

AN EPIDEMIOLOGICAL STUDY OF THE BIOMEDICAL EFFECTS
OF EXPOSURE TO A VINYL CHLORIDE → POLY VINYL CHLORIDE
CHEMICAL PROCESS AMONG 882 CURRENT CHEMICAL WORKERS

April 1974

by

Robert H. Wyatt
Jack W. Buchanan, Jr.
Duncan R. Campbell
Alphonse H. Doll, Jr.
Joseph C. Slaughter

Faculty Advisors: Donald L. Hochstrasser, Ph.D.
Joseph Alter, M.D.
Jane Kotchen, M.D.

Community Medicine 831
Department of Community Medicine
University of Kentucky College of Medicine

"THIS STUDENT REPORT FULFILLS A TEACHING
REQUIREMENT IN COMMUNITY MEDICINE. THE
STATEMENTS HEREIN HAVE NOT BEEN VALIDATED
BY THE DEPARTMENT OF COMMUNITY MEDICINE
AND ARE NOT OFFICIAL VIEWS OF THE COLLEGE
OF MEDICINE, UNIVERSITY OF KENTUCKY."

20248001

TABLE OF CONTENTS

	Page
Acknowledgements	1
Abstract	2
Introduction	3
Materials and Methods	4
Results and Discussion	6
I. Description of the Population	6
II. SMA-12 Test Results	13
Conclusion	38
References	40
Appendix A:	42
Chi Square analysis to check for independence of the variable subpopulation and range of test results.	
Appendix B:	44
Per Cent abnormal SMA-12 tests by subpopulation with X^2 analysis for independence of variables subpopulation and range of test results.	
Appendix C:	49
Form used to collect data from company employment and medical records.	
Appendix D:	50
Title and Number of Units and B.F. Goodrich Chemical Company Louisville, Ky.	

20248002

Acknowledgements

We wish to express our gratitude to the following people:

Dr. Donald Hochstrasser for kind guidance and enthusiastic support throughout the project;

Dr. Jane Kotchen for endless help with the statistical analysis and interpretation;

Dr. J. Bradford Block, Office of Occupational Health and Safety, Kentucky Department of Labor, for helpful advice and conversation;

Messrs. P. Lawrence, K. Pember, and Dr. M. Johnson and the many other people of the B.F. Goodrich Company for their willingness and cooperation in our examination of company employment and medical records;

Dr. Abram S. Benenson and Dr. Martin Marx for helpful criticism about the epidemiologic approach;

Dr. D. Kratzer for advice on statistical methods;

Mrs. Nancy Hill and Ms. Joan Ploetz for kind help with the computer programming and Chi-square analyses.

20248003

ABSTRACT

The employment records, company medical records, and results of recent SMA-12 blood chemistry tests of 882 current hourly paid workers of the B.F. Goodrich Chemical Company, Louisville, Kentucky, have been examined in detail. Four hundred thirteen of these workers have at least one month or greater work experience in a unit of the plant in which vinyl chloride is processed into polyvinyl chloride (VC → PVC process) and in which there has been found to be a greater than chance occurrence of angiosarcoma of the liver among both present and past employees. Four hundred sixty-nine other current workers have no experience in this unit. There are no other striking differences between the two groups of workers when comparing their work histories, medical histories, and results of SMA-12 blood chemistry tests. However, among the 413 current workers with some exposure to the VC → PVC process, there are a slightly higher blood albumin concentration and a lesser rate of increase of blood cholesterol concentration with age as compared to the 469 other workers at a statistically significant level. Questionably significant differences are also present between the two groups with respect to occurrence of liver-spleen disease, allergic disorders, and genitourinary problems.

