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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 72-118-104

MARSH PLATING CORPORATION
YPSILANTI, MICHIGAN
DECEMBER, 1973

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I. TOXICITY DETERMINATION

It has been determined that exposure to chromic acid, as found within the Nickel-Chrome Plating Department of this facility is toxic. This exposure has resulted in employee complaints of chronic rhinorrhea ("runny" nose), sneezing, nasal "sores," blood in the nasal mucous after blowing the nose, frequent nosebleeds and skin eruptions. Furthermore, 35 of 37 (95%) exposed workers who received medical examinations were shown to have significant nasal pathology while a lesser number of employees had developed characteristic chrome-induced skin lesions even though airborne concentrations of chromic acid as measured during this evaluation were well below existing standards. Those workers employed in areas of the plant where chromic acid exposure was negligible were determined to be free of cutaneous and nasal pathology suggestive of such exposure.

The mechanisms by which the observed nasal pathology may have developed are (1) long term exposure to low levels of hexavalent chromium in the work room atmosphere, (2) direct contact of affected nasal tissues with hexavalent chromium (such etiology was demonstrated here to be related to poor work practices and inadequate personal hygiene), or (3) a combination of both above mentioned mechanisms. It is believed that the nasal damage observed at this establishment has resulted from the combination mechanism.

In order to ameliorate the existing hazard, recommendations have been offered to the plant management regarding both the environmental and medical aspects of safe usage for chromic acid. It has been pointed out that major emphasis should be given to the development of an adequate health and safety program to address the need for good work practices (eg. proper use of protective gear, the advisability of refraining from eating, drinking and smoking in work areas, keeping personal items such as outer garments and handbags outside of work areas, etc.), heightened employee awareness of existing and potential hazards, and educating employees regarding the need for good personal hygiene care.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Marsh Plating Corporation, Ypsilanti, Michigan
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V
d) NIOSH - Region V

For the purposes of informing the 50-60 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

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 affects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer and an authorized representative of employees regarding exposure to chromic acid and to other potentially toxic substances used in the electroplating plating processes of the Marsh Plating Corporation, Ypsilanti, Michigan. The request was initiated after a number of employees filed Workmen's Compensation claims for medical ailments that were alleged to result from an occupational exposure to chromic acid.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

This establishment is engaged in the electroplating of small parts for the automotive industry (eg. seat belt buckles, fasteners, etc.). The plant is divided into two work areas, situated on two different levels, separated by a permanent wall. The upper level, a low bay, contains two automated nickel rack plating lines. The lower level, a high bay, contains one automated zinc rack plating line, two automated zinc barrel plating lines, one manually operated phosphate barrel line and one sporadically used copper-cadmium barrel line. General area ventilation on the lower level is provided by a large air make-up unit, however, at the time of the survey there was no provision for make-up ventilation on the upper level (i.e. the Nickel Plating Department). All plating lines are supplied with local slot exhaust ventilation for tanks which contain potentially hazardous agents (eg. caustics, chromates, phosphates, etc.).

The automated lines are designed in a U-shaped configuration. Employees are situated at the open end of each U-shaped line where the raw (i.e. unplated) parts are placed on racks or into barrels. There are six to ten workers assigned to each of the three rack plating operations and one worker for each of the two barrel plating processes. The automated lines commence and terminate at employee work stations.

The manually operated lines consist of a series of rectangular tanks arranged in two parallel rows. One employee, assigned to each of these two lines, moves the raw parts contained in large barrels through the process. The worker is situated between the rows of tanks where the barrels are manipulated with the aid of an overhead hoist.

