10-21-70
MGOtt

A STATISTICAL EVALUATION OF RESPIRATORY SYSTEM INDICATORS AMONG PIPE COVERERS

INTRODUCTION

This report presents statistical findings developed from an epidemiologic study of pipe coverers. The report does not include a review of literature on the subject or a medical interpretation of the results. In the location under study, the job of pipe coverer has existed since 1910. A list of 173 men who have held this job was prepared from company personnel records. Virtually all men who worked on the job for at least a year are included in the list, as well as most of the men who worked less than a year. As of January 1970, the status of the 173 men was as follows:

Still Working For Company		130
Active Pipe Coverers	94	
No Longer Pipe Coverers	36	
Quit or Released From Company		18
Retired		~~12~~ 11
Deceased		~~13~~ 14

Within the identified exposed-to-risk population, the relationship between time-on-job and health indicators reflective of the well-being of respiratory function was investigated. The health indices examined in this study include (1) the mortality rate for cancer of the respiratory system (based on company insurance records, 1940-1970; (2) the incidence of morbidity episodes involving diseases of the respiratory system (based on company insurance records, September 1969-August 1970); and, (3) vitalometer measurements (derived from a multiphasic health screening program, 1967-1970).

METHODOLOGY

Selection Of Exposed-To-Risk Population And Controls

Pipe coverers were identified through personnel lists prepared on a monthly basis by the company. The personnel lists are ordered by department and job classification within department and are retained as far back as the 1920's. However, only the January listings are retained beyond ten years. Since pipe coverers tend to remain on the job for a long period of time, this method is adequate for identifying the exposed-to-risk population.

Two sets of controls were utilized in this study. The first set of controls consisted of the total plant population and the second consisted of pipe fitters. While the total

plant population was selected for convenience, a probability sample of the pipe fitter population was selected because these men had jobs closely related to the pipe coverers except for exposure to asbestos. The pipe fitters were identified by the same method as was used to identify the pipe coverers. Because there are many more pipe fitters than coverers, a thirty percent sample was drawn by terminal digit sampling of company identification numbers.

Method of Morbidity Analysis

For the purpose of this study, a morbidity episode is an absence characterized by the filing of a proper accident and sickness benefits claim covering a continuous period of absence from work. The claim includes a physician's certification of the medical cause of the absence. In most cases, the morbidity episode must extend beyond seven calendar days before a record of the event is created. The program, as such, is available to hourly employees of the company. The expected number of disability days shown in Tables 1 and 2 are based on a five year age grouping of data on over 5,000 hourly employees.

Method of Vitalometer Analysis

The company's multiphasic screening program, offered on a voluntary basis, calls for F.E.V. Total and F.E.V. 1 Sec measurements to be recorded for each participant. A Collins Vitalometer produces the tracings which are digitized by a technician. For analysis purposes, the most positive of three repeated tracings for each individual is computerized. A regression equation was developed from the total screened population to adjust for height and age. Monthly comparison of measured results has shown that, over the three years of the program, consistent readings have been obtained.

Using data generated through a multiphasic screening program has the advantage that neither the subject nor the technician is aware of uses to which the results might be put. Participation in the health inventory program was about 67% during the first cycle of the program. By combining first and second cycles, vitalometer readings were obtained for 101 men in the pipe coverer population.

Several selection factors which could bias somewhat the findings of this study should be noted. First, it was not feasible to follow up on the 18 employees who left the company; two of these men were known to have left because of poor health. Secondly, a morbidity study covering a period two years following the first cycle of the multiphasic screening program revealed that participants in the program experience fewer illness-absence episodes than non-participants. The study did not enable us to determine the reasons for this difference.

While the same selection factors apply to the control populations, caution must be exercised in interpreting results because of these unknowns.

Method of Mortality Analysis

The mortality analysis is based on copies of death certificates received by the company Group Insurance Department as proof of death. As mentioned previously, individuals released from the company, excluding retirees, will be lost to a mortality study based on insurance records. The two control groups referred to in Table 6 were studied over a more recent time period than the pipe coverers, even though the first twenty years following initial placement on the job was not accumulated as part of the exposure-to-risk years for pipe coverers. However, since the mortality rate due to cancer of the respiratory system has been increasing over the years, this comparison should error slightly on the conservative side. The mortality rates for the three groups were calculated on an age-adjusted basis.

