Clinical Allergy, 1984, Volume 14, pages 351–354

Aspergillus fumigatus spore concentration in outside air: Cardiff and St Louis compared

J. MULLINS, PATRICIA S. HUTCHESON *and* R. G. SLAVIN

Asthma Research Unit, Sully Hospital, Penarth, South Glamorgan, Wales, and Department of Internal Medicine, Division of Allergy and Immunology, St Louis University School of Medicine, St Louis, Missouri, U.S.A.

(Received 1st August 1981; accepted for publication 19 June 1983)

Summary

Intermittent sampling of the atmosphere 3 days/week over a 12-month period using Andersen samplers in Cardiff, Wales, U.K. and St Louis, Missouri, U.S.A., indicated average *A. fumigatus* spore concentrations of 13·5/m^3 in St Louis and 11·3/m^3 in Cardiff. Both sites showed seasonal variations with highest concentrations during winter.

Introduction

Awareness of the diagnosis of allergic bronchopulmonary aspergillosis has increased steadily since the publications by Hinson, Moon and Plummer, (1952) and Pepys (1969). However, the prevalence of the disease has appeared to be greater in the U.K. than in the U.S.A. (Slavin *et al.*, 1969).

Schwartz *et al.* (1978) noted a similar frequency of sensitivity to *A. fumigatus* antigens using prick and serum antibody tests in populations from Cleveland and London, which suggested that the potential for the disease was much the same in the U.K. and the U.S.A. Hoehne, Reed and Dickie (1973) felt that this apparent difference in prevalence was due to cases being missed in the U.S.A. because of false-negative skin and precipitin tests due to the poor antigens available in the U.S.A.

Surveys of the *A. fumigatus* spore concentration in the U.S.A. (Solomon, 1976; Solomon & Burge 1975; Solomon, Burge & Boise, 1978) indicated much lower levels than those reported inside a hospital ward in London (Noble & Clayton, 1963) and it was suggested that the differences in spore concentration might be responsible for the differences in prevalence of the disease (Slavin, 1978).

To test this possibility, a census of *A. fumigatus* spores in the air at Cardiff, Wales, U.K. and St Louis, Missouri, U.S.A. was taken simultaneously over a 12-month period using the same methods of sampling, culturing, and incubation.

Correspondence: Dr Raymond G. Slavin, Department of Internal Medicine, Division of Allergy and Immunology, St Louis University School of Medicine, 1402 South Grand Boulevard, Room R210 Doisy Hall, St Louis, Missouri 63104, U.S.A.

Methods and materials

Sampling sites

Cardiff (51° 23′N, 03° 14′W): on the roof of Sully Hospital 14 m above ground level (Mullins, Harvey & Seaton, 1976).

St Louis (38° 27′N, 90° 14′W): on the roof of St Louis University Medical School Library 11 m above ground level and 136 m above sea level surrounded on all sides by urban development to a distance of 9–18 km.

Sampling methods

Sampling was carried out from June 1978 until May 1979 using Andersen samplers (Andersen, 1958) placed upright 30 cm above the surface of the roof in a Hyde and Williams sampler to protect from direct precipitation. The power supply to the samplers was regulated by time clocks (Sangamo Western Ltd) and interval times (ATC) which allowed sampling to take place for 1 min of each hr for a 24-hr period (0900–0900 hr) in Cardiff and for 2 min of each hr in St Louis. In St Louis, the culture plates were replaced at 1700 hr to ensure that no drying of the culture plates occurred. In Cardiff, lower ambient temperatures made this precaution unnecessary.

Malt extract agar was used throughout this survey and plates were subsequently incubated at 37°C for 48 hr.

Readings of temperature, sunshine, and rainfall were obtained from official meterological stations at: St Charles, Missouri (38° 45′ N, 90° 22′W: 163 m above sea level) and Cardiff (Wales) Airport (51° 24′ N, 03° 19′W. 76 m above sea level).