The basic plating process involves a standard series of cleaning, pickling, and rinsing treatments to prepare the surface of parts for the electrolytic deposition of a particular metal. The plated parts are treated with another series of wet rinsing and air drying operations prior to inspection and final packing. Procedures regarding the utilization of chromatas in the basic process vary considerably in accordance with the type of metal plating. The zinc and copper-cadmium plating operations on the lower level of the plant employ a dilute clear chrome, black chromate and/or dichromate dip in concentrations of one to two ounces per gallon of solution at or near ambient temperatures. By contrast, the nickel plating lines on the upper level utilize technical grade chromium trioxide as chromic acid in concentrations of 40 to 42 ounces per gallon of solution at temperatures of 118 to 120 degrees fahrenheit.

All employees are required to wear eye protection but safety glasses as supplied by management are generally not used. Gloves are also furnished to employees, however, many of the workers elect not to utilize any type of hand protection. Employees wearing gloves do not remove or store gloves properly. Personal clothing is worn on the job and this clothing is apparently not changed prior to departure from the plant. Other personal items, such as outer garments (i.e. coats, sweaters) and purses are indiscriminately hung or placed near work stations. Eating, drinking and smoking are common practices in all work areas.

B. Evaluation Design

Following a preliminary observational survey which facilitated recognition of the most probable health hazard (May 1, 1973), it was necessary to return to the plant to conduct more in-depth analyses of employee exposure to chromic acid. Procedures used to assess the validity of the alleged hazard, included on-site interviews with the management, a walk-through inspection of the work place, administration of medical questionnaires to all workers potentially exposed to chromic acid in the Nickel Plating Department, as well as a selected group of workers from other departments, medical examination of the skin and nasal structures of all workers completing the questionnaire, and extensive environmental air sampling to detect potentially toxic contaminants in the workroom atmosphere. Furthermore, a chemical "spot test" was used to test for the presence of hexavalent chromium on a variety of workroom surfaces.

C. Evaluation Methods

All of the 37 employees in the Nickel Plating Department agreed to participate in this study. In addition, 15 workers in other areas of the plant were selected to serve as a control population (i.e. a group of workers not exposed to significant quantities of hexavalent chromium). Both groups of workers were treated in a similar manner.

On the days of the study, each worker was individually administered a questionnaire by a NIOSH Medical Officer. Sex, age, race, length of employment at the plant and a complete occupational history were recorded. A brief past medical history was confined to the ears, nose, throat and cutaneous structures, as well as any adverse reaction to chemical substances in general that may have occurred prior to the study. Regarding symptomatology, each worker was requested to indicate the presence or absence of several specific symptoms, including burning or redness of the eyes, burning of the nose, throat, or chest, rhinorrhea, sneezing, nosebleeds, blood in the nasal mucous, nasal sores, and skin eruptions. A positive response for any symptom was followed by a question regarding the number of times the symptom had occurred since the worker was employed. Additionally, the worker was asked to estimate the length of time employed, prior to first observing a particular symptom. These latter responses were categorized as follows: 1 = 1 day; 2 = 1 week; 3 = 1 month; 4 = 6 months; 5 = 1 year or longer before first noting the symptom. In the case of skin eruptions, the worker was asked to identify the location of the lesion(s).

Each worker received a physical examination of the skin and nasal structures by medical specialists in dermatology and otolaryngology, respectively. All medical observations made in the field were recorded in terms of standard descriptive morphology. At a later date, these records were reviewed by one of us (S.R.C.) who had not performed physical examinations in the field. In this way, it became apparent that a precise spectrum of nasal pathology had been recorded by the otolaryngologist. A numerical grading system was designed on the basis of descriptive morphology and, a statistical analysis of employment data to establish a temporally related sequence of events. The Fisher's Exact Test[1] was used to test for the equality of proportions of subjects (workers) with absent or minor nasal mucosal pathology compared to those subjects with more severe nasal pathology in groups with shorter ($\leq$ 1 year) and longer ($>$ 1 year) periods of exposure to chromic acid.

