PLAINTIFF'S EXHIBIT
DOW-2941

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%).

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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.

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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.

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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.

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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.

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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

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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	17.6	18.4

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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

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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

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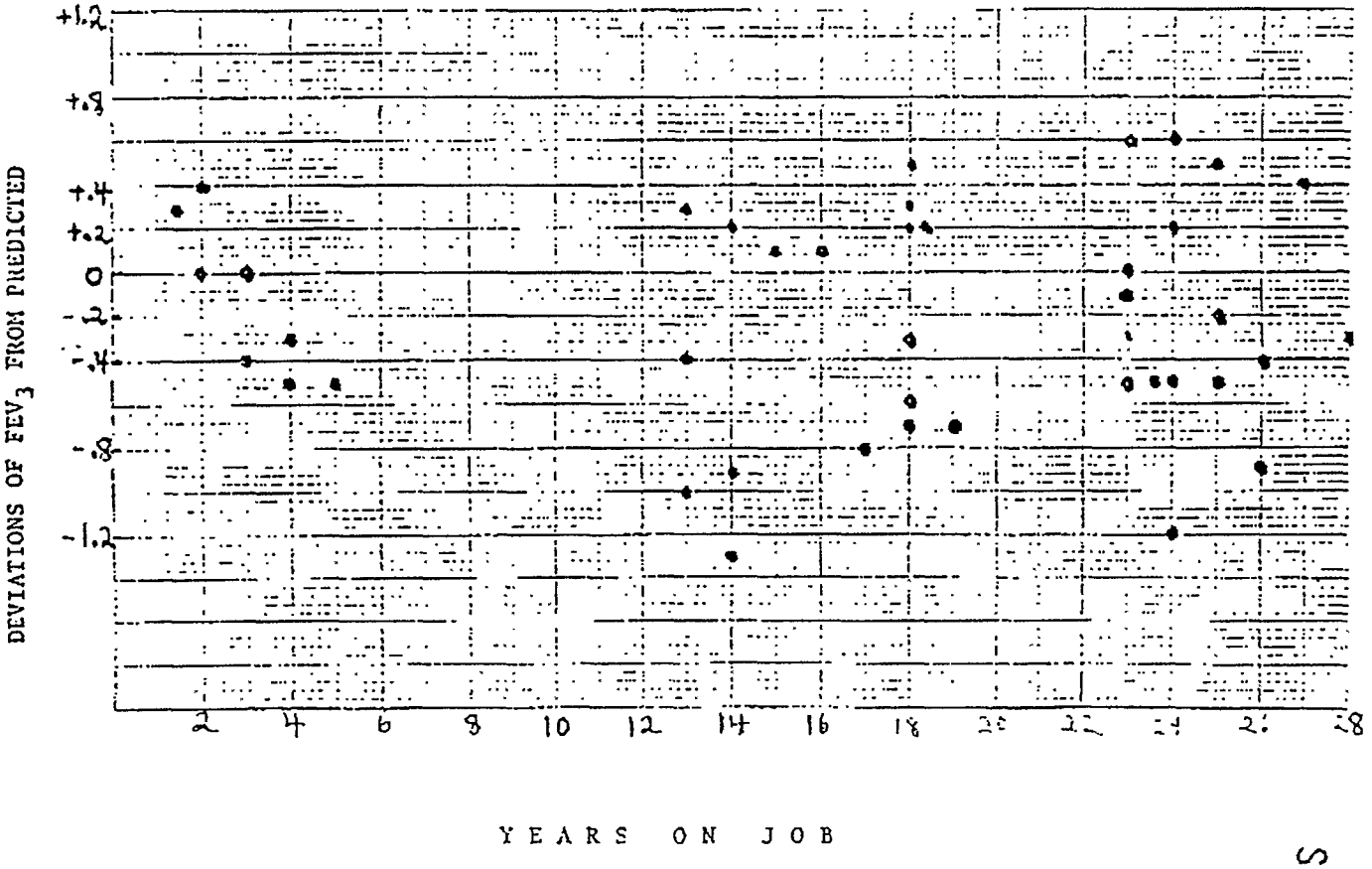
FIGURE I. SCATTER PLOT OF DEVIATIONS IN FEV_3 FROM PREDICTED VERSUS YEARS ON JOB FOR 42 INSULATORS (ADJUSTED FOR SMOKING HISTORY)



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