned the windows were opened and closed as necessary, depending on weather conditions. One of the three occupants in each home was an individual who was highly allergic to ragweed pollen.

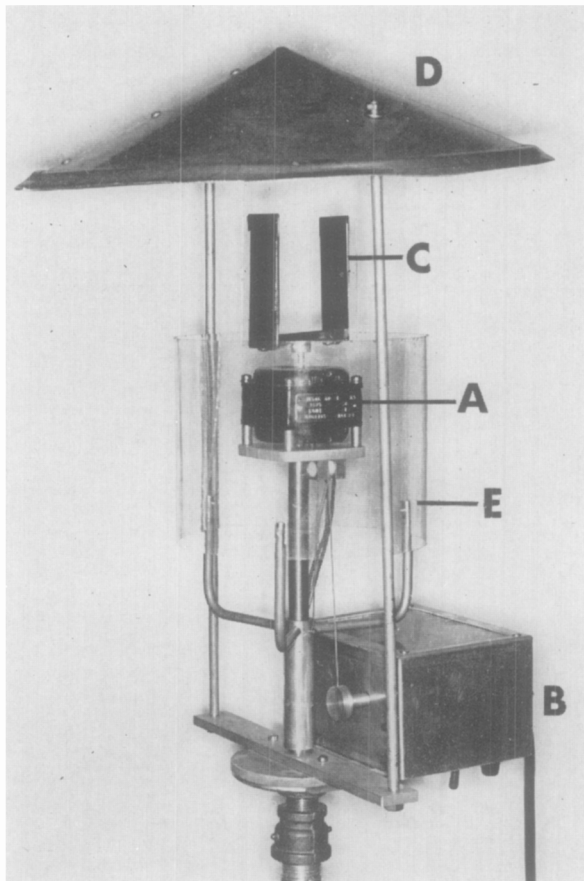


Fig. 1.—Intermittent rotoslide apparatus (designed and built by Dr. Eugene C. Ogden, Brookhaven National Laboratories, Brookhaven, L. I., N. Y.).
Key: A, rotator motor; B, timing mechanism; C, rotating slide carrier and slides; D, stationary weather shield; E, movable weather shield.

Measurements of pollen, mold, and bacterial concentrations were made in each home, as well as outdoors just adjacent to the homes. Temperature levels and relative humidity were measured and recorded automatically at each location. All of these measurements were conducted daily from June 15, 1962, through Oct. 1, 1962. Bacterial counts were obtained at a standard time at each location by exposing, for 15 minutes daily, standard Petri plates which contained nutrient blood agar. Mold counts were obtained using Sabouraud's medium in a similar manner. No attempt was made to identify the various bacterial or mold colonies.