During this same period of time, environmental air samples were collected from the breathing zones of several workers in exposed and control areas. All samples were collected using a vacuum pump which was operated at a flow rate of 1.7 to 2 liters of air per minute. Samples for zinc, nickel, total chrome and phosphate were collected on 0.45 micron membrane filter paper. Cyanide and nitrate were collected with a midget impinger containing ten milliliters of 0.1 normal sodium hydroxide. Chloride was collected with a midget impinger containing ten milliliters of 0.5 molar sodium acetate and samples for hexavalent chromium were collected on 5.0 microns polyvinylchloride (PVC) filters. A minimum volume of 100 liters of air was collected for each sample.

In the laboratory, the membrane filters were wet ashed with distilled nitric acid and hydrolyzed with one normal hydrochloric acid prior to analysis. Zinc, nickel, and total chromium concentrations were determined by atomic absorption methodologies.[2] The phosphate content of filter samples was determined by the use of colorimetric analysis.[3] Samples for chloride, cyanide and nitrate were analyzed by specific ion electrodes.[4] The method of Abell and Carlson[5] was used to determine the concentration of hexavalent chromium.

A chemical "spot test" was used to detect the presence of hexavalent chromium on various surfaces within the plant. This test was adapted from the method of Feigl.[6] Prior to the field study, our laboratory prepared a one per cent alcoholic solution of diphenylcarbazide(DPC) using ethyl alcohol and s-DPC (Eastman Kodak). The solution was stored in a semi-opaque, dark brown bottle to prevent photodecomposition. The test was performed by immersing an ordinary cotton tipped applicator in a stock solution of one normal sulfuric acid and rubbing the cotton tip vigorously on the surface to be tested. One or two drops of the one per cent alcoholic solution of DPC was then placed on the cotton tip and in the presence of hexavalent chrome a more of less intense blue violet to red color was formed. The applicators were discarded after each test. Work tables, racks, parts, gloves, and worker's fingers were tested for the presence of hexavalent chrome in both known areas of exposure and areas considered to be without chromic acid (eg. eating areas, rest rooms, etc.).

D. Evaluation Criteria

The Occupational Health Standards promulgated by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Table G-1, G-2) applicable to the individual substance of this evaluation is as follows:

Substance	8-Hour Time Weighted Average	Acceptable Ceiling Concentration
Chromic Acid & Chromates	....	0.1 mg/m^3*
Nickel, metal & soluble compounds as Ni	1.0 mg/M^3	-
Phosphoric Acid	1.0 mg/m^3	-
Cyanide	5.0 mg/m^3	-
Nitric Acid	5.0 mg/m^3	-
Hydrogen Chloride	-	7.0 mg/m^3

*Approximate milligrams of substance per cubic meter of air.

Occupational Health Standards for individual substances are established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a normal working lifetime. Where the standard is recorded as a ceiling concentration, the level of that substance in the work room atmosphere shall at no time exceed that value.

Additionally, the National Institute for Occupational Safety and Health (NIOSH) has published the "Criteria For A Recommended Standard....Occupational Exposure to Chromic Acid." The limit recommended in this document is lower for chromic acid than the Federal Ceiling Concentration. It is listed for the reason that the more restrictive limit may eventually be adopted as the Federal Standard.

Substance	8-Hour Time Weighted Average	Acceptable Ceiling Concentration
Chromic Acid	0.05 mg/m^3*	0.1 mg/m^3

*Approximate milligrams measured as chromium trioxide per cubic meter of air.

Biological criteria for toxicity to chromic acid was based on nasal and dermatologic examinations (See results).

E. Evaluation Results and Discussion

1. Medical Questionnaires

The demographic data concerning the electroplate workers in this study is shown in Table I. Although exposed and control groups are not well matched for sex distribution, there is no known difference between the male and female biological response to chromic acid. Other variables such as age, race and length of employment are not significantly different for the two study groups.

