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Prevalence of Chronic Respiratory Disease

Asbestosis in Ship Repair Workers

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Study of pipe coverers, pipe fitters, and welders at a ship repair yard indicated that pipe coverers had more changes in their lungs, as evidenced by examination of x-ray films, and slightly lower pulmonary function than the other two groups. All groups showed slightly lowered pulmonary function as compared with workers who did new-ship construction and were not exposed to asbestos. Aerometric measurement showed levels of asbestos that were, in general, lower than current threshold limit values. These findings reemphasize the need for control of asbestos in the work areas, as well as careful medical surveillance of workers exposed to asbestos.

IN AN earlier report on respiratory disease in new-ship construction, we noted a 10.7% prevalence of asbestosis in pipe coverers.¹ We also noted that workers exposed to 75 million particles per cubic foot · year or more were considered to have asbestosis by our criteria. New-ship construction is regarded as less hazardous than repair work because it is less dusty. Specific data on disease prevalence in shipyard repair work is scant, and criteria used to assess disease preva-

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lence vary. Accordingly, the purpose of the present study was to assess the risk of ship repair work and to examine the dose-response relationship of asbestos exposure to asbestosis in a different working population.

Methods

The 63 pipe coverers listed in the personnel files of the shipyard were selected for study. Each was matched with a welder and a pipe fitter of approximately the same age and years of work at the shipyard. This matching was done by us from records supplied by the personnel department. These factors agreed to within two years. The men were contacted through their foremen and asked to participate in the survey. In instances where the "control" person had terminated, another matched control was selected. Persons out ill or retired were not replaced.

All participants were asked a set of standard questions concerning respiratory symptoms and smoking habits, similar to the British Medical Research Council questionnaire. Occupational histories were obtained. Pulmonary function was measured by a variety of tests. Forced vital capacity (FVC) and forced expiratory volume in one second (FEV_{1.0}) were measured on a Stead-Wells spirometer at fast paper speed (32 cm/sec) with the subject seated without a nose-clip. Five trials were made, and the average of the last three was used. Volumes were corrected to body temperature, pressure, and saturation (BTPS).

Peak expiratory flow rates (PEFR) were measured on a Wright peak flowmeter that had

been calibrated under conditions of constant humidity. Readings were taken at a rate of 100 per cent. Five trials were made and the average of the last three was used. The subject was seated at ambient temperature and humidity, and the meter was saturated.

Maximum expiratory flow rates were obtained on a Wright peak flowmeter with the subject standing, and the readings were corrected to BTPS.

Total respiratory resistance was measured at 3 Hz using a fixed oscillation method. Total respiratory resistance was measured with the subject in a quiet breathing with the subject in a more satisfactory breathing subject then either inhaled to functional residual capacity or exhaled to residual volume and then relaxed to functional residual volume. Resistance measurements were made on an average of five breaths was measured during inspiration at a rate of 0.25 and 0.5 liters/sec.

Posteroanterior and lateral chest x-ray films were obtained on most of the subjects. The films were read by three observers (H.P.) separately and with the subject's occupational history of the subject. The films were classified by the degree of fibrosis and presence of calcification according to the International Labor Office (ILO) agreements in readings of chest x-ray films. The observers reading the film to a decision as to the presence of asbestosis was recommended by the ILO criteria.

Pulmonary diffusing capacity was measured by the single-breath technique using carbon monoxide and helium in room air. The method of Cotes and Saunders was used. The high-oxygen method was used. From the blood in the pulmonary membrane component (as well as the diffusing capacity) measurements that did not meet the published criteria were not used. The criteria that were used were the following: (1) poor technique, (2) holding defective, (3) volumes on room air and on 100% oxygen differing by more than 400 cc; (4) operator error.