20218004

INTRODUCTION

Vinyl chloride has been shown to be carcinogenic to animals under certain circumstances. 1-14 Recently there has been shown to be a greater than chance association between exposure to polyvinyl chloride manufacturing processes and angiosarcoma of the liver, a rare blood vessel tumor. Specifically, seven employees of the B.F. Goodrich (BFG) plant in Louisville, and more recently, employees of similar plants around the world have been found to have the tumor. All seven employees of BFG worked in a section of the plant which converts vinyl chloride to polyvinyl chloride (Unit 62). (For other units of BFG see Appendix D.)

Virtually every employee of the BFG plant in Louisville has been given an SMA-12 blood chemistry test as a result of company medical policy. We have examined these tests in detail for all hourly paid employees who received the test, along with job history, age, significant illnesses and other variables. We initially asked the question:

"Is there a significant difference between Unit 62 workers and non-Unit 62 workers at the B.F. Goodrich plant with respect to personal, occupational or medical history or with respect to SMA-12 results."

We have also attempted to quantify Unit 62 employees' length of exposure as well as the time their exposure occurred and to consider this in our analyses.

20248005

MATERIALS AND METHODS

As a group of five medical students looking at the community health problems of Louisville and the surrounding region, our introduction to the problems of occupational health, and particularly the problem of angiosarcoma among workers at the B.F. Goodrich chemical plant, came from a personal interview with the medical consultant to the Department of Occupational Health in the Kentucky Department of Labor at Frankfort, Dr. J. Bradford Block. Subsequent background information came from interviews with several helpful and cooperative people at the B.F. Goodrich Plant, who are hopefully all mentioned in the reference section of this study. A review of the B.F. Goodrich plant problem was obtained from articles appearing in the Courier-Journal newspaper over the preceding four months.

This study was based on objective data gathered from current hourly employee work and medical records at the Goodrich plant. Any employee without either a medical history or SMA-12 blood test result was dropped from our study. With these basic restrictions, we obtained a total study population of 882 employees.

The following information was obtained from the cardex summary of the hourly employees work records:

1. Name and birth date
2. Total years employed by BFG, Louisville
3. Dates employed by the plant
4. Present unit in plant to which employee is assigned
5. Other units to which employee has been assigned
6. Whether employee has ever been assigned to Unit 62 for greater than 1 month (VC=Yes)
7. Dates assigned to Unit 62

20248006

8. Total time assigned to Unit 62

9. Job title in Unit 62

From the hourly employees medical records were obtained race, height and weight at the time of initial employment, categorical major illnesses, and SMA-12 blood test results. The particular blood tests recorded are shown in Figure 2.

The recording of categorical medical illnesses was to some degree an individual decision for each of the five investigators. It should be noted that each employee after missing work for a medical reason must be cleared through the medical office at the plant before returning to work, and records of the illness are kept in the company medical record. Minor surgical procedures were generally disregarded unless related to systemic or medical problems. Allergies to drugs were not recorded.

There was no information in the health records regarding smoking and drinking habits, the lack of which admittedly limits the interpretation of the medical data.

The data thus obtained was transferred to computer coding sheets and then to computer cards. Standard packaged computer programs were used in the data analysis. The Statistical Analysis System was used to obtain means, regressions, and correlations. The Statistical Package for Social Sciences was used to obtain one way and two-way frequencies as well as cumulative frequencies and percentiles.

The SMA-12 battery of blood tests was done on nearly every employee of the plant in February and March of 1974. The samples were collected in the morning hours after at least 12 hours of fasting. The samples were taken to a local clinical laboratory in Louisville and processed immediately using the standard technique in the SMA process.

20248007

RESULTS AND DISCUSSION

I. Description of the Population

A. Definition of two subpopulations

The total hourly employee population of the plant can be divided categorically into two groups: the employees of one group have never been assigned to Unit 62 (VC = NO; VC = vinyl chloride processing unit), and the employees of the other group (VC = YES) have had work assignments in Unit 62 for 1 month or greater. This division resulted in two numerically comparable subpopulations as shown in Table 1.