With the exception of skin eruptions, the incidence of each of the other index symptoms (i.e. consistent with chromic acid exposure) is higher for the workers in the nickel-chrome plating area than for those workers in other areas of the plant (see Table II). It is of interest that no worker in the control population complained of nasal sores. These sores were defined as discrete areas of nasal irritation which burned intensely when the affected nostril was manually collapsed. Moreover, the temporal appearance of symptoms was described quite differently by exposed and control groups. In fact, the mean length of time before noting the appearance of any given symptom was reportedly less in the control group than in the exposed group. It should be mentioned that the control population, for the most part, was exposed to harsh acidic fumes emanating from a "pickling" operation in proximity to their work stations and workers in the nickel-chrome area were not so exposed. This would explain the general similarity of symptoms reported by each group, as well as the reason for the earlier onset of symptoms in the control group.

2. Medical Examinations

The criteria used to grade the appearance of the nasal mucosa are described in Table III. 35 of the 37(95%) workers in the exposed group had pathologic changes in the mucosa. None of these workers reported any previous job experience that involved exposure to chromium compounds. Table IV shows the distribution of the various types of nasal lesions among the workers in the exposed group. All but one worker in the control group had normally appearing nasal mucosae. The employee in the control group with a nasal lesion had a well circumscribed, one centimeter perforation of the cartilaginous septum. However, in contradistinction to the hyperemic, actively weeping, crusted appearance of the lesions seen in the exposed workers (i.e. with perforated septums), this control subject had a perforation surrounded by completely normal mucosa. The control subject had only been employed three months, whereas the exposed subjects with perforations had been employed between four and eleven years. On further questioning, the worker in the control group denied any previous history of nasal trauma or nasal surgery but described working more than three years in a garment manufacturing operation where she was engaged in the dying of fabrics. Since chromium compounds have wide industrial applications as dye mordants, the occupational history offered by this one control subject with a nasal perforation suggested a previous exposure to chromates which may account for the lesion. In the absence of nasal deformity, there was no reason to suspect a lepromatous or syphilitic origin for the perforation.

Table V shows that 9(43%) of the workers employed one year or less in the nickel-chrome plating area had either no nasal lesions or very minor pathologic changes. Only 1(6%) of the workers employed for more than one year had no or minor nasal pathology. On the other hand, 15(94%) workers employed longer than a year had more severe nasal lesions compared to 12(57%) workers with similar pathology who worked one year or less. The association between length of employment and the development of increasingly severe nasal patholog is significantly positive at the p = .01 level. Or, stated another way, workers employed one year or less at this facility have significantly less nasal pathology than workers employed for longer periods of time. In general, this temporal pattern or trend would seem to support the contention that each grade of pathology represents part of a continuum that starts with a shallow erosion of the mucosa and ultimately goes on to a perforation. The data is not complete enough to indicate whether grade 2 precedes grade 3 or visa versa but other observers have suggested that the ulceration caused by chromic acid will become an atrophic scar if the worker is removed from the industrial environment.[8,9]

Five workers in the nickel-chrome plating area had characteristic "chrome bites" or "chrome holes" on the hands. These eruptions appeared as single or multiple, centrally ulcerated papules that had penetrated into the underlying soft tissues. The base of the ulceration was often covered with an exudate or an adherent crust. None of the workers in the control group had skin eruptions suggestive of the type of chrome-induced lesions seen in the exposed group. Many of the workers in the control group demonstrated eczematous eruptions that appeared to be irritant in nature but could also be accounted for by an allergic contact dermatitis. The parts used in the control areas of the plant retained a heavy coating of cutting oil in which they had been shipped from the manufacturer. More than likely, the cutting oil was responsible for the skin eruptions observed in the control group, particularly in the case of abdominal lesions which resulted from the seepage of cutting oil into the workers' outer garments. Conversely, simple irritant-type lesions were rarely observed among the workers exposed to chromic acid. This may explain why employees in the exposed group reported that dermatologic symptoms appeared between six months and a year after starting work, whereas employees in the control group developed problems within the first month on the job.