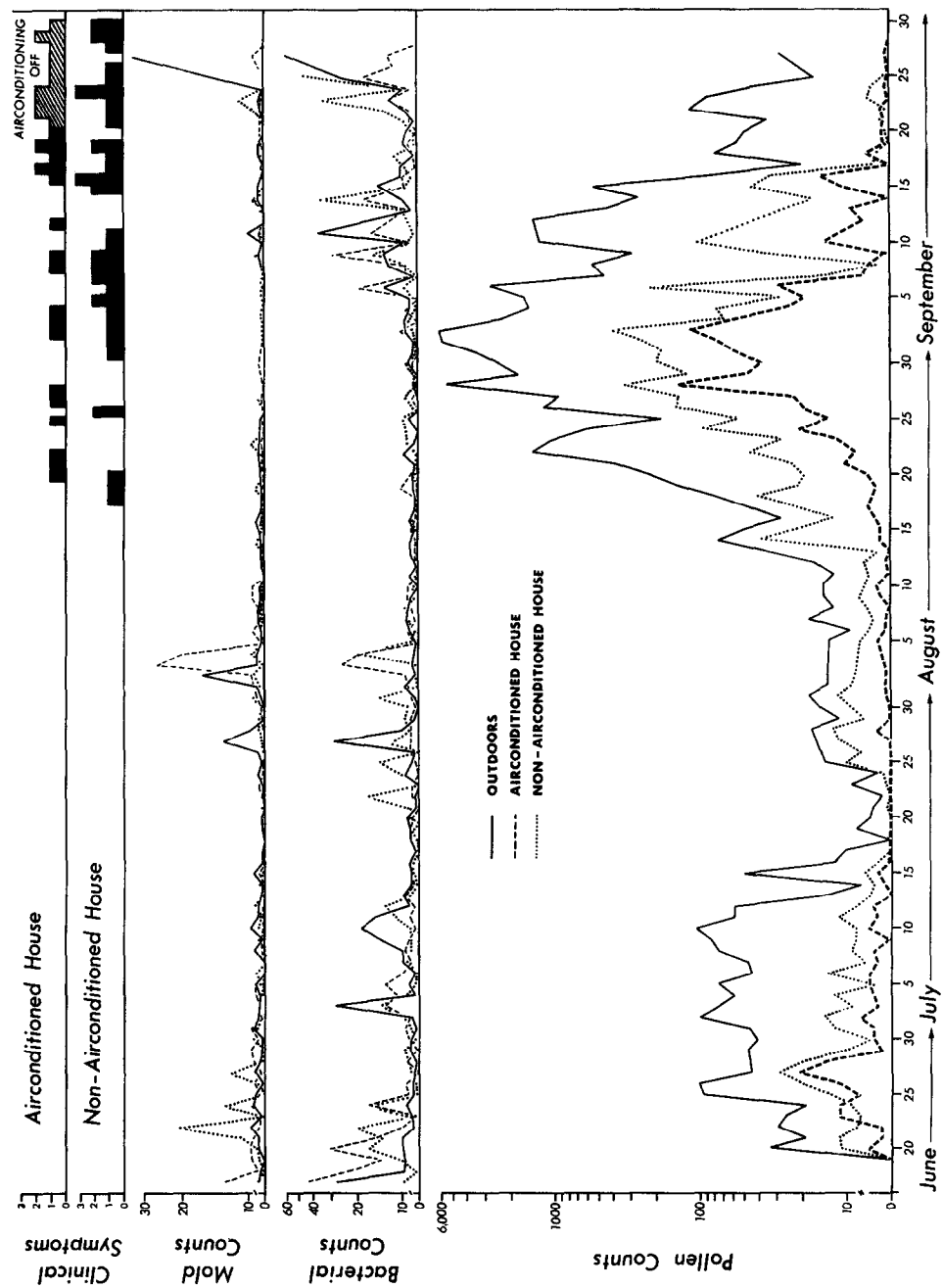


Fig. 2.—For legend see opposite page.

Pollen counts were determined with the use of four different types of apparatus. However, three of these, namely the modified Durham shelter,⁶ the Marx volumetric impinger,⁷ and the slide-edge cylinder impinger⁸ are not as accurate a sampler of the pollen concentrations as the intermittent rotoslide apparatus. Therefore the data contained in this report are solely those obtained with the intermittent rotoslide apparatus.

The intermittent rotoslide apparatus (Fig. 1) was developed at Brookhaven National Laboratories by Dr. Eugene C. Ogden⁹ and associates and was loaned to us for use in this study. The basic feature of the apparatus consists of two glass microscopic slides (1 by 3 inches) which are mounted vertically at either end of a special holder which rotates 1,675 revolutions per minute. An appropriate adhesive (silicone jelly) is coated on the 1 mm. leading edge of each slide, upon which the pollen collects. In normal operation this apparatus rotates for 2½ minutes in each 30 minute period. When not operating, a special cylindrical protector prevents accumulation of pollen on the slide. In a period of 24 hours it functions for a total of 2 hours. Previous experience has shown that a longer period of rotation caused overloading of the slide. Exposed slides were stained with Calberla's solution and mounted on the microscope stage with the help of a special plastic holder, which permitted the slides to be held in a vertical position so that the slide edge could be examined directly. An area 1 mm. wide by 50 mm. long was counted on each slide. Theoretically, the efficiency of the rotoslide is reported to be 100 per cent for ragweed pollen. Under wind tunnel conditions at Brookhaven, however, the actual efficiency was found to be about 75 per cent. Assuming a 75 per cent efficiency, and recording the total number of pollen grains on both slides, the following formula was evolved for determining volumetric concentrations:

$$\frac{\text{Pollen Grains}}{\text{Cubic Meter of Air}} = \frac{N}{E \times A \times D \times R \times T}$$

Where: N = number of grains counted on both slides (total area 1 sq. cm.); E = efficiency (75 per cent); A = area (1 sq. cm. or 0.0001 M.²); D = distance/revolution (0.3585 M./rev.); R = revolutions/min. (1,675 rev./min.); and T = total sampling time (120 min.).

