Bronchiolitis obliterans in a man who used his wood-burning stove to burn synthetic construction materials

Education

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This article has been peer reviewed.

Can Med Assoc J 1997;156:1171-3.

Abstract

MANY PEOPLE HEAT THEIR HOMES WITH WOOD-BURNING STOVES. However, toxic fire effluent can escape from old or improperly operated stoves. The authors describe a case in which bronchiolitis obliterans developed in a man within hours after he burned synthetic construction materials in his wood-burning stove. Certain factors, such as careless or improper use of the stove, the size of the room, the lack of open-air ventilation and the composition of the materials burned, strongly point to inhalation of the fire effluent as the cause.

Résumé

BEAUCOUP DE PERSONNES CHAUFFENT AU BOIS. Des poêles qui sont vieux ou mal utilisés peuvent toutefois laisser échapper des effluents toxiques. Les auteurs décrivent un cas de bronchiolite oblitérante qui a fait son apparition chez un homme quelques heures après qu'il eût fait brûler des matériaux de construction synthétiques dans son poêle à bois. Certains facteurs, comme l'imprudence, la mauvaise utilisation du poêle, les dimensions de la pièce, l'absence de ventilation sur l'extérieur et la composition des matériaux brûlés, indiquent fortement que le problème a été causé par une inhalation d'effluent.

Some people who live in homes heated by wood-burning stoves have mild respiratory disturbances that are apparently related to the inhalation of traces of escaping fire effluents.[1] In one case the burning of chemically preserved wood caused metal poisoning.[2] We report a case in which a man had an acute respiratory illness after burning synthetic building materials.

Case report

A previously healthy 37-year-old man presented in winter with an 11-day history of unproductive cough, increasing dyspnea and fever. He was a 27 pack-year smoker. He had no pets and had no humidifiers at home or at work.

The patient's temperature was 37.6°C, respiratory rate 20 breaths/min, pulse rate 100 beats/min and blood pressure 120/78 mm Hg. Breath sounds were decreased bilaterally, and basal crackles were heard. Chest radiographs revealed reticulonodular infiltrates, prominent in the middle regions of the lungs, without hilar adenopathy. Lung volumes and flow rates were normal. The diffusing capacity was 48% of predicted. The blood pH was 7.43, partial pressure of oxygen 64 mm Hg, partial pressure of carbon dioxide 33 mm Hg, and the bicarbonate concentration 22 mmol/L, base excess –1. The leukocyte count was 14.6 $\times 10^9$/L (62% neutrophils, 14% lymphocytes, 15% monocytes and 6% bands). The erythrocyte sedimentation rate was 128 mm/h. Results were normal for the following tests: urinalysis, routine blood tests for cardiac, liver, kidney and pan-

creatic islet functions, electrocardiogram, blood culture, humoral and cell immunity tests, cold agglutinins, nuclear and DNA antibody tests, viral serology, culture of throat washings for viruses, tuberculin test, liver biopsy, mediastinoscopy and bronchoscopy.

Open lung biopsy revealed bronchiolitis obliterans (Fig. 1) without evident microorganisms or viral inclusions. Culture of the biopsy specimen was negative for aerobic and anaerobic bacteria, fungi, *Mycoplasma* and *Mycobacteria*. The patient gradually recovered without medication.

Further enquiry revealed that the patient had been renovating his family room the day his illness began. He had removed wood particle-board panelling (12 panels) and polystyrene insulation (3 sheets, each 2.5 cm thick) from the walls and had burned them in the wood-burning stove located in the family room. His family had been out of the house. He had seen little or no smoke but had begun to feel unwell, with a slight cough, after about 4 hours.

Investigation of burn conditions

The building material was fed into the stove through an opening on the top (Fig. 2), which was left uncovered throughout. The room was dry, not mouldy, but it was small (about 50 m^3, with a ceiling 2 m high). No windows or doors were open at the time.

The panels were made of bonded, fine wood particles. A sample was ashed at 1000°C, in the presence of oxygen and an oxidizing catalyst, and the gaseous effluent was subjected to the same conditions. Duplicate analyses of effluent nitrogen oxides revealed a nitrogen content of 5.11% and 4.91% by weight. Infrared analyses of an insulation sheet sample confirmed these to be made of polystyrene, and duplicate metal analyses revealed bromine (2.2% and 2.13% by weight).

Comments

Inhalation of fire effluents appears to have initiated the bronchiolitis obliterans in this case. We could find no infectious cause, and the patient's family was not at home during the burning and remained well.