Table 1: Total Study Population Divided into Two Subpopulations ^a

VC = NO (current employees with no assignment to Unit 62)	469
VC = YES (current employees with work assignments $\geq$ 1 month in Unit 62)	413
Total study population	882

^a Based on current employment records of all hourly paid employees of BFG Chemical Company April 1, 1974.

The reason for this division is based on the observation that all seven of the employees of the plant who have been identified as having or having died with angiosarcoma of the liver have had at least 12 years of work assignment in Unit 62. Apparently no other unit in the plant can be thusly identified.

B. Work history

The work history of the two subpopulations is broken down in Table 2. Note that the two subpopulations have been employed about the same number of years on the average. The VC = YES employees have spent on the average one half of that time in Unit 62.

20248008

Table 3 shows how the number of employees in each subpopulation (VC = YES and VC = NO) are distributed according to number of "exposure years". The variable "exposure year" is defined as follows:

Table 2: Details of Work History of the Total Study Population
by Subpopulation ^a

	VC = YES (Unit 62 work $\geq$ one month) ^b	VC = NO (Unit 62 work = 0 mos.)
mean number of years employed in plant	13.9	12.4
mean year VC (Unit 62) experience started	1962	--
mean year VC (Unit 62) experience ended	1970	--
mean number of years spent in VC (Unit 62)	6.9	0
mean number of years spent in plant in other units than Unit 62	7.0	12.4

^a Information based on employment records of all current hourly paid employees of BFG Chemical Company April 1, 1974.

^b No employee was found to have worked in Unit 62 for less than one month.

number of "exposure years"

for VC = NO employees, is equal to the number of years employed by the plant:

for VC = YES employees, is equal to the number of years in which the employee was assigned to Unit 62.

20218003

Table 3: Number of Employees of Each Subpopulation
by Number of Exposure Years ^{a, b}

<u>Number of Exposure Years</u> ^a	<u>Number of Employees</u>	
	VC = NO	VC = YES
0-4	186	244
5-9	35	59
10-14	50	27
15-19	35	34
20-24	90	28
25-29	62	16
30-34	11	5
	469	413 /882

a Definition of "exposure years" is in text.

b Data taken from employment records of all current hourly paid employees of BFG Chemical Company, Louisville, Ky. April 1, 1974.

From Table 3 one may note that for each 5 year unit of exposure years, there are fairly comparably sized numbers of employees from each subpopulation. This should allow for some statistical comparison between other variables as they vary with exposure years for the two groups, except for exposure years > 30 for VC = NO and > 25 for VC = YES.

20218010

C. Age Groups

The mean age of each group and the number of employees falling into five year age groups are compared for the two groups, VC = YES and VC = NO, in Figure 1. It may be noted that except for three age groups, the number of VC = NO employees is greater than the number of VC = YES employees. More specifically, in the age range 30-44 years, the number of VC = YES employees is greater. Another way of viewing Figure 1 is to see that the VC = YES histogram is singly peaked at the 40-44 year age range, whereas the VC = NO histogram is doubly peaked at the 25-29 year and 50-54 year age ranges. This probably reflects the effect of a combination of the number and size of the various chemical processes done at the plant and the degree of automation in each process upon the hiring and internal job assignment history of the plant as a whole. No other inferences can be made with the authors' available information about the plant.

D. Race

Table 4 shows how the two subpopulations break down according to race. The category other/unknown consists almost entirely of employees for whom information about race was not obtained.

Table 4: Breakdown of the Two Subpopulations by Race ^a

<u>Race</u>	<u>Number of Employees</u>			
	VC = YES		VC = NO	
white	331	80.1%	352	75.1%
black	34	8.2%	48	10.1%
other/unknown	48	11.6%	69	14.7%
	<u>413</u>	<u>100.0%</u>	<u>469</u>	<u>100.0%</u>

^a Data taken from VDRL test result form in company medical record of all current employees of BFG Chemical Company, Louisville, Ky. April 1, 1974.

20248011