

UNUSUAL FORMALDEHYDE-INDUCED HYPERSENSITIVITY IN TWO SCHOOLGIRLS*

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Two schoolgirls developed a syndrome resembling Henoch-Schonlein purpura while attending a recently opened school insulated with urea-formaldehyde foam (UFFI). Skin rashes and swellings were accompanied by bizarre, blue-green discoloration of the skin. Subsequent investigations by county, state and federal authorities, and low measured concentrations of formaldehyde, prompted initial conclusions that in-school formaldehyde exposures were not responsible for the girls' problems. Subsequent controlled exposures to UFFI and formaldehyde while in hospital elicited the whole cascade of symptoms. The chronology of the onset and amplification of systems make it probable that the formaldehyde exposures precipitating the girls' hypersensitivity, occurred in the school.

INTRODUCTION

The investigator is often frustrated when trying to make positive identification of the culprit events and entities producing a hypersensitization involving indoor air pollutants. Measurement of the concentrations of a suspected agent is usually done long after the initial sensitization has happened. Aging of the original source may have greatly reduced the emissions of the suspect air pollutant. This case is instructive because of the careful follow up studies which showed definitive hypersensitivity to formaldehyde. The chronology of events points strongly to the initial sensitization having occurred at a school foamed with UFFI. However, it will forever be unknown what the triggering events actually were or to what concentrations the girls were actually exposed at those times.

Hypersensitivities are often difficult to treat or to correlate with exposures. The research community has tended to avoid forays into this field. Consequently, the problem of hypersensitivity in relation to indoor air quality remains an acutely under-addressed area of indoor air and human health.

DESCRIPTION AND METHODS

A large high school building for 1600 students opened in August 1979. During construction, the exterior walls, constructed with vertical-cell hollow concrete blocks, were injected with UFFI. Interior

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walls were painted with epoxy resin but wall surfaces above a suspended ceiling were left unpainted. The unpainted areas above the suspended ceilings act as return air ducts of the air conditioning system.

The National Institute of Occupational Safety and Health (NIOSH) Method P&CAM 125 was used for analysis of formaldehyde in air. The sampling times varying between two and seven hours. During sampling, the ventilation systems were switched off.

The two affected girls were in different classes, but assigned part of the day to the same classroom. Both girls' desks were directly below the same supply air duct. These 18 and 19-year-old white females developed recurrent episodes of rashes or bruise-like skin lesions involving the trunk and extremities, abdominal pain and distension, joint pain and swelling, headaches, cramps, sleep disturbances and fainting. The skin lesions were accompanied by blue-green surface coloration of large areas of the skin on the trunk and extremities. Some of the surface coloration was removable with alcohol.

Tests conducted by earlier examining physicians produced results that were mostly negative. Some type of collagen vascular disease was suspected. Positive findings included intermittent microscopic to gross hematuria. Immune complexes became elevated in both patients; IgE was mildly elevated in one girl. The patients were placed on home bound teaching. During these times their conditions improved dramatically with complete disappearance of symptoms. Complete details of the medical findings are contained in Ref. 1.

Concerns expressed by parents prompted investigations in turn by the school board, county and state health departments and NIOSH. Examinations were made of the school and concentrations of formaldehyde were measured during the spring and summer of 1982.

RESULTS AND DISCUSSION

About 30 air samples were collected on four days during March, April, and July of 1982. Formaldehyde concentration measured by the state and NIOSH varied from nondetectable to 0.16 ppm and 0.02 ppm to 0.17 ppm, respectively. Only three samples contained more than 0.10 ppm. Each investigating authority ruled out a problem at the school as being a reason for the students' illness. In a report issued by NIOSH (2) it was stated that at this school there was no health hazard due to formaldehyde generated from the UFFI. Furthermore the blue-green discoloration was "felt compatible with a superficial material, possibly applied to the skin."

Subsequently, both girls were challenged with formaldehyde while under surveillance in hospital. Patch skin tests were made with UFFI blocks taped to the skin for 24 hours and with 10% formalin solution. A small cotton ball was used as control. The UFFI and formalin produced erythematous skin rash around the challenge areas. Blue-green discolorations appeared later and became generalized. The patients suffered several periods of unconsciousness, abdominal pain and distension, arthralgia, dyspnea, hemoptysis, hematuria, heavy albuminuria and a host of generalized skin lesions. The symptoms continued for four days and then gradually subsided.

Henoch-Schonlein purpura is a multi-faceted syndrome characterized by symptoms of purpuric rash, edema, arthralgia, colicky abdominal pain and nephritis. The fundamental etiology is unknown. We identify the girls' symptoms with a new type of hypersensitivity to formaldehyde - a syndrome associated with Henoch-Schonlein purpura with associated chloroderma presenting blue-green skin discoloration.

There is little doubt that the two teenage schoolgirls became sensitized and increasingly hypersensitive to formaldehyde during 1979-82. Circumstantial evidence points to the original sensitizing and subsequent early hypersensitivity episodes taking place while they were attending the school. The most probable cause was formaldehyde vapor released from the UFFI.

Although the measured formaldehyde concentrations were generally in the acceptable range for comfort (<0.1 ppm), one cannot assume that this was always the case while the girls were in attendance at the school. Firstly, the offgassing rate of formaldehyde would have been appreciably higher in 1979 than in 1982 when the formaldehyde was measured (3). Secondly, it is not necessarily correct to assume the "worst case situation pertaining to the release of formaldehyde vapors" (1) prevailed at the school when the school's ventilation systems were shut off. The measurement of formaldehyde were made with the ventilation systems off. The classrooms are then more isolated from the unpainted, above-ceiling spaces into which formaldehyde can be more readily emitted. Also when the ventilation is on, slight negative pressures prevail in the above-ceiling, return-air ducts. These negative pressures could draw formaldehyde vapor out of the UFFI-filled blocks to be recirculated into the classrooms. Settling was also observed to have produced occasional cracking of walls which could locally facilitate release of formaldehyde. It is, therefore, reasonable to suppose that the formaldehyde levels during some periods of the girls' occupancy of the school were higher than those actually measured during a few days during March to July, 1982.

CONCLUSIONS AND RECOMMENDATIONS

This case study identifies a new type of hypersensitivity; Henoch-Schonlein purpura together with chloroderma presenting blue-green skin discoloration. Assignment of formaldehyde as the causative agent was established while making controlled exposures in hospital. Circumstantial evidence points to the girls' health problems originating with formaldehyde exposures encountered at their newly opened, UFFI-containing school. The fact that both girls began developing this rare form of Henoch-Schonlein purpura soon after the school's opening and experienced remission of symptoms while on homebound teaching, points to the UFFI as the likely source of the problem. The negative conclusions implicating formaldehyde exposures that the school were made by the county, state and NIOSH without full knowledge of the consequences of controlled in-hospital exposures of the schoolgirls to the UFFI. Had they been fully cognizant of the indisputable evidence for the girls' sensitization to formaldehyde, their conclusions might have been different. What this case study does point out is the considerable difficulty the practitioner investigating indoor air quality complaints is likely to have in identifying the culprit in situations where hypersensitivity is involved.

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