AIRWAY OBSTRUCTION AND REDUCED DIFFUSION CAPACITY IN SWEDISH ALUMINUM POTROOM WORKERS

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Aluminum is produced by electrolytic extraction from alumina (Al_2O_3) in the presence of fluoride. The aluminum potroom workers are exposed to various airborne contaminants such as aluminum-oxide, particulate and gaseous fluorides, sulphur dioxide and organic particles. Several investigators using dynamic spirometry have reported of obstructive lung function impairment in aluminum potroom workers[1,2,6,7] even without signs of atopy.[4] It has also been shown that exposure to alumina can cause pulmonary fibrosis in laboratory animals.[3] This study was undertaken in order to study the degree and nature of the affection of the lung function using more extensive lung function tests.

MATERIAL AND METHODS

Subjects

The exposed group consists of 38 male aluminum potroom workers (mean age 39 years, range 21–63 years) who had been employed for at least one year (mean 14 years, range 1–32 years). Twenty office workers (mean age 48 years, range 24–65 years) from the same factory served as controls. Only individuals without signs of atopy were included in the study. All participants were nonsmokers at the time of the investigation. In the exposed group 14 were ex-smokers and in the control group 8 were ex-smokers.

Exposure

During the last decade the local industrial health organization has performed frequent measurements of fluoride and total dust exposure. In 1987, when this investigation was performed, the participating potroom workers had a mean exposure of 0.4 mg/m^3 fluorides and 1.7 mg/m^3 total dust. The exposure is below the Swedish TLV values (fluorides 2 mg/m^3, total dust 10 mg/m^3).

Lung Function Measurements

The lung function tests were performed upright in the sitting position. The tests were performed twice or more, and the best value was chosen. Signals from the dry, rolling seal spirometer, the N_2-meter with a pneumotachograph, the CO-meter, and the body box of the hybrid type were computerized, and the calculation of different variables was guided by the cursor for interactive control of critical points in some curves. Following variables were calculated: vital capacity, total lung capacity, residual volume, forced expiratory volume in one second (FEV_1), maximal expiratory flow at 50% of the forced vital capacity (MEF_{50}), mean transit time, closing volume, slope of the alveolar plateau, and single breath pulmonary diffusion capacity (TL_{COSB}).

Bronchial Challenge Test

Bronchial provocations were performed by inhalations in a De Vilbiss Nebulizer of methacholine in increasing concentrations from 0.5 mg/ml, each incremental of dose representing a four-fold increase of the methacholine concentration. Peak expiratory flow was measured three minutes after starting the inhalation. The provocation was ceased when PEF decreased 20% or more of the pre-challenge values or after inhalation of the highest concentration (32 mg/ml). Calculations of the concentrations of methacholine that yields a decrease in PEF of 20 and 10% from the pre-challenge values was performed.

Statistics

Values of the lung function measurements were