U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-86-675

TUFTS MEDICAL SCHOOL
BOSTON, MASSACHUSETTS

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I. SUMMARY

On May 17, and June 6 & 7, 1979, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at Tufts Medical School in Boston, Massachusetts, to investigate an apparent cluster of cases of angioneurotic edema (massive swelling involving any part of the body). On May 17, a walk-through survey of all work areas at the school was conducted, personal interviews with four affected employees were performed, and an inventory of chemicals used by these employees was collected to evaluate the possibility of a work-related etiology for the workers' symptoms. On June 6 & 7, interviews were conducted with five affected employees, and employees' physicians were consulted. Also a review of medical records, environmental observation of work practices, and environmental samples were collected by NIOSH investigators.

Environmental sampling was restricted to determination of formaldehyde vapor levels since it was the only common exposure and is a known sensitizing agent. The level of formaldehyde in each sample obtained was less than the quantitation limit and also below the NIOSH recommended standard of 1 ppm.

Of the five affected employees studied by NIOSH, two were confirmed to have had symptoms of angioneurotic edema. One was known to have non-hereditary angioneurotic edema; and the other indicated a familial and personal history of hereditary angioedema. The one case of non-hereditary angioneurotic edema did not apparently originate in the work environment. The other three affected employees had atopic histories that preceeded their symptoms of angioedema.

On the basis of the data obtained in this investigation, NIOSH has determined that the cluster of five cases with symptoms of angioneurotic edema was probably not caused by chemical exposure at Tufts Medical School. However, certain chemicals in the work environment, such as formaldehyde, may have precipitated an allergic reaction to employees with allergic histories. It is recommended that the employee with non-hereditary angioneurotic edema prudently minimize exposure to any chemical sensitizing agents such as formaldehyde that could trigger episodes of angioneurotic edema. Recommendations to improve health and safety in the work environment are presented on pages 5 and 6 of this report.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. The Dean of Medicine at Tufts Medical School requested such an investigation from NIOSH to determine the etiology of a cluster of five cases of angioneurotic edema that had occurred in employees who worked with cadavers and other pathology specimens at this institution. Personal interviews, professional consultations, review of medical records, a chemical inventory, environmental samples, and an inspection of the work environment were performed to determine the causes of this apparent disease outbreak.

III. BACKGROUND

Tufts Medical School is comprised of four refurnished, pre-1900 buildings. The dental and medical building, the Stern's building, the Arnold building, and the South Cove building are all interconnected by enclosed hallways and crosswalks.

The areas of concern for chemical exposure for the five employees with symptoms of angioneurotic edema were the gross anatomy laboratory, and Pathology Department, located in the dental and medical building, and the anatomy teaching laboratories located in Arnold building. Exposures to embalming fluids, formalin, or antifungal agents were suspected as being causally associated with the outbreak.

IV. EVALUATION DESIGN & METHODS

Information gathered during the initial survey on May 17 indicated that all affected employees had allergic histories and had worked with pathology specimens. The follow-up survey of June 6 & 7 probed the medical and exposure histories of each affected employee to find common links. Environmental evaluation of formaldehyde was done because it was used by all of the affected employees and is a known sensitizing agent.

The medical evaluations included the administration of a non-directed questionnaire which detailed a work history (including chemical substances encountered), an allergic/familial history, a description of the symptom complex, a probing for aggravating and instigating factors, and therapeutic actions taken.

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*Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

Each individual's medical records at the Tufts Student/Employee Medical Clinic were reviewed. Consultations were conducted with several specialists in immunology/allergy who had seen and treated the affected employees.

Environmental sampling for formaldehyde could only be performed in the teaching laboratories because Tufts Medical School was on semister break and all other areas such as the gross anatomy laboratory and pathology department had minimal activity. Further, the teaching laboratory was where one of the most affected employees had worked, and was an area where concentrations of formaldehyde would likely be higher than anywhere else.

In order to simulate a worst possible exposure to formaldehyde vapor, a 5 gallon bucket of formalin solution containing anatomical specimens used in the teaching laboratory was opened and put near the center of the room. After a few minutes of equilibration of room air with the formaldehyde vapor sampling trains of battery operated pumps with impregnated charcoal tubes were positioned at various distances from the bucket to measure formaldehyde vapor exposure.

The sampling pumps were operated at 1.0 liter per minute for 31 minutes. Samples were then sent to NIOSH laboratories for formaldehyde analysis. Bulk samples of embalming and formalin solutions were also collected to determine percent formaldehyde. Analysis was performed according to the NIOSH Manual of Analytical Methods PCAM 125.

V. EVALUATION CRITERIA

The principal hazards which have been associated with human exposure to airborne formaldehyde are irritation of respiratory tract, eyes, and skin (1). The odor of formaldehyde is perceptible at or below 1 ppm and may be disturbing to individuals unaccustomed to it. Inhalation of high levels of formaldehyde (>10 ppm) has caused pulmonary edema, pneumonitis, and death. The NIOSH recommended standard for formaldehyde exposure is 1 ppm for a 15-minute ceiling, the ACGIH TLV (Threshold Limit Value) is 2 ppm for an 8-hour workday, and the OSHA standard is 3 ppm for an 8-hour workday, with a 10 ppm maximum ceiling.