Substituting in this formula:

$$\text{Pollen Grains/Cu. Meter of Air} = \frac{\text{Number of grains counted}}{5.4}$$

It was thought that the intermittent rotoslide apparatus gave the most meaningful results when compared to the other methods described. It has the advantage of being fairly efficient at all wind speeds, is independent of wind direction and speed, the slides are easily stored and counted, and the data can be easily converted to volumetric equivalents. The results illustrated in Fig. 2

Fig. 2.—Comparative enumeration of total daily pollen, bacteria, and mold counts in homes air conditioned, not air conditioned, and outdoors in suburban Philadelphia during summer months of 1962. Clinical symptomatology of a ragweed-allergic patient residing in each home who were evaluated daily during the ragweed pollen season and the results tabulated as to relative medication and discomfort level.

represent information obtained with this apparatus. The results with the other three devices roughly paralleled the rotoslide figures, but were not believed to be as accurate or as discriminating as those obtained with the rotoslide apparatus, for the reasons mentioned.

RESULTS AND DISCUSSION

Fig. 2 depicts the results of the study which was conducted from June 15, 1962, through Oct. 1, 1962. It is readily apparent that there was a general reduction to about 6 per cent of the outside level of pollen in the house that was not air conditioned, and an additional reduction to less than 2 per cent of the outside counts in the air-conditioned house. The absolute amount of pollen in each area varied daily, as would be expected. However, the same ratio of outdoor (not air conditioned) to indoor (air conditioned) counts persisted throughout the season.

Also illustrated in this figure are the symptoms of the highly allergic individuals residing in each of these homes. Both patients were of the same sex and age, had had no specific desensitization treatment for ragweed, and, in the past, had about the same amount of discomfort during the ragweed season. Each patient kept a daily log of her symptoms, as well as the amount of antihistamine medication necessary for relief. It was unequivocal that the allergic individual residing in the air-conditioned area had fewer symptoms and required less medication than the control subject residing in the home that was not air conditioned.

Total bacterial and mold counts showed no definite pattern in a comparison of results for the test and control areas. In a previous study⁵ there was marked lowering of the concentration of these contaminants in the air-conditioned areas. It must be emphasized, however, that the previous results were obtained in a completely closed unoccupied area. It is thought that the failure to confirm this finding was due to the fact that bacteria were brought into the area by the occupants. Molds may be readily introduced by food products, clothing, etc.

Constant recording of temperature and relative humidity in the two homes indicated the marked consistency of temperature in the air-conditioned home ($72^{\circ} \pm 2^{\circ}$ F.) when compared to the marked temperature variations in the home that was not air conditioned. Humidity fluctuated within 10 per cent or less in the air-conditioned home as compared to a 30 to 40 per cent fluctuation in the home that was not. No correlation could be made between cooling, humidity, and the biologic factors studied.

CONCLUSIONS

The results of this study indicate that central air conditioning is an effective method of lowering pollen concentrations in a normally occupied residence. In addition, it also may be inferred that lowering of these pollen counts in such areas is a satisfactory method of controlling the environment of patients suffering from pollinosis. In this study, no effect on the bacterial and mold counts in these areas was observed.

SUMMARY

Pollen, mold, and bacterial determinations were made over a 4 month period from June to October in two houses, one of which was equipped with a central air-conditioning system. These determinations were compared to each other and to similar determinations made outdoors. A "rotoslide" pollen counter gave the most reliable and reproducible results. Central air conditioning markedly lowered the pollen counts during the ragweed pollen season in comparison with the home with no air conditioning and to outdoors. A highly allergic individual residing in the air-conditioned house had less symptoms during the season than a comparable allergic individual residing in the control house.

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