3. Environmental Survey

Regarding environmental air sampling, 101 samples were collected from the nickel-chrome plating area and control areas of the plant. The laboratory performed 147 analyses for potential environmental contaminants. The results for total chrome, nickel, zinc, cyanide, nitrate, chloride and hexavalent chrome concentrations are reported in Table VI. While the air concentrations of total chrome and hexavalent chrome were significantly higher in the exposed areas of the plant, without exception, all potential contaminants in the plant were several orders of magnitude below the allowable Federal Standards, as well as the more restrictive proposed NIOSH Standards for "safe" exposure to these compounds.

The diphenylcarbazide (DPC) spot test was carried out in all areas of the plant. In the nickel-chrome plating area all of the racks on which the parts were hung prior to plating were positive for hexavalent chrome. 9 of 12 (75%) "protective" rubber gloves worn by workers tested positively and all but one of those gloves was positive for hexavalent chrome on the inside of the digits as well. Since many of the exposed workers did not wear any glove protection, the skin on the finger tips of these workers was tested. 9 of 13 (69%) workers' finger tips were positive. In certain control areas (i.e. zinc and copper-cadmium plating) the racks were weakly positive following the plating operation. As previously mentioned, a very dilute solution of clear chrome (a brightener) was used in these areas which would explain the presence of hexavalent chrome in minute quantities. The gloves worn by workers on the zinc lines were all negative for hexavalent chrome inside and four of five tested were negative on the outside of the digits also. No worker in the control group had a positive response on the finger tips even in the absence of glove usage.

Other areas of the plant were tested for the presence of hexavalent chrome and it was found that the surface of tables in the eating areas were all positive. The handles on the vending machines in the eating areas were also positive. In the restrooms, the counter surfaces and faucet handles on the sinks were weakly positive. The cloth towels used in the restroom dispensers were positive in every instance where they had been recently moistened.

4. Discussion

There are only five studies in the scientific literature in which an attempt has been made to correlate environmental levels of chromic acid with the observed toxic response in (human) nasal structures (see Table VII).[10-14] These studies were conducted in electroplating facilities and each investigation demonstrated adverse effects after relatively short periods of exposure (i.e. length of employment). Nasal irritation was consistently observed at environmental air levels as low as 0.1 milligrams per cubic meter of air (mg/m^3), however, concentrations associated with nasal pathology were more frequently recorded at ten to fifty times above this level. In Bloomfield's study, nasal perforation developed in three workers with periods of exposure ranging from 6.5 to 20 months. Kleinfield found four workers with nasal perforation whose respective periods of exposure ranged from 2 to 12 months. In all of these investigations, poor environmental control of chromic acid mist was considered to be the most important contributory factor in the development of nasal lesions.

In contrast to the older literature, the study being reported herein showed a very high incidence of nasal pathology which developed over a protracted period of time at extremely low environmental levels of exposure to chromic acid. While minor nasal lesions were detected after relatively short periods of exposure, nasal perforations (as observed in our four cases) were not detected in workers with less than forty-eight months of exposure. There are a number of possible explanations for these unusual findings: (1) Another agent in the plant atmosphere might be responsible for the nasal pathology. (2) The existing Federal Standard for a safe exposure to chromic acid might be set at too high a level to prevent the development of nasal damage over a prolonged period of time. (3) Hexavalent chrome per se, which has not been previously measured alone as an environmental contaminant, may cause adverse effects at the environmental concentrations detected in this study. (4) Other factors, such as poor work habits and inadequate personal hygiene may be playing a greater role in the development of nasal lesions than has been suggested in the older literature.

Concerning the first possibility, all other potential atmospheric contaminants were sampled during the study and no other agent was detected in concentrations of a significant nature. Other than chromic acid, the only agent found in the nickel-chrome plating area which might conceivably be responsible for the development of nasal lesions was nitric acid. Not only was this agent found in negligible concentrations in the atmosphere, but there was no respiratory disability associated with the nasal lesions in these electroplate workers which would be expected in the case of a significant exposure to this acid. Additionally, the control population in this study was also exposed to nitric acid and therewere no demonstrable nasal effects in this group. Therefore, it is unlikely that another agent was responsible for the observed nasal pathology in the exposed group of employees.