Smoking History

A smoking history collected as part of the multiphasic screening program was not judged as satisfactory for use in this study. The set of questions concerning smoking history has been restructured and appears to be producing results that can be useful in the future. The lack of smoking history does impose considerable limitations on the conclusions that can be drawn from the study.

RESULTS

Table 1 shows that while no pipe fitter employment groups differ from the total plant in disability days due to respiratory disease, there are differences among the pipe coverers. The largest difference occurs among pipe coverers with 10 years or more of continuous employment on the job. These differences, however, are not fully reflected in total disability days. In Table 2, the number of episodes involving respiratory disease are compared. Based on a poisson approximation test, significant differences between observed and expected episodes were found for three employment groups among the pipe coverers and for no pipe fitter groups. However, the significant differences in the continuously employed group might be expected to carry over to the total group.

Vitalometer Analysis

The readings shown in Table 3 are height and age corrected. Only after ten years of employment do significant differences between corresponding groups of pipe coverers and fitters appear. The prior-to-employment group consists of men who worked at other jobs during the first cycle of the multiphasic screening program and later became coverers or fitters. A non-linear regression equation

was developed for F.E.V. Total and F.E.V. 1 Sec using years since first exposure as a pipe coverer for the independent variable. The regression lines, along with the scatter plot of individual readings, are shown in Figure I through Figure IV for both fitters and coverers.

Mortality Analysis

All causes of death among pipe coverers up to 1970 are listed in Table 5. These deaths are categorized by interval between initial employment as a pipe coverer and death, and by length of employment as a pipe coverer. An excess of total deaths and respiratory cancer deaths among pipe coverers, as compared to two other groups, is indicated in Table 6. The number of observations is quite small. In addition, two of the men dying from respiratory cancer also worked with lead arsenate.

SUMMARY

The data presented in this study were derived only from ongoing routine functions of the company Medical Department. The investigation of vitalometer readings, morbidity episodes due to respiratory disease, and mortality due to respiratory cancer, indicated that pipe coverers performed less well than did the comparison groups.

There are two important limitations of the study aside from the size of the exposed-to-risk population. First, no smoking history was obtained. Second, follow-back of individuals no longer with the company was not undertaken.

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MGOtt

STATISTICAL EVALUATION OF RESPIRATORY SYSTEM INDICATORS AMONG INSULATORS

Introduction

This report presents statistical findings developed from an epidemiologic study of insulators employed by the Texas Division of The Dow Chemical Company. The report does not include a literature review or a medical interpretation of the results. These crucial elements of a study are properly left to the industrial physician responsible for the health of these workers.

The objectives of the statistical evaluation were: (1) to identify through personnel records all employees who worked as insulators at the Texas Division; (2) to determine the current status of these workers and the dates of their employment as insulators; and, (3) to examine the relationship between exposure duration and several respiratory system indicators, namely the number of morbidity episodes due to diseases of the respiratory system, the number of deaths due to respiratory cancer and two respiratory function measures, the forced midexpiratory flow ($FEF_{25-75\%}$) and the forced expiratory volume at three seconds (FEV_3).

The insulator craft has existed since 1941 at the Texas Division. Between 1941 and 1971, seventy-two men who worked as insulators were identified through personnel lists. As of August 1971, the status of these workers was as follows:

Total	72
Still Working For Texas Division	30
Active Insulators	29
Not Active As Insulators	1
Released From Company	29
Retired	9
Transferred From Texas Div.	2
Deceased	2

Two factors which pose limitations on the statistical analysis are evident from the above tabulation. These factors are: (1) the rather small size of the exposed-to risk population (72 men), and, (2) the large percent of these employees released from employment (40%).

Methodology

Seniority lists for the insulator craft which were available through the Personnel Department were reviewed to identify the population-at-risk. Since insulators participated in the periodic health exam program, a double check of the population was possible. The verification procedure revealed that the seniority lists had provided complete and accurate identification of the population. The work history card for each in-scope employee was examined to determine the date of birth, the current status of the employee, and the dates during which the employee worked as an insulator. Years-on-job was subsequently used as an indicator of relative exposure levels.