VI. RESULTS & DISCUSSION

A. Environmental

The level of formaldehyde in each sample was less than the quantitation limit. The charcoal tube samples are reported containing less than 4 micrograms of formaldehyde per sample, a level which is less than the 1 ppm NIOSH recommended standard for formaldehyde.

Bulk sample No. 1 could not be analyzed for formaldehyde by ion chromatography due to the interfering substances present in the sample. Portions of the sample were then reacted with chromotropic acid as in PCAM 125. This colorimetric method could not be used since a different shade of color was formed (alcohol, phenol, and other aromatic hydrocarbons interfere with this method). Then, a titration method was attempted without any success. The pH of the solution was too low for titrating formaldehyde with standardized sulfuric acid.

Bulk sample No. 2 was analyzed for formaldehyde content by titrating with standard 0.1005 N sulfuric acid. From duplicating analyses, the formaldehyde concentration was determined to be 24.1 mg per ml. This is equivalent to 2.4 percent formalin solution.

B. Medical

Analysis of the questionnaires clearly delineated atopic histories for all five individuals. Two of these employees described a prodromal symptom complex consisting of GI discomfort/diarrhea; edema of the hands, feet, perineum, or face; and the appearance of "hives". Three of the five patients felt that trauma or pressure was the causative factor for their edematous extremities (feet). One individual's family history was strongly suggestive of hereditary angioneurotic edema.

Review of medical records indicated that one patient had recently been tested for hereditary angioneurotic edema. The results indicated that the patient's complement system showed no reduction in C1 esterase inhibitor level. This negative finding indicated that angioneurotic edema was non-hereditary in this patient. It was further noted that this patient had suffered recurrent episodes of upper airway edema and some chronic disability due to sensitivity to environmental allergens. The initial symptoms of angioneurotic edema seem to have started in January 1979, after the patient had an allergic reaction to allergy desensitization shots. Apparently a fresh allergen dose injected into the patient caused the first adverse allergic reaction. The desensitization shot program was discontinued soon after but the allergic reactions continued. Various medications have been administered (i.e., epinephrine, Benadryl*, etc.), to decrease the recurrence and severity of the allergic condition In the summer of 1979, this patient was hospitalized and was given a tracheotomy to control laryngospasm and laryngostridor and to decrease dependence on medication. The individual's condition had stabilized since this operation.

*Mention of commerical name or products does not constitute endorsement by NIOSH

Other records underscored the history of atopy in each person. Scratch, patch, and prick tests on these people revealed a wide spectrum of confirmed allergens (i.e., animal dander, dust pollen, wood, formaldehyde, food, etc.).

After completing questionnaires with the five affected employees, reviewing their medical records, and consulting with the specialists involved with these cases, the following determinations were made:

1) The employee affected by life-threatening upper airway edema, in addition to other hypersensitivity symptoms, may best be characterized as having a non-hereditary allergic angioneuortic edema. The exposure to the varied laboratory substances at Tufts Medical School may well have triggered one of the attacks.

2) The employee with both the familial and personal history of angioedema may have hereditary angioedema. Measurement of CI esterase inhibitor may well confirm this diagnosis to be true. This illness is not occupationally derived, but may be triggered by workplace exposures such as formaldehyde.

3) The other three affected employees gave past histories of edema involving their extremities (hands & feet). Transient rash and GI discomfort were also noted. None of these individuals had any allergic involvement of the head or neck. Their symptoms are not suggestive of angioedema. Their exposure to confirmed allergens in the laboratory may have triggered certain of their attacks, and such exposures should be minimized.

VII. CONCLUSIONS & RECOMMENDATIONS

- While none of these cases can be said to have clearly originated in the occupational environment, it must be noted that either a known or latent hypersensitized individual may have allergic manifestations triggered by exposure to workplace substances. It is therefore recommended that the one employee who is hypersensitized to environmental allergens minimize any exposure to chemicals such as formaldehyde that might bring about an allergic attack.

- Allergy histories of all present and future employees should be obtained so that administrative control can be exercised if employees are sensitized to workplace chemicals.

- As prudent health measure, annual employee physical exams should be given to personnel who are on the Tufts Medical School payroll.

- All pathology laboratory employees (medical and environmental students included) should be educated about the health effects and proper work practices in handling animal specimens and toxic chemicals.

- Enforcement of proper work practices and the wearing of protective clothing should be performed by pathology supervisory personnel.

- An effective method for incorporating recommendations made by the Tufts Medical School Safety and Health Committee should be established by the University Administration.

- The filter banks and duct work in the gross anatomy laboratory are very dirty and need to be thoroughly cleaned (by vacuuming). Filter banks and duct work in this area should be maintained on a regular basis.

VIII. REFERENCES

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X. DISTRIBUTION & AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. Tufts Medical School
2. NIOSH - Region I
3. U.S. Department of Labor, OSHA, Region I.

For the purpose of informing the "affected employees," the employer shall promptly "post" the determination report for a period of 30 days in a prominent place near where exposed employees work.