The current standard for what is considered to be a "safe" exposure to chromic acid has been reviewed quite recently.[15] It has been recommended that the present Federal Standard, a ceiling level of 0.1 mg/m^3, should be lowered to 0.05 mg/m^3 (calculated as an 8-hour time-weighted average concentration). No consideration has been given to the possibility that signs and symptoms of nasal damage may occur at the low environmental levels detected in this study (mean total chrome concentration 0.0071 mg/m^3). The demonstration of a statistically positive association between the workers' length of exposure and the development of increasingly severe nasal pathology suggests that very low concentrations of chromic acid in the atmosphere may, in fact, play a role over long periods of time.

Furthermore, although Samitz[16] has demonstrated that chromium is a serious health hazard only when it is encountered in the hexavalent state, there has been no research available to date on which to base a standard for safe exposure to hexavalent chrome. It should be pointed out that a general air sample for chromic acid may contain both the hexavalent and trivalent species of chromium and the precise ratio of these species can not be appreciated without special analytical techniques as employed in our study. It is entirely possible that levels of hexavalant chrome between .000019 and .0091 mg/m^3, as measured during this investigation, may produce nasal damage, whereas chromic acid analyzed as total chrome may be innocuous at much greater concentrations (i.e. given that a high proportion of the chromium is in the trivalent state).

Finally, work practices at this facility were reviewed in great detail by the authors. One of us (S.R.C.), after observing employees through more than sixteen hours of normal operations, was able to make the following observations: (a) The majority of workers in this plant did not wear any type of personal protective gear, even where this gear was readily available (eg. safety glasses and gloves). (b) Employees were noted to wear clothing that had often been soiled by the moisture from the plating racks. (c) Employees were observed to frequently wipe their faces and pick their noses with unwashed hands and while wearing wet gloves. (d) Employees wearing gloves were not trained to remove the gloves in accordance with good industrial hygiene practice. (e) Contaminated gloves were carried into eating areas and placed on tables and chairs. (f) Smoking cigarettes, eating food and drinking beverages in the work areas was the rule rather than the exception. These activities were observed to bring the wet gloves or hands of the worker in close proximity with the nose. (g) Workers were rarely noted to wash their hands before eating or leaving the plant. (h) Most of the employees hung their sweaters, handbags and other articles of clothing on the work tables where these items were invariable soiled with contaminated fluids from the plating racks.

There was a profound lack of emphasis by both management and labor on the principles of good industrial hygiene practice and personal hygiene needs. These circumstances may be of greater importance in determining the etiologic factors contributing to the development of nasal lesions than the ambient levels of chromic acid. The transfer of chromic acid from the work surfaces to nasal tissues appeared to be a significant consideration following our observation of the workers. The credibility of this "transfer" or "direct contact" etiology was born out by the results of subsequent DPC "spot testing" for chromic acid on various workroom surfaces. Hexavalent chrome was detected on racks, parts, work tables, gloves (inside and outside) and the finger tips of a majority of workers in the nickel-chrome plating area. The true extent of poor work practices was underscored by the finding of hexavalent chrome, not only on work area surfaces, but also in eating areas and restrooms as well.

While occasional mention of the need for good industrial hygiene practices (other than adequate ventilation) and good personal hygiene care is found in the literature, direct contact of the nasal tissues with chromic acid has not been formally considered as an etiologic mechanism in the development of nasal pathology. A "direct contact" etiology may help to explain why the length of exposure prior to the development of nasal lesions has ranged so widely in the older literature and in the current investigation. Thus, a worker with a good individual work practices and personal hygiene care may be free of pathology while working in the same plant atmosphere as a fellow employee who has a nasal perforation. The latter employee would be expected to have less than acceptable work habits and personal hygiene care.