Morbidity Data

Morbidity episodes are recorded in the employee's medical record. The date of the episode and the physician's diagnosis are listed for each event. Extracting this information was most time consuming because of the need to pull individual records and the unedited nature of the data. Since no prior use of these data for statistical purposes is known to the author, it was necessary to assume that the completeness of reporting and quality of the information was adequate. Morbidity data for the exposed-to-risk population were abstracted beginning in 1960. The number of episodes by cause and the frequency of episodes per 100 work-years-at-risk were tabulated for the total insulator population. A matched pairs design was used to compare the morbidity experience of the insulators with that of a suitable control group. In this case, the control group was selected from Power Department employees. Resources were conserved by restricting the comparison to the 24 insulators who worked continuously from 1960 through July 1971 versus 24 Power Department employees of the same age. These employees also worked continuously during the observation period. The pairing procedure eliminated the need to take into account the age of the worker or the period of observation in comparisons between the two groups. Until such time that routine data processing of morbidity data is initiated, the matched pairs type of analysis will remain the most efficient way to statistically treat morbidity data.

Spirometric Measurements

Spirometric measurements for insulators were provided through the periodic health exam program. The most recent testing for each insulator was selected for analysis. Readings were available for 42 insulators. Two measures, the $FEF_{25-75\%}$ and the FEV_3, were selected for analysis. The age and height, as well as smoking history, were obtained for each insulator at the time of his exam. Because of several limitations, three categories--nonsmoker, current smokers of at least one pack per day, and all others,--were used to describe the smoking history for each worker. The objective of this phase of the study was to determine if the two respiratory function measures, corrected for age, height and smoking history, were related to years-on-job. Age and height corrections for the FEV_3 were based on "Guides To The Evaluation of Permanent Impairment - The Respiratory System" (1965). A factor of .95 was used to adjust FVC readings to FEV_3 readings. Age and height corrections for the $FEF_{25-75\%}$ were obtained from "Spirometric Standards For Healthy Nonsmoking Adults" by Morris, et al (1971). The $FEF_{25-75\%}$ readings were dichotomized according to the sign of the deviations from predicted norms to simplify the analysis.

Mortality Data

The mortality analysis was based on copies of death certificates received by the Company Group Insurance Department as proof of death. Individuals released from the Company, excluding retirees, are lost to any mortality study based strictly on insurance records. The potential biases introduced by this loss of information have been discussed in the literature. The control group for the mortality comparisons consisted of a cohort of 6500 Midland location hourly workers followed between 1954 and 1969. The expected numbers of deaths were calculated based on mortality rates for the cohort population, adjusting for age by the indirect method.

Results

Morbidity Analysis

The overall morbidity experience for insulators from 1960 to August 1971 is summarized in Table 1. As expected, episodes related to diseases of the respiratory system account for over forty percent of the total absences due to sickness. Table 2 shows a comparison of morbidity experience between insulators and Power Department employees. The between individual range in the number of total episodes (0 to 20) indicates the wide variability in utilization of group insurance benefits. There are no statistically significant differences at the .05 level between the two groups. This is true both with respect to total episodes and with respect to episodes due to diseases of the respiratory system.

Spirometric Analysis

Table 3 shows the average deviations of FEV_3 readings from predicted norms by years of exposure. No significant association at the .05 level was found between years of exposure and FEV_3. Adjustments for smoking history had little effect on the results. The scatter plot of individual FEV_3 deviations from predicted versus years-on-job is shown in Figure I. In contrast, Table 5 indicates that nonsmokers perform near predicted norms and about .4 liters better than the average of either of the two smoking groups. Similar results are obtained for the percent of $FEF_{25-75\%}$ readings below predicted norms. Thus, smoking history was found to be related to respiratory function performance while years on the job was not. The possible effects on these readings of selection biases, such as population attrition, are unknown.