Table 6.—Carbon Monoxide Diffusing Capacity With Single-Breath Method by Occupation and Cigarette Smoking in Repair Shipyard, 1968

Occupation	No.	CO Diffusing Capacity (ml/min/mm Hg)			Vc (ml)
		Room Air	High Oxygen	Dm (ml/min/mm Hg)	
Welders	10	22.2	13.8	27.4	114.5
Painters	17	21.5	12.3	31.9	101.8
Electricians	12	25.9	14.1	33.0	103.2
Current smokers	11	20.3	12.0	27.3	91.5
Welders	12	24.5	13.9	34.3	99.1
Current smokers	21	22.9	11.9	39.7	86.5
Asbestos workers*	33	25.69	12.22	39.48	69.01
Current smokers	30	22.47	9.08	43.20	45.44

* Data from radiography.¹

Table 7.—Asbestos Dust Sampling at Repair Shipyard During Period, 1952-1966*

Day	No. of Samples	Dust Concentrations (Million Particles/cu ft)†		
		Minimum	Maximum	Mean ± SD
Shop samples				
General shop	19	0.6	9.4	2.8 ± 2.6
Layout area (layout, wrapping, stapling, sewing)	15	0.8	13.3	4.8 ± 3.7
Cutting (hand saw, band saw)	26	1.1	100.0	19.0 ± 30.0
Opening & unrolling bulk material	22	0.8	33.6	7.2 ± 7.3
Mixing cement	8	27.2	90.0	57.3 ± 23.5
Shipboard samples				
Tearing out	41	2.4	132.0	29.2 ± 30.4

* Most sampling was conducted prior to 1965. In 1965, fiber glass was substituted for amosite on major portions of work.
† Total dust was counted. No attempt was made to define % of fibers. Concentrations represented instantaneous conditions.

Table 8.—Summation of Sampling Results in Repair Shipyard, 1969*

Location	Total No. of Air Samples	Concentrations (Fibers/ml)			No. of Samples With	
		Minimum	Maximum	Mean	> 5 Fibers/ml	> 12 Fibers/ml
Shop	19	0.01	3.1	0.3	0	0
Ship	62	0.01	25.0	2.9	11	2

* Data from J. Lynch and W. A. Burgess, SM (unpublished data).

category, "questionable," refers to the Z or Z/p category of the ILO and a profusion of 2/1 or less; "marked change" refers to p classification or more, with a profusion of 2/2 or more.³ Questionable readings were more frequent in pipe coverers but occurred in all groups, while marked changes were noted only in pipe coverers. It should be emphasized that the occupation of the man was not known at the time of the initial readings, and only the posteroanterior and

lateral films taken at the time of the survey were available to the readers.

The difference between pipe coverers and the other categories was significant at the probability level, $P < 0.01$, when those with a marked change are considered. Similarly, the pipe coverers had significantly higher prevalence of questionable readings ($P < 0.05$).

Calcifications, either pleural or pleural and diaphragmatic, were significantly more

common among pipe coverers. This could not be accounted for by a previous history of pneumonia, bronchopneumonia, or trauma. Diaphragmatic calcification was more common among pipe coverers, but it was present in only five cases. This was not a statistically significant increase in prevalence. Pleural calcification, observed in 11 cases, was significantly higher ($P < 0.05$) in pipe coverers.

Shaggy heart occurred more often in the pipe coverers ($P < 0.01$) than in the pipe fitters or welders. Among the 13 pipe coverers with shaggy hearts, six occurred in the persons with marked x-ray film changes and seven in those with questionable changes. Two pipe fitters were considered to have shaggy hearts but no welders were.

Diffusing Capacity.—Table 6 presents the results of the measurement of the diffusing capacities of men in whom the criteria for acceptance were met. Of the 186 subjects, only 83 were suitable for calculation of Dm and Vc. There were 27 subjects who offered poor cooperation; and in 74 subjects the alveolar volumes, as calculated from the single-breath helium, were too different. There was one refusal and one operator's error.

The diffusing capacity is lower in the pipe coverers than in the other categories. It is also lower in smokers than in nonsmokers. As was noted in an earlier study by W. F. van Ganse, MD, B. G. Ferris, Jr., MD, and J. E. Cotes, MD (unpublished data), the Vc is decreased in cigarette smokers, whereas the Dm generally shows a slight rise or no change. The Dm does tend to decrease with age, however. A group of unexposed workers from another study¹ gave values for the diffusing capacity similar to those seen in the pipe fitters and welders but higher than those in the pipe coverers.

