

Asthma due to inhaled wood dusts— Western red cedar and Iroko

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Summary

Occupational type exposure tests with wood dusts provoked specific late asthmatic reactions to Iroko or cedar wood dust in two asthmatic woodworkers respectively. Aqueous extracts gave immediate reactions only to Iroko in the Iroko sensitive patient, who also had precipitins only to the Iroko extract. No skin or serological or inhalation test reactions were given in non-exposed subjects.

Introduction

Respiratory manifestations due to the inhalation of wood dusts are not uncommon. The specificity of the reactions in terms of different dusts in individual subjects is strongly suggestive of allergy. Bronchial reactions like the immediate, late and dual reactions elicited by fungal antigens, e.g. *A. fumigatus*, avian antigens, house-dust and *Dermatophagoides* spp. extracts (Pepys *et al.*, 1968; McCarthy & Pepys, 1971; Booij-Noord *et al.*, 1972), are reported to wood dusts by Sosman *et al.* (1969) and Gandevia & Milne (1970). In inhalation tests with wood dusts themselves and with aqueous and alcoholic extracts of these dusts they elicited immediate reactions to oak in one case, combined immediate and late asthmatic reactions to mahogany in another patient, and late asthmatic reactions to cedar in two others.

Two patients giving specific late asthmatic reactions like those recorded by Gandevia & Milne (1970) to inhalation tests with different wood dusts are reported here.

Materials and methods

The two male patients with asthma attributed to wood dust exposure were investigated in hospital when they were symptom free.

Case histories

(1) *Patient F.V.*, aged 34, had no family or personal history of atopy. He first developed wheezing and shortness of breath at the age of 32 years when he had been working with Iroko wood for 2 days. He was off work for the following 7 days and the symptoms

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gradually subsided. He had worked with Iroko wood 12 months previously, without any symptoms. He then had no further contact with it for 3 months, and kept well. On his first re-exposure to the Iroko dust he developed a severe attack of asthma in the evening following the day's work. Since then he ceased working as a carpenter but continued to have mild wheezing and shortness of breath. A few scattered expiratory rhonchi were heard on auscultation.

Investigations. Haemoglobin, white blood count, differential and absolute eosinophil counts were normal. Plasma proteins were normal. The chest X-ray showed no abnormalities. Skin tests to twenty-three common allergens were negative.

Pulmonary function tests:

	VC (ml)	FRC (ml)	TLC (ml)	RV/TLC	FVC (ml)	FEV ₁ (ml)	FEV ₁ /FVC	TL _{co} *	AR† (LV ml)
Result	4250	3050	6250	32%	4020	3100	77%	30.9	1.94 (3170)
% Predicted	102	95	106		93	90		109	147

* Single breath. † Airways resistance.

(2) *Patient J.P.*, aged 35, a carpenter for 19 years, had no previous history of respiratory disease. There was no personal or family history of atopy. He first developed rhinitis in December 1969, and 7 days later developed wheezing and breathlessness. Initially these symptoms were present only on weekdays resolving at weekends but they later increased in severity and became persistent.

After 6 months it became clear that the symptoms were associated with exposure to Western red cedar wood dust. He ceased exposure and the symptoms resolved over the following 4 weeks. Since that time he has had no further contact with this wood and has remained well. On examination no abnormalities were found.

Investigations. Haemoglobin, white blood count, wet absolute eosinophil counts and ESR were all normal. Chest X-ray showed no abnormalities. Skin tests to twenty-one common allergens were negative.

Pulmonary function tests:

	VC (ml)	FRC (ml)	TLC (ml)	RV/TLC	FVC (ml)	FEV ₁ (ml)	FEV ₁ /FVC	TL _{co} *	AR† (LV ml)
Result	3750	2980	5780	35%	3600	2900	80.5%	28.3	1.98 (2980)
% Predicted	101	100	110		98	100		123	141

* Single breath. † Airways resistance.

(3) Two asthmatic subjects and one healthy subject who were not exposed to the wood dusts were tested as controls and gave negative reactions to both Iroko and cedar wood dusts.

Wood dusts and their extracts

The suspected wood dusts, Iroko (*Chlorophora excelsa*) and Western red cedar (*Thuja plicata*) were studied and Kapor wood dust was also used for testing.

Extracts were made of the Iroko and Western red cedar with carbol-saline or by extraction with toluene. The dialysed extracts were freeze-dried and then redissolved in carbol-saline for testing. No reactions were given to prick tests with these in a large number of non-exposed subjects.

Agar-gel double diffusion tests were made on the sera of the two patients and on the sera of nineteen non-exposed subjects.

Inhalation test procedures

(1) Both patients were tested with the wood dusts themselves, using the method described by Pepys, Pickering & Loudon (1972) in which the dust is shaken repeatedly from one tray to another placed 0.3 m below. This was repeated for up to 30 min in a small cubicle.