Mortality Analysis

Table 6 summarizes the mortality findings of the study. The observed deaths among insulators is less than expected in each category of comparison. However, since the exposed-to-risk population is relatively small and the period of observation is short, the favorable experience to date does not, in itself, insure similar results in the future.

Summary

The statistical evaluation was carried out along the lines set forth in the Introduction of this report. While the necessary data were indeed available, they were sometimes a burden to gather. This was especially true when they had been microfilmed. With regard to the insulators, no evidence was found to indicate an association between years on the job and the respiratory system indicators which were investigated. The many qualification statements which appeared in the report attest to the fact that the data were collected under real world and not laboratory conditions.

Table 1. Episodes Of Morbidity Observed Since 1960 Among 46 Insulators Actively Employed As Of 1960.

Cause	Number Of Episodes	Number Of Episodes Per 100 Person Years At Risk
All Causes	166	39.1
Diseases of the Respiratory System	70	16.5
Accidental Injuries	20	4.7
Diseases of the Digestive System	18	4.2
Diseases of the Circulatory System	14	3.3
Diseases of the Genito-Urinary System	14	3.3
Diseases of the Nervous System and Sense Organs	8	1.9
Infective & Parasitic Diseases	7	1.7
Diseases of the Musculoskeletal System & Connective Tissue	7	1.7
Neoplasms - Total	4	.9
Endocrine, Nutritional & Metabolic Diseases	--	---
Mental Disorders	--	---
Diseases of the Skin & Subcutaneous Tissue	--	---
All Other Causes	4	.9

Table 2. Comparison Of Morbidity Episodes Occurring Between January 1960 And July 1971 For 24 Insulators Paired With 24 Power Department Employees Based On Age.

Pair Number	Total Episodes		Respiratory Episodes	
	Insulators	Power Dept. Empl.	Insulators	Power Dept. Empl.
1	2	17	0	10
2	0	7	0	4
3	8	0	5	0
4	5	6	0	1
5	3	4	0	0
6	3	20	2	8
7	6	2	3	1
8	2	5	1	3
9	7	5	5	3
10	2	0	2	0
11	4	4	3	0
12	6	3	2	0
13	2	5	1	0
14	2	0	1	0
15	1	1	0	0
16	3	4	1	1
17	6	12	1	8
18	10	7	7	2
19	11	5	2	4
20	6	1	3	0
21	8	2	5	1
22	3	5	1	1
23	6	2	3	1
24	4	6	1	3
Total	110	123	49	51
Number of Episodes/100 Person Years At Risk	40.0	44.2	17.8	18.4

Table 3. Mean FEV_3 Readings Expressed As Deviations From Predicted Norms By Exposure Group, Adjusted And Unadjusted For Smoking History.

Exposure Group	Average Exposure Years	Number of Men	FEV_3 In Liters	
			Adjusted For Smoking History	Unadjusted For Smoking History
< 10 Years	3.1	8	-.13	-.13
10 - 19 Years	16.1	17	-.28	-.34
20 - 29 Years	24.5	17	-.19	-.14

Table 4. Percent Of $FEF_{25-75\%}$ Readings Below Predicted Norm By Exposure Group, Adjusted And Unadjusted For Smoking History.

Exposure Group	Average Exposure Years	Number of Men	% Of $FEF_{25-75\%}$ Below Predicted Norm	
			Adjusted For Smoking History	Unadjusted For Smoking History
< 10 Years	3.1	8	38	38
10 - 19 Years	16.1	17	42	47
20 - 29 Years	24.5	17	38	35

