Medical Surveillance of Vinyl Chloride Workers

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Presented at the public hearing on vinyl chloride, Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C., June 25, 1974

My name is Dr. Ralph Cook. I am a physician in the Midland Division* of Dow Chemical U.S.A. I obtained my medical degree from Wayne State University. I received residency training in Occupational Medicine and a master's degree in public health from the University of Michigan. I have completed requirements for certification in occupational medicine and have taken my board examination. While in the military, I worked in the toxicology laboratory of the Army Environmental Hygiene Agency, Edgewood Arsenal, Maryland. At the present time I am involved in a study for the Division of Medical Sciences, National Research Council, under contract to the Environmental Protection Agency. I came to Dow two years ago and am currently in charge of the division's Health Inventory Program.

Today, I would like to report an analysis of selected health surveillance data on 335 chemical workers who had industrial exposures to vinyl chloride. The details of their exposures have already been reviewed by Mr. Daniel.**.

In the clinical parameters considered in our study, there was nothing of statistical significance below vinyl chloride levels of 200 ppm. Above this level only diastolic blood pressure showed a statistically significant deviation.

We have provided periodic employee health examinations to a varying degree for over 20 years. I refer you to the *American Industrial Hygiene Association Journal* (33, 19 (1972)) in which C. G. Kramer and J. E. Mutchler of The Dow Chemical Company correlated clinical and environmental measurements for workers exposed to vinyl chloride prior to 1967. Their findings "suggest that repeated exposure to vinyl chloride at TWA levels of 300 ppm or above for a working lifetime together with very low levels of vinylidene chloride may result in slight changes in certain physiological and clinical laboratory parameters. The possibility of some impairments in liver function tests must be considered, even though no overt clinical disease was evident in any of the individuals studied."

Since 1967 we have utilized multiphasic health-screening techniques to evaluate our employees' health status. We call this our Health Inventory Program. The employee is evaluated in our Health Screening Center, which, during the year, is moved to various locations around the plant. This program has evolved somewhat since its inception to the

* Since this paper was presented, the Midland Division has been renamed the Michigan Division.

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int where it now includes a history and the easurement of over 40 separate anthropomorphi- l and biochemical variables. It is an extraction of ta from this program that I wish to discuss today. A synopsis of the parameters that are evaluated our current program is covered by Table 1. lich is in the record.

The medical history includes, among other ngs, information on hospitalizations, numbness the hands, respiratory difficulties, liver probns, alcohol ingestion, anemia, and current mediions. We do a detailed smoking history. We quire into the number of stillborns, miscarriages, d birth defects.

Our evaluation includes chest x-ray, electrocarogram, pulmonary functions, hematology, urilysis, and a variety of blood chemistries, includ- lactic dehydrogenase (LDH), serum glutamic alacetic transaminase (SGOT), total bilirubin, aline phosphatase, BUN, uric acid, creatinine, cium, total protein, albumin, and cholesterol.

The results are compiled and reviewed by a ysician. Based upon the physician's evaluation, lowup studies are instituted.

We recommend that each employee request that forward the results of his periodic health inveny evaluation to his personal physician. We stress sponsible followup and continuity of medical e.

In this study, the population of interest was fined to be production employees at one manacturing location who worked for at least one year tween 1942 and January 1972 in areas with potenl vinyl chloride exposure. It was further defined include only those individuals who were employs of the Midland Division between February 1967 d March 1974, the inclusive period of the Health ventory Program.

Based upon a review of industrial hygiene data, ch individual was assigned to one of four exsure groups: high, intermediate, low and unfined. The categories were based on estimated ne-weighted average concentrations for an eightur day (TWA). The high level was defined as posures above 200 ppm for at least one month's ration; the intermediate level was 25 to 200 ppm; d the low level as less than 25 ppm. For 81 dividuals insufficient industrial hygiene data was ailable to accurately estimate their exposures, d they were placed in the undefined group. A bjective evaluation by industrial hygienists indited that the exposures in the undefined group re, for the most part, in the low to intermediate nge.

In placement of individuals in particular exposure groups, precedence was given first to a history of high exposure; then intermediate exposure; next undefined exposure; and, finally, low exposure.

Table 2, also in the record, gives a breakdown as to the number of employees in each group and the number who voluntarily participated in the Health Inventory Program. The participation rate among the various exposure groups was about 80% .

As of March 1974, we were in the final stages of our fourth cycle through the plant. Because of major revisions in the Health Inventory Program in 1970, data before and after this date have been analyzed separately. This conveniently breaks our analysis down into a study of the first two cycles and the last two.