The "direct contact" etiology of nasal damage in chromic acid exposed workers was not considered in previous studies, possibly because environmental exposures were relatively high. However, follow-up evaluations are lacking in all of the older studies and if anything, even where environmental controls have significantly reduced ambient levels of chromic acid, nasal pathology has still been observed at these lower concentrations.[11] By defining a spectrum of nasal pathology in our study, the early detection of chrome-induced lesions should be facilitated prior to the development of septal perforation. To establish an ongoing continuity of health care for workers potentially exposed to chromic acid, the importance of an occupational health program cannot be overemphasized. A complete description of the usefulness of an occupational health program has been reviewed elsewhere by Cohen.[17] The work of Samitz and his co-workers indicates that improved industrial hygiene practices and the utilization of chrome reducing solutions and ointments can help to successfully lower the incidence of cutaneous and nasal pathology in chromate exposed workers.[18,19]

In summary, chromic acid mist and solution, as found and used in the Nickel Plating Department of this establishment is considered toxic. As a result of this exposure, 35 of 37(95%) electroplate workers in this area have developed significant nasal pathology while a lesser number of employees have sustained skin lesions. Workers in other areas of the plant were evaluated and determined to be free of the signs of chromic acid exposure. The mechanisms by which the observed nasal pathology may have developed are (1) long term exposure to low levels of hexavalent chromium in the work room atmosphere, (2) direct contact of affected nasal tissues with hexavalent chromium (such etiology was demonstrated here to be related to poor work practices and inadequate personal hygiene), or (3) a combination of both above mentioned mechanisms. It is believed that the nasal damage observed at this establishment has resulted from the combination mechanism. Additional studies are needed to address this subject in more detail.

In order to ameliorate the existing[19] hazard, the recommendations offered in the NIOSH "Criteria Document"[15] regarding both the environmental and medical standard of safe usage for chromic acid....should be undertaken by the plant management. Particular emphasis should be given to the development of an adequate health and safety program to address the need for good work practices (eg. proper use of protective gear, the advisability of refraining from eating, drinking and smoking in work areas, keeping personal items such as outer garments and handbags outside of work areas, etc.), heightened employee awareness of existing and potential hazards, and educating employees regarding the need for good personal hygiene care. Furthermore, a preventive and protective regimen using a 10% ascorbic acid solution and/or ointment (i.e. for cutaneous and nasal structures), as proven effective in the printing and lithography industries,[20] is strongly advised.

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VII. TABLES

TABLE I

DEMOGRAPHIC DATA CONCERNING 52 ELECTROPLATE WORKERS

WITH AND WITHOUT EXPOSURE TO CHROMIC ACID

	Exposed(N=37)	Non-Exposed(N=15)
Sex Distribution		
male	7	9
female	30	6
Mean Age (years)	29.1 (range 18-57)	31.1 (range 18-63)
Race Distribution		
caucasian	36	15
black	1	0
Mean Length of Employment (months)	26.9 (range 0.3-132)	26.1 (range 0.1-96)

TABLE II

SYMPTOMS REPORTED FROM 52 ELECTROPLATE WORKERS

WITH AND WITHOUT EXPOSURE TO CHROMIC ACID

Symptom	Total #Workers Reporting Symptom(%)		Approx. Length of Employment Before Noticing Symptom *	
	Exposed(N=37)	Non-Exposed(N=15)	Exposed	Non-Exposed
Sneezing	28(77)	3(20)	2.5	1.7
Rhinorrhea	31(84)	5(33)	3.1	2.6
Blood in Nasal Mucous	16(43)	2(13)	3.2	2.0
Nosebleed	11(30)	2(13)	3.5	3.0
Nasal Sores	23(62)	0(0)	3.9	-
Skin Eruption	14(38)	6(40)	4.5	2.1

* Numbers represent the mean estimation of time reported by all workers (i.e. prior to first noticing symptom) according to the following classifications: 1 = one day; 2 = one week; 3 = one month; 4 = six months; and 5 = one year or longer. See text.