(2) An aqueous extract was administered as an aerosol by means of a Wrights nebulizer, through which air or oxygen flowed at 8 l/min, and a BLB-oro-nasal mask and a rebreathing bag. The aerosol was given for a total of 5 min in three consecutive periods of 1, 2 and 2 min with 10 min intervals between each period of exposure. The concentration selected for testing gave less than a 3 mm weal on prick testing. The FEV₁ and FVC were measured before the test and at each interval in the test. After the total period of challenge, these measurements were repeated at 10 min intervals up to 1 hr and then hourly for 8 hr.

[1] Patient F.V.

Inhalation tests

The following inhalation tests were performed on different days:

- Challenge
- 1 Control inhalation with carbol-saline.
 - 2 Iroko wood dust exposure for 30 min.
 - 3 Kapor wood dust exposure for 30 min.
 - 4 Iroko wood dust exposure for 30 min.
 - 5 Inhalation of 20 mg disodium cromoglycate (Intal) 10 min before the challenge with Iroko wood dust exposure for 30 min.
 - 6 Iroko-aqueous extract at 0.1 mg/ml for 5 min.
 - 7 Iroko-aqueous extract at 1 mg/ml for 5 min.
 - 8 Iroko-aqueous extract at 10 mg/ml for 5 min.
 - 9 Iroko-toluene extract 10 mg/ml for 5 min.
 - 10 Iroko-aqueous extract 20 mg/ml for 5 min.
 - 11 Western red cedar wood dust exposure for 30 min.
 - 12 Iroko wood dust exposure for 30 min.

Results. The control carbol-saline test (1) and the tests with Kapor wood dust (3) and Western red cedar wood dust (11), gave negative reactions. The pulmonary function tests showed little diurnal variation.

Late and similar asthmatic reactions were elicited by tests 2, 4 and 12 with Iroko wood dust (Fig. 1). In tests 2, 4 and 12 the FEV₁ at 24 hr were 14%, 24% and 20% respectively below the initial level. A late reaction was elicited by test 5 where disodium cromoglycate was given before the challenge, though in this test unlike tests 2, 4 and 12 the FEV₁ returned to initial levels within 24 hr. The late asthmatic reaction started 1-3 hr after the test and reached its maximum over the next 2-4 hr. Inhalation of 1% isoprenaline gave only partial reversal, of short duration, of the asthmatic reaction. More prolonged reversal was produced by the subcutaneous injection of adrenaline. Inhalation tests with the highest concentration of the aqueous extract (20 mg/ml) (test 10) and of the toluene extract (test 9) provoked small immediate asthmatic reactions.

CO gas transfer factor (TL_{CO}) (single breath method). In test 2, 6 hr after the test the TL_{CO} was 34, the FEV_1 being reduced by 20%. In test 5, 3 hr after the test the TL_{CO} was 32 and the FEV_1 was reduced by 34%.

Sputum cytology. In test 4 cough and sputum were produced. The sputum 5 hr after the test contained many white blood cells, 50% being eosinophils, and at 23 hr 75% were eosinophils.

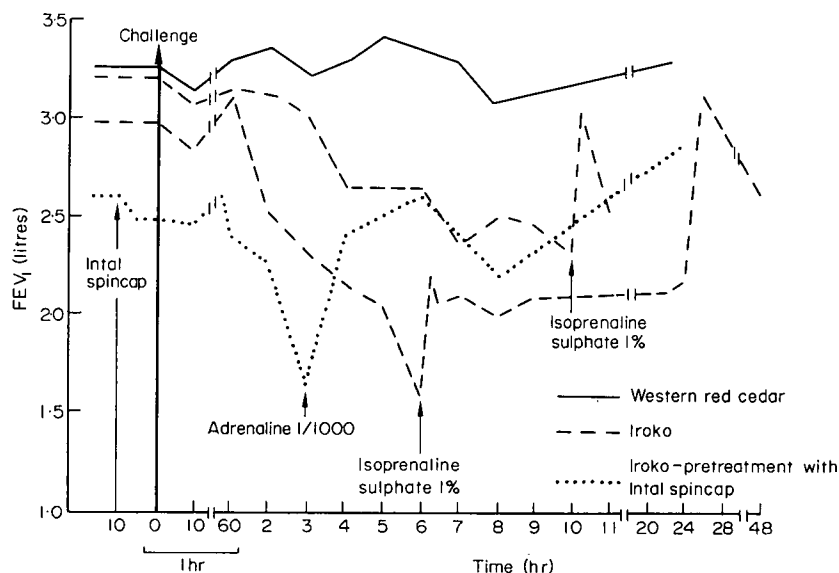


Fig. 1. Inhalation test with Iroko and Western red cedar dust in patient F.V.

White blood cell and absolute eosinophil counts

	Baseline	6-8 hr	24 hr
Challenge 1	6200 (240)	7200 (380)	
2	4700 (220)	5300 (180)	5100 (240)
3	4600 (360)	8800 (500)	
4	7000 (470)	9000 (410)	9400 (530)
5	5800 (680)	10900 (350)	7300 (690)
6	—	7400 (280)	
7	7000 (300)	6500 (250)	
8	5300 (250)	—	
9	5300 (300)	7600 (460)	
10	5700 (350)	5700 (130)	
11	5000 (160)	6400 (130)	
12	5700 (180)		

Prick tests (weal diam. in mm)

Iroko wood dust (carbolic-saline extract)			Iroko (toluene extract)
0.1 mg/ml	1 mg/ml	10 mg/ml	Undiluted
0.5 mm	2.5 mm	3.5 mm	3.5 mm

[2] Patient J.P.