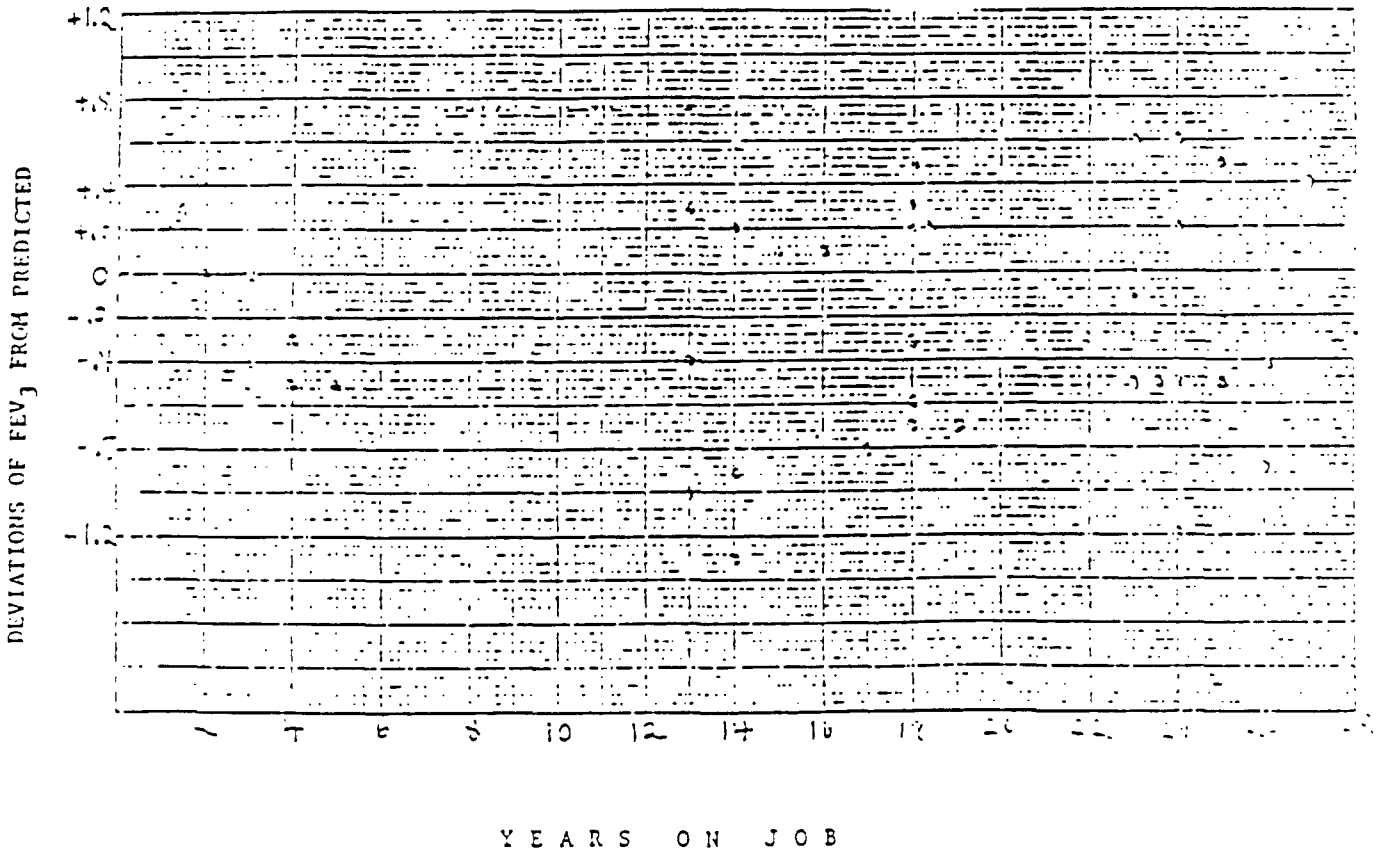
Table 5. Mean FEV_3 Readings Expressed As Deviations From Predicted Norms And Percent Of $FEF_{25-75\%}$ Readings Below Predicted Norm By Smoking Category.

Smoking Category	Number of Men	Deviations Of FEV_3 In Liters From Predicted Norms	% Of $FEF_{25-75\%}$ Below Predicted Norms
Nonsmokers	10	+.09	10
Current Smokers Of At Least One Pack Per Day	13	-.32	46
All Other	19	-.31	53

Table 6. Observed And Expected Deaths Among Insulators By Interval Since First Exposure

Interval Since First Exposure	Years Exposed To Risk	Total Deaths		Deaths Due To Respiratory Cancer	
		Observed	Expected	Observed	Expected
Total	942.1	2	4.4	0	.3
Less Than 20 Years	806.2	2	2.7	0	.2
More Than 20 Years	135.9	0	1.7	0	.1