The patient saw little or no smoke in the room. Smoke is visible because of particulates; however, its acute toxicity often derives mainly from invisible or poorly visible gases and volatilized chemicals.[1,3] Effluent composition depends on temperature, available oxygen and fuel characteristics.[3] In general, certain plastics with thermolabile polymeric bonds, such as polystyrene, start to decompose at temperatures less than those required for wood, with rapid release of highly volatile monomeric constituents, such as styrene.[4,5] The polystyrene insulation used by the patient contained bromine, once widely used with flame-retardants in plastics.[4] For wood panels made of particle board, urea-formaldehyde polymers are commonly used as binders and are sources of nitrogen oxides when burned.

The patient had left the stove's burning chamber uncovered. Depending on the position of the flue damper (unknown), the opening would increase the air intake

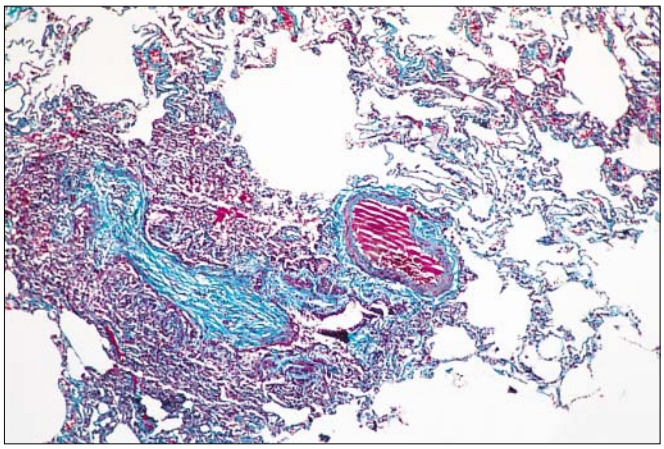

Fig. 1: Photomicrograph of lung biopsy specimen from a man with bronchiolitis obliterans after burning synthetic construction materials in his wood-burning stove. Left of the arteriole (red) is a terminal bronchiole and a respiratory bronchiole occluded by fibroblastic-collagen tissue (blue-green), surrounded by alveoli consolidated with mononuclear inflammatory cells. (Masson Trichrome stain; original magnification ×125, increased by 142%.)

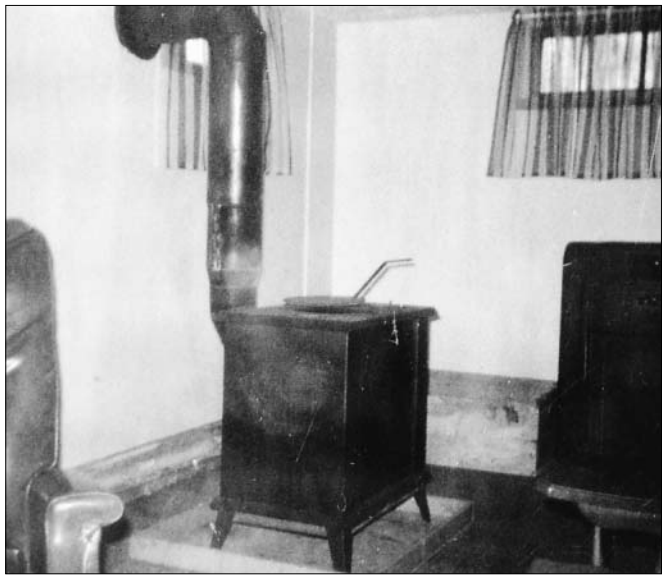

Fig. 2: Wood-burning stove used to burn construction materials. Note low ceiling and closed windows in the room (lid covering the top opening of the stove, visible here, was not used during the burning). (Figure reproduced from Polaroid photo supplied by the patient).

and combustion in the chamber and the draw of smoke into the chimney. However, it would also facilitate the escape of volatile effluents into the room. Such conditions may explain why he saw little or no smoke and why his respiratory disease may reasonably be attributed to toxic inhalation. Because fire effluents contain an enormous variety of combustion products,[5] pulmonary injury cannot be attributed to any one in particular. However, nitrogen oxides and styrene have been found to cause bronchiolitis obliterans[6] and bronchial epithelial necrosis[7] respectively.

The use of wood-burning stoves for home-heating has increased since 1970.[1] This case history and another[2] illustrate some of the hazards when these stoves are used to dispose of synthetic materials, especially if the stoves are old or improperly operated.

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