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Occupational Disease in the Rubber Industry

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We have studied mortality patterns in a large cohort of rubber workers. We have examined workers exposed to curing fumes, processing dusts, and industrial talc and have begun to evaluate exposures of these workers in detail.

Gastrointestinal (especially stomach) cancer appears in excess in processing workers. Lung cancer is excessive in curing workers. Leukemia is increased generally. All three groups studied for respiratory disease have an increase in disease prevalence which is related to intensity and duration of exposure.

Since both an increase in stomach cancer and respiratory disease is seen in processing workers, exposures in this area must be controlled. Since both lung cancer and chronic respiratory disease is excessive in curing rooms, this exposure must be controlled. The leukemia risk is probably related to solvents. Whether this is all explainable by past benzene exposure is unknown. Further studies are planned to refine our knowledge concerning these risks so that occupational disease in the rubber industry can be prevented.

Introduction

Harvard is involved in three-way agreements with the B. F. Goodrich Co., Armstrong Rubber Co., and Mansfield Tire and Rubber Co. with the United Rubber, Cork, Linoleum and Plastic Workers of America (URW) in each case being the third party.

The agreement designates two bodies. The first is the Occupational Health Committee (OHC), composed of three management and three union representatives. The Occupational Health Committee reviews and approves the research plans proposed by the University research team, makes recommendations for the implementation of the findings of the research, and reviews occupational health problems referred to it by local plant Health and Safety Committees for possible referral to the University.

The second, an Occupational Research Study Group (ORSG) is established at Harvard. This research team conducts epidemiologic studies and in-plant investigations to define potentially hazardous conditions. The Occupational Research Study Group also assists in the development of safe standards for occupational environments.

At Harvard the ORSG includes members from the Departments of Environmental Health Sciences (formerly industrial hygiene), Epidemiology, and Physiology.

The Harvard program includes mortality studies to define possible unknown health hazards. Joint medical–industrial hygiene studies of plant populations are also conducted to elucidate the effects of potentially hazardous materials or conditions. The latter studies are supported by extensive laboratory research programs. Selected studies in each of the above program areas will be described in this paper. Our aim has been to find causes of occupational disease (if it exists) and then to find ways to prevent it.

Mortality Studies

The mortality experience of approximately 25,000 past and current employees from one plant in Ohio going back to 1925 has been reviewed by Monson and Nakano (*1, 2*). Starting in October, 1971, mortality data were collected from three primary sources—the dues files of the union (URW), the employee file maintained by the company, and the death file maintained by the company. The data were supplemented by death certificates obtained from the company insurance carrier and the Ohio and other state health departments. Information on the vital status of terminated employees was obtained with the assistance of the Internal Revenue Service and the Social Security Administration.

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A comparison was made between numbers of deaths observed among rubber workers as compared to numbers of deaths expected on the basis of United States death rates. In this comparison, race, sex, age, and time were taken into account. Comparisons were made for all rubber workers as well as for groups of rubber workers who had worked together in specific areas of the plant.

The mortality experience between January 1, 1940 and June 30, 1974 of 13,571 while male employees at this single plant revealed that mortality was between 62% and 82% of that expected based on United States death rates (*1*). With the exception of cancer, there was no strong indication that there were excess deaths from any specific cause of death. There was an indication of excess deaths from specific cancers among workers of a number of different departments, as shown in Tables 1 and 2. Excess gastrointestinal cancer was seen in all age categories, and was greatest in processing workers who died at age 75 and above. Excess lung cancer was limited to tire curing workers who started work between age 25 and 34 and who died in 1955 or later. Excess bladder cancer was greatest in men who worked at least 35 yr and who died at age 75 or above. No excess risk was present in men who started working after 1934. (In men who started working between 1930 and 1934, there were 7 deaths due to bladder cancer and 5.1 expected). Except for age started working, the patterns for lymphatic cancer and myeloma and for leukemia did not differ greatly. In men who started working before age 25, an excess was seen only for leukemia. There was no evidence for an excess of either category of cancer in men who started working after 1934.

Table 1. Observed and expected deaths due to selected diseases, according to work area in which employee usually worked.

Disease	Work area	No. of deaths Observed	No. of deaths Expected
All gastrointestinal cancer	Processing	52	38.2
	Rubber reclaim	11	7.7
Stomach cancer	Processing	18	9.9
Large intestine cancer	Processing	14	10.5
Pancreas cancer	Elevator/cleaning	6	2.9
Lung cancer	Tire curing	20	12.4
Prostate cancer	Miscellaneous tire	12	8.8
Bladder cancer	Warehouse/shipping	8	2.6
	Tire building	9	4.8
	All	48	39.5
Brain cancer	Tire building	7	3.7
Lymphatic cancer and myeloma	Tire building	11	7.1
Leukemia	Tires	18	11.7
	Processing	10	4.2
	All	55	43.0
Asthma	Services	11	7.0
Diabetes	Warehouse/shipping	11	5.8
Vascular diseases of central nervous system	Operating services	19	14.1
Pneumonia	Tire curing	12	7.7

The mortality studies have identified the plant areas and occupations which require study to elucidate possible carcinogenic agents. Such studies obviously have the major shortcoming that a discontinued exposure could be responsible for today's mortality. One must deal with long induction periods in cancer, usually a minimum of 20 yr. The rubber industry has certainly been dynamic, and materials and processes have changed. However, based on these data and other confirming studies, we are attempting to identify specific substances which may be responsible for gastrointestinal cancer in processing workers, lung cancer in tire curing workers, and bladder cancer and leukemia in general workers.