In the first two cycles, February 1967 to December 1970, 10 clinical parameters were evaluated. Two of them, serum protein and hemoglobin, had insufficient data and were discarded. Data of the remaining eight were analyzed: FVC (forced vital capacity), FEV_1 (forced expiratory volume—one second), systolic blood pressure, diastolic blood pressure, white blood count, total bilirubin, SGPT (serum glutamic pyruvic transminase) and alkaline phosphatase. The mean value of each of these tests was determined for the exposure group and for a control group of matched pairs. The control group was matched for sex, age, smoking history, month of exam, and, where posible, master number. Our master numbers are sequential based upon date of hire. Master numbers of similar magnitude indicate similar lengths of employment. The only statistically significant deviation ($P < .05$) was for a decreased diastolic blood pressure on the high exposure group. All other tests in all exposure groups, including undefined exposure, showed no statistically significant differences. What's the clinical significance of the finding? I don't know.

A number of questions from the history have also been analyzed: shortness of breath; chronic cough; yellow jaundice; stomach, liver, and intestinal trouble; numbness in hands and feet; cancer or malignant growth; anemia or blood problems. No significant differences were noted between the exposure group and the matched-pair control group.

Similar analyses were made on selected laboratory data and questions of the last two health inventories, January 1971 to March 1974. Tables 3 and 4 give a list of parameters that were considered for this report.

The questions were similar to those asked previously. The laboratory studies included pulmonary functions, hemoglobin, white blood count, total

bilirubin. SGOT (serum glutamic oxalacetic transaminase), LDH (lactic dehydrogenase), total protein, protein albumin, and protein globulin. During this period three separate techniques for alkaline phosphatase, involving three separate normal ranges, were utilized by our consulting laboratory. For this reason a statistical analysis of the results of this study was not made. Review of the individual results revealed nothing of clinical concern. In all other parameters studied nothing of statistical significance was found.

We have studied various parameters of our employees' health for over 20 years, including a number of those suggested by the proposed standard. We plan to continue this medical surveillance and will continue incorporating new techniques as they are developed and as they apply to our operation—techniques such as automated multiphasic testing, computerized medical records, enzymatic studies, analysis of metabolic end products, chromosome studies, and exfoliative cytology.

This report is a summary of our findings of past studies. Above 200 ppm some deviations were noted in various health parameters; below 200 ppm nothing of statistical significance has been observed.

A group from the Institute of Environmental and Industrial Health, University of Michigan, has made an extensive study of over 5000 employees of 32 plants involved in various phases of vinyl chloride and polyvinyl chloride manufacturing. Their findings can found in a series of articles entitled "Occupational Acroosteolysis" in the *Archives of Environmental Health* (22, 61(January 1971)). Our Midland location was one of the plants studied. They found no acroosteolysis in our work force.

As has been mentioned in previous testimony, a group of health researchers from Mt. Sinai New York Medical Center has also recently studied a group of our Midland location employees.

In Dr. Selikoff's preliminary evaluation he brings up some interesting clinical observations. Dr. Selikoff stated yesterday his evaluation is incomplete and further analysis of his data is needed. As Dow has indicated to Dr. Selikoff several times, we look forward to working with him in developing meaningful dose response information—to combining our 20-plus years of industrial hygiene data, our 20-plus years of medical surveillance data—with his expertise in occupational medicine. Our ultimate concern is the health of our employees.

Table 1 – Health Inventory

Identification	Pulmonary Functions	Chemistries:
Work History	Vision	BUN
Family History	Hearing	Glucose
Smoking History	Intraocular Tensions	Uric Acid
Family Physician	Height	Creatinine
Medical History	Weight	Calcium
Medications	Blood Pressure	Bilirubin
X-Ray	Hematology	Protein Total
Electrocardiogram	Urinalysis	Albumin
		SGOT
		Alkaline Phosphatase
		LDH
		Cholesterol

able 2 – Employee Participation in Health Inventory Program by Exposure Group

	Total	High	Intermediate	Low	Undefined
Employees Of 1/68	335	118	63	73	81
Employees Of 1/74	276	102	54	63	57
Employees With One Or More Exams 2/67 to 3/74	277	93	56	64	64
Employees With One Or More Exams 2/67 To 12/70	239	83	44	54	58
Employees With One Or More Exams 1/71 To 3/74	219	72	44	55	47

able 3 – Parameters Studied January 1971 to 'arch 1974

SGOT (Serum Glutamic Oxalacetic Transaminase)
ALKALINE PHOSPHATASE
LDH (Lactic Dehydrogenase)
TOTAL PROTEIN
ALBUMIN
GLOBULIN
TOTAL BILIRUBIN
DIASTOLIC BLOOD PRESSURE
SYSTOLIC BLOOD PRESSURE
FVC (Forced Vital Capacity)
FEV (Forced Expiratory Volume — One Second)
HEMOGLOBIN

Table 4 – Health Inventory Questions Cycles Three and Four

- SHORTNESS OF BREATH
- COUGH LASTING OVER THREE MONTHS
- NUMBNESS IN HANDS OR FEET
- YELLOW JAUNDICE
- LIVER TROUBLE
- ANEMIA OR BLOOD PROBLEMS
- CANCER OR MALIGNANT GROWTH