FIGURE I. SCATTER PLOT OF DEVIATIONS IN FEV_3 FROM PREDICTED VERSUS YEARS ON JOB FOR 42 INSULATORS (ADJUSTED FOR SMOKING HISTORY)



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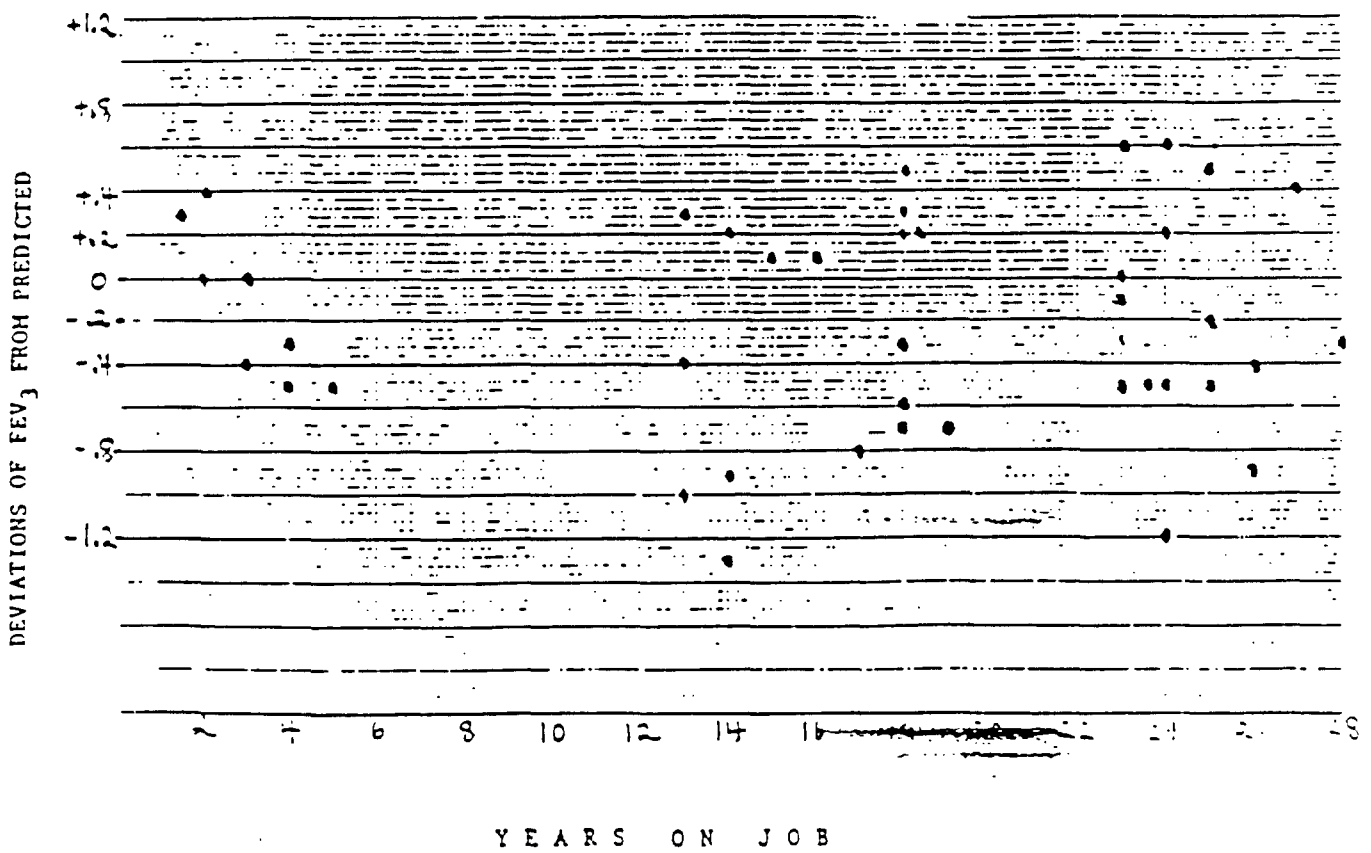

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