Occupational Health Field Studies

Our field study program was initiated by a detailed walk-through survey of all plants covered by the agreements during 1971 and 1972 to gain familiarity with the materials and the processes involved in the manufacture of rubber products and the potential occupational health hazards. Our major management contact at each plant was the personnel manager, although we interviewed the plant manager, production personnel, safety staff, and medical staff. We contacted the local president and met with union members of the safety committee.

Our interview with the company management prior to the plant survey was designed to develop information on safety and occupational disease statistics, broad personnel data such as population, turnover, and age distribution of factory workers, a management consensus of the important occupational health problems, and an outline of the plant medical coverage.

A meeting held with union personnel provided a list of the major industrial health concerns of the union membership including specific plant problems and control difficulties. An early meeting with the union representatives permitted us to view these specific areas during our plant tour.

A detailed preliminary industrial hygiene survey of the plant was conducted with both management and union representatives. The company representative was usually the staff person who had responsibility for safety and the union member was either the local president or the chairman of the safety committee of the union. All production areas were visited. Detailed information was made available on materials, processes, and environmental controls. Our access to plant areas and specific information on processes has been complete.

A proposal was then prepared and submitted to the Occupational Health Committee identifying the company-wide problems which we felt deserved either correction or further research. The approach led to the choice of several specific field studies. Because there was considerable fume and dustiness in tire curing area, compounding areas, and areas in which industrial talc was used, we elected to study these three populations.

Methods

The study population comprised 121 men exposed to tire curing fumes, 65 men working in compounding, and 80 men exposed to talc; 189 workers of the same age and work duration, exposed to no known respiratory hazards, served as controls. Chest x-rays, pulmonary

Table 2. Standard mortality ratios (SMR) and observed deaths (ObD) for selected cancers, according to selected characteristics.

Characteristic	Gastrointestinal cancer [a]		Lung cancer [b]		Bladder cancer [c]		Lymphatic cancer and myeloma [c]		Leukemia	
	SMR	ObD	SMR	ObD	SMR	ObD	SMR	ObD	SMR	ObD
Age started working										
<25	120	7	90	4	110	7	90	14	180	19
25–34	120	22	220	24	130	21	110	22	100	18
≧35	160	23	50	3	120	20	110	15	120	18
Year started working										
<1925	130	21	130	8	140	24	100	14	140	21
1925–34	130	22	200	14	140	19	120	22	160	25
≧1935	180	9	120	10	60	5	80	15	70	9
Years worked										
5–24	150	24	130	11	110	17	100	24	90	18
25–34	140	20	140	10	100	14	90	13	170	23
≧35	100	3	200	10	170	17	120	14	150	14
Age at death										
<65	110	18	140	17	100	14	100	29	120	25
65–74	110	16	140	10	90	13	100	15	150	21
≧75	250	18	220	4	220	21	110	7	110	9
Year of death										
<1955	110	13	70	2	90	8	130	12	120	12
1955–64	160	21	160	12	130	17	90	17	150	23
≧1965	130	18	160	17	130	23	100	22	110	20

[a] Employees who usually worked in processing.

[b] Employees who ever worked in tire curing.

[c] All employees.

function tests, questionnaires and personal dust or fume exposure was assessed. The details of these studies have been reported (*3–6*).

Summary of Results

The curing workers had a higher prevalence of chronic bronchitis than the controls. Of the curing workers with greater than 10 yr of exposure to fume, 25% met the criteria for the epidemiologic diagnosis of chronic obstructive lung disease (COLD). This was three times that of the control group. The increase in respiratory morbidity in the curing workers was related to both intensity and length of exposure to fume. Cigarette smoking had the usual effect but could not explain the difference between the curing and control groups. We attribute the greater prevalence of respiratory morbidity and decreased pulmonary function to curing fume exposure. Workers on the manual automobile tire presses are at the highest risk of developing pulmonary disease. No chest x-ray abnormalities were noted.

The 65 processing (compounding) workers exposed to processing dusts, when compared with the controls, had a higher prevalence of chronic productive cough. The processing workers with greater than ten years of exposure showed a significant decrease in the ratio of $FEV_{1.0}/FVC$, the $FEV_{1.0}$, the residual $FEV_{1.0}$, and the flow rates at 50% and 25% of the forced vital capacity. None of the pulmonary function effects could be solely explained on the basis of smoking, age, ethnic, or socioeconomic factors: all were related to the length of exposure. Based on these results we concluded that exposure in the processing area produces pulmonary disease. No chest x-ray abnormalities were noted. Exposure levels were 1–3 mg/m3 for mass respirable particulate; much of this is carbon black.

The talc workers were exposed to talc at levels below the current threshold limit value (TLV) of 20 mppcf for nonfibrous talc. The talc currently used has a low percentage of free silica. The talc workers had a statistically significantly greater prevalence of productive cough and of positive chronic obstructive lung disease (COLD) criteria when compared to the control workers. The talc workers with exposure duration greater than 10 yr had significantly decreased residual $FEV_{1.0}$. Multiple regression analysis of $FEV_{1.0}$ in the talc workers estimated that each year of exposure to talc dust reduced the $FEV_{1.0}$ by 26 ml. Talc workers had a clear increase in respiratory morbidity, despite the absence of chest x-ray changes. These findings were seen with dust levels considerably below what is considered safe for occupational exposures.

Laboratory Investigations

Gold has isolated a carcinogenic adsorbate on carbon black (*7*). This study will be later translated into specific field sampling and analytical methods to describe properly the exposure of workers in the processing area to carbon black. In another major laboratory study, Dr. Otto Grubner, a member of the Occupational Health Research Group at Harvard, is conducting a detailed study of chemical compounds that become airborne during the curing of tires. Final results are not yet available.

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