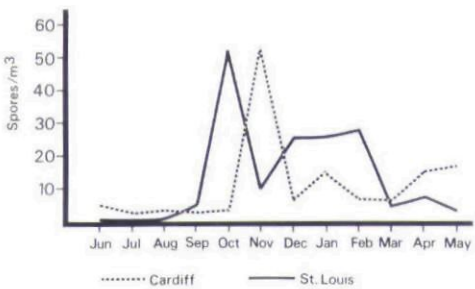

Fig. 1. Average monthly concentrations of *A. fumigatus* spores recorded in Cardiff and St Louis 1978–1979.

Results

Average monthly *A. fumigatus* spore concentrations are shown in Fig. 1. The average concentrations recorded were 13·5/m^3 at St Louis and 11·3/m^3 at Cardiff. Highest average *A. fumigatus* spore concentrations were recorded in October in St Louis and in November in Cardiff. At both sites, there was a marked seasonal fluctuation with lowest concentrations recorded in the summer months and highest concentrations recorded in the winter months.

Average concentration in the winter months (October to March inclusive) were 24·2/m^3 in St Louis and 15·1/m^3 in Cardiff, and in the summer months (April to September inclusive) were 2·8/m ^{3} in St Louis and 6·9/m^3 in Cardiff.

Meteorological data (Fig. 2) also show similar trends at both stations but with

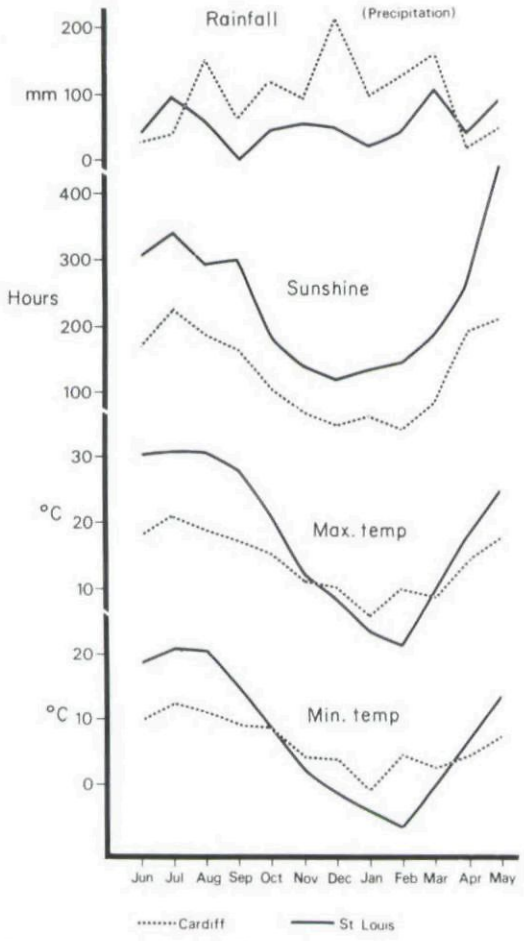

Fig. 2. Monthly average (temperature) and cumulative (rainfall and sunshine) meteorological recordings in Cardiff and St Louis 1978–1979.

sunshine and temperature exhibiting a wider range at St Louis than at Cardiff and with more rainfall in Cardiff than in St Louis, but no apparent simple correlations with spore concentration.

Discussion

The results obtained from the two sampling sites showed similar concentrations and seasonal patterns, which indicate that patients will experience a similar challenge of *A. fumigatus* spores in both areas.

Ayerst (1969) found that high 'water activity' in the substrate was necessary for growth of *A. fumigatus*. Similarly, Mullins *et al.* (1973) felt that the winter increase of *A. fumigatus* concentrations seemed to be related to the increased availability of substrate following leaf fall and with the seasonal increase in rainfall and drop in temperature leading to greater possibility of adequate moisture levels occurring in the substrate.

In fact, *A. fumigatus* spore concentrations in outside air are very low when compared to spore concentrations of the moulds which comprise the 'summer' air

spora. This is particularly significant when one considers the enormous spore production capability of *A. fumigatus* which can be observed under optimum culture conditions or in a compost heap. Although at their maximum in winter, *A. fumigatus* concentrations are no higher than those recorded for *Cladosporium* which suggests that conditions for abundant growth of *A. fumigatus* are rare.

The high concentrations recorded in the U.K. by Noble & Clayton (1963) have not been recorded in other surveys in the U.K. (Hudson, 1969, 1973; Mullins *et al.*, 1973), which confirm the conclusions of this study that *A. fumigatus* concentrations in the U.K. and the U.S.A. are comparable.

Acknowledgments

This study was supported by grant RO1-OH-00398 from the National Institute of Occupational Safety and Health, Public Health Service, Department of Health, Education and Welfare, U.S.A. and grant II/C/USA10 from the Wellcome Trust.

References

ANDERSEN, A.A. (1958) New sampler for the collection, sizing and enumeration of viable airborne particles. *Journal of Bacteriology*, **76,** 471.

AYERST, G. (1969) The effects of moisture and temperature on growth and spore germination in some fungi. *Journal of Stored Product Research*, **5,** 127.

HINSON, K.F.W., MOON, A.J. & PLUMMER, N.S. (1952) Bronchopulmonary aspergillosis. *Thorax*, **7,** 317.

HOEHNE, J.H., REED, C.E. & DICKIE, H.A. (1973) Allergic bronchopulmonary aspergillosis is not rare. *Chest*, **63,** 177.

HUDSON, H.J. (1969) Aspergilli in the air spora at Cambridge. *Transactions of the British Mycological Society*, **52,** 153.

HUDSON, H.J. (1973) Thermophilous and thermotolerant fungi in the air spora at Cambridge. *Transactions of the British Mycological Society*, **61,** 595.

HYDE, H.A. (1950) Studies in atmospheric pollen. IV. Pollen deposition in Great Britain. Part 1. The influence of situation and weather. *New Phytologist*, **49,** 398.

MULLINS, J., HARVEY, R. & SEATON, A. (1976) Sources and incidence of airborne *Aspergillus fumigatus* (Fres). *Clinical Allergy*, **6,** 209.

NOBLE, W.C. & CLAYTON, Y.M. (1963) Fungi in the air of hospital wards. *Journal of General Microbiology*, **32,** 397.

PEPYS, J. (1969) *Hypersensitivity Disease of the Lungs Due to Fungi and Organic Dusts. Monographs in Allergy*. S. Karger, Basel.

SCHWARTZ, H.J., CITRON, K.M., CHESTER, E.H., KAIMAL, J., BARLOW, P.B., BAUM, G.L. & SCHUYLER, M.R. (1978) A comparison of the prevalence of sensitization of Aspergillus antigens among asthmatics in Cleveland and London. *Journal of Allergy and Clinical Immunology*, **62,** 9.

SLAVIN, R.G. (1978) What does a fungus among us really mean? *Journal of Allergy and Clinical Immunology*, **62,** 7.

SLAVIN, R.G., STANCZYK, D.J., LONIGRO, A.J. & BROWN, G.O. (1969) Allergic bronchopulmonary aspergillosis—a North American rarity. *American Journal of Medicine*, **47,** 306.

SOLOMON, W.R. (1976) A volumetric study of winter fungus prevalence in the air of midwestern homes. *Journal of Allergy and Clinical Immunology*, **57,** 46.

SOLOMON, W.R. & BURGE, H.P. (1975) *Aspergillus fumigatus* levels in and out of doors in urban air. *Journal of Allergy and Clinical Immunology*, **55,** 90.

SOLOMON, W.R., BURGE, H.P. & BOISE, J.P. (1978) Airborne *Aspergillus fumigatus* levels outside and within a large clinical center. *Journal of Allergy and Clinical Immunology*, **62,** 56.