Inhalation tests

The following inhalation tests were performed:

1. Iroko wood dust exposure for 30 min.
2. Western red cedar wood dust exposure for 30 min.

Results (Fig. 2). The control study using Iroko dust was negative and minimal diurnal variation was demonstrated. Exposure to Western red cedar wood dust provoked a late asthmatic reaction. This reaction commenced at 2–3 hr and was maximal between 9 and 13 hr: at this latter point the reaction was reversed with subcutaneous adrenaline, the reaction lasting for about 48 hr.

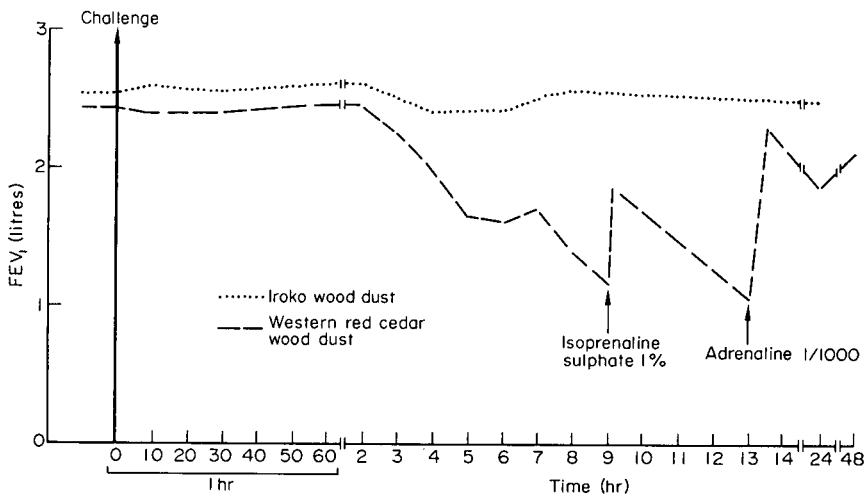


Fig. 2. Inhalation test with Iroko and Western red cedar dust in patient J.P.

CO gas transfer factor (TL_{CO}). In test 2, 5 hr after the test the TL_{CO} was 31, the FEV_1 being reduced by 33%.

White blood cell and absolute eosinophil counts

Challenge 1	7800 (220)	8800 (410)
2	9200 (450)	10600 (620)

Prick tests (weal diam. in mm)

Western red cedar (carbøl-saline extract)		Western red cedar (carbøl-saline extract)	
1 mg/ml	10 mg/ml	1 mg/ml	10 mg/ml
-ve	-ve	-ve	-ve

Precipitin tests. No reactions were given to the extracts by the sera of nineteen non-exposed subjects. The serum of patient F.V. who was allergic to Iroko gave a positive precipitin reaction only to the Iroko extract. Patient J.P. gave negative reactions to both extracts.

Discussion

The occupational type exposure employed for the inhalation test gave satisfactory and specific reactions to the relevant wood dust. Gandevia & Milne (1970) elicited late and long lasting reactions with aqueous extracts in contrast to tests with the saw-dusts themselves as reported here. The late asthmatic reaction to the wood dusts resembles that produced in non-atopic subjects with avian sensitivity and with precipitins but not reagins in their serum (Pepys *et al.*, 1968; Faux *et al.*, 1971). Some of these latter subjects gave immediate prick test reactions to intracutaneous tests. It may be that these immediate reactions are due to the short-term IgG antibody described in man by Parish (1970). This could provide the immediate reaction which plays an important introductory role in the development of Type III, immune-complex reactions which are associated with late asthmatic reactions. In the patient with Iroko sensitivity it is of interest that not only were precipitins found against this extract, as have been reported for other wood dust extracts by Sosman *et al.* (1969), but immediate skin and bronchial reactions were produced by aqueous Iroko extracts. The challenge with the wood dust itself would therefore correspond better with the nature of the clinical exposure, though some wood dust sensitive patients report that their sensitivity develops to the point where rapidly developing asthmatic reactions are produced on exposure at work. The nature of the antibody giving the immediate reaction to the Iroko has not been determined. It is probably IgE antibody, since the short-term IgG antibody may not be capable or may be far less capable of mediating an immediate asthmatic reaction. The sputum eosinophilia produced in the positive inhalation test also suggests an IgE mediated reaction.

Disodium cromoglycate did not inhibit the late asthmatic reaction to the Iroko wood dust. This contrasts with its inhibitory effect on the late asthmatic reaction to piperazine dihydrochloride dust (Pepys *et al.*, 1972), where however it was given before and repeated 4 hr after the test. No tests were made with a later dose of disodium cromoglycate in the present study, nor was it tried for its effect on the immediate reaction. The lengthy investigational procedure made it difficult to perform all the tests on this occasion.

Much more immunological evidence is needed, but these findings support the conclusion of Sosman *et al.* (1969) that the bronchial reactions to wood dusts are mediated by immunological mechanisms.

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