Rales in two or more sites were significantly more common in pipe coverers than in either welders or pipe fitters. Six of the ten pipe coverers whose x-ray films were consistent with moderately advanced asbestosis had rales, whereas the rate in pipe fitters and welders together was 12.1%. This occurred even though the observer did not know either work category or roentgenologic classification at the time of auscultation. Rales were less well correlated with "borderline" asbestosis, being present in 15.8% of

the subjects in this category. Of pipe coverers whose x-ray films were negative, 28.2% had rales, suggesting that rales can precede x-ray film changes as a manifestation of asbestosis, as has been observed by others. The converse can likewise occur.

There was no significant difference between the prevalence of rales in the welders as compared to the pipe fitters. The prevalence of rales (12.1%) in these two groups of subjects, who probably have some exposure to asbestos in the course of their work, was more than the 8.2% that was found in a group of shipyard workers with little to no asbestos exposure.¹

Measurements of the total respiratory resistance by the oscillation method generally were not rewarding. We were not able to demonstrate any differences between occupational group, age, or smoking categories. Similar negative results were found with the volume-flow plots. Some of this may be due to the relatively small numbers.

A total of 131 dust samples were collected from 1952 to 1966 at this yard (Table 7). In addition, 81 extended-time personal lapel samples using membrane filters were collected during a special three-month study period (Table 8). Sampling times for these extended-time samples ranged from one-half to four hours. Two thirds of these samples were collected during shipboard operations, while the remainder were collected in the shop (J. Lynch and W. A. Burgess, SM, unpublished data). Mean shipboard and shop concentrations for the membrane-filter samples are summarized in Table 8. There may be occasions when the time-weighted average concentration may exceed the proposed threshold limit value (TLV) or five fibers per milliliter in shipyard locations (J. Lynch and W. A. Burgess, SM, unpublished data). Because of the intermittent character of work of this yard, and with the recent substitution of fiber glass, it was not possible to develop good estimates of lifetime exposure for comparison with the previous study. As expected, dust levels during tearing out were high. Unfortunately the number of samples taken during tearing out was low.

Definite changes consistent with asbestosis were seen in this yard despite the relatively low levels of exposure. Over the years these levels were probably comparable to or

higher than those seen in a ship construction. Since w those men who were still a have missed diseased indi retired or left the job. It wa do a retrospective study to earlier experiences had bee to the methods of record k all records after a three-y sent to a central deposito identified only by the man nel records also were not long periods.

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2. Peters JM, Mead J, Van G flow-volume device for measurin tion in the field: Results on wor levels of toluene diisocyanate. A 99:617-622, 1969.

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5. Edwards JH, Lynch JR: T

higher than those seen in a yard doing new-ship construction. Since we examined only those men who were still at work, we could not include diseased individuals who had retired or left the job. It was not possible to do a retrospective study to determine what earlier experiences had been. This was due to the methods of record keeping, in which all records after a three-year period were sent to a central depository and could be identified only by the man's name. Personal records also were not maintained for long periods.

Because this yard did repair work, all groups may be slightly exposed, since the different types of work tend to be done at the same time and this simultaneous activity may result in less difference between groups. Unexposed workers from another study had better pulmonary function than those working in the repair yard and a lower prevalence of rales, both of which tend to support this possibility. A number of the factors measured indicate that the pipe coverers

had more disease than the other two groups. In this particular study, changes in the chest x-ray films seemed to be most useful. Tests of pulmonary function, such as FVC and FEV_{1.0}, were not as dramatic as has been reported,⁹ although their lack of sensitivity may well reflect the more general exposures of the control groups in a yard doing repair work. It is of interest that, despite the relatively low levels of asbestos in the yard, changes consistent with asbestosis were observed. These may reflect higher exposures in the past. Even so, this study reemphasizes the need for continued control of exposure to asbestos and for careful medical surveillance of workers exposed to asbestos.

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Stefana Puleo, MS, did the computations.

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