TABLE III

CRITERIA FOR GRADING APPEARANCE OF NASAL MUCOSA

Grade	Morphologic Appearance
0	Normal nasal mucosa
1	Shallow erosion of septal mucosa with or without crusting*
2	Ulceration and crusting of septal mucosa with or without scarring**
3	Avascular, scarified areas or septal mucosa without erosion or ulceration
4	Perforation of septal mucosa

Crusting is defined as the presence of brownish exudate overlying a lesion on septal mucosa.

* Scarring is defined as the presence of avascular (i.e. punctate, glistening white) areas on septal mucosa.

TABLE IV

MORPHOLOGIC APPEARANCE OF NASAL MUCOSA IN 52 ELECTROPLATE WORKERS WITH AND WITHOUT EXPOSURE TO CHROMIC ACID

Grade	# Workers(%)	
	Exposed(N=37)	Non-Exposed(N=15)
0	2(5)	14(93)
1	8(22)	-
2	12(32)	-
3	11(30)	-
4	4(11)	1(7)*

* Worker reported an occupational history suggestive of previous exposure to chromates. See text.

TABLE V

CONTINGENCY TABLE SHOWING NUMBERS OF EMPLOYEES WITH MINOR AND MORE SEVERE NASAL MUCOSAL PATHOLOGY

FOR TWO GROUPS OF ELECTROPLATE WORKERS EXPOSED TO CHROMIC ACID

	No/Minor Pathology (Grade 0-1)	More Severe Pathology (Grade 2-3-4)	Total
Workers Employed 1 Year or Less	9(43%)*	12(57%)	21
Workers Employed More Than 1 Year	1(6%)	15(94%)	16
Total	10	27	37

* Percentage of row total.

TABLE VII

A REVIEW OF ALL STUDIES WHERE AN ATTEMPT HAS BEEN MADE TO CORRELATE CHROMIC ACID EXPOSURE AND TOXIC EFFECTS

Study	# Subjects	# Cases With Nasal Pathology(%)	Mean Length Of Employment(months)	Range of Atmospheric Concentrations(mg/m^3)*
Bloomfield and Bloom[10]	19	11(58)	6.5 (range 0.25-36)	0.12 - 5.6
Zvaifler and Gresh[11]	>100	-	-	0.42 - 1.2**
Vigliani and Zurlo[12]	150	-	-	0.11 - 0.15**
Kleinfield and Russo[13]	9	7(78)	6.1 (range 0.5-12)	0.18 - 1.4
Gomes[14]	258	161(62)	-	<0.1 - >1.0**
Cohen, Davis, Kramkowski	37	35(95)	26.9 (range 0.3-132)	0.0014 - 0.0493

* Reported as milligrams per cubic meter(air) of total chrome.

** Medical and environmental aspects of survey not performed simultaneously.

TABLE VI

RESULTS OF ENVIRONMENTAL SAMPLING FOR ATMOSPHERIC CONTAMINANTS

Chemical Substance	Nickel-Chrome Plating Area		Control Plating Areas	
	# Samples	Mean Atmospheric Concentration(mg/m^3)	# Samples	Mean Atmospheric Concentration(mg/m^3)
Total Chrome	36	0.0071 (range ND* -0.0493)	12	0.0001 (range ND -0.0007)
Hexavalent Chrome	25	0.0029 (range ND -0.0091)	3	0.0003 (range 0.0001-0.0004)
Nickel	14	0.0271 (range 0.0089-0.0712)	0	-
Zinc	0	-	9	0.0016 (range 0.0003-0.0042)
Phosphate	0	-	9	0.0046 (range ND -0.0227)
Cyanide	7	ND	7	0.0057 (range ND -0.0898)
Nitrate	7	0.0888 (range 0.0313-0.1660)	7	0.0529 (range 0.0206-0.0917)
Chloride	6	0.1607 (range 0.0339-0.3880)	5	0.0521 (range 0.0118-0.1257)

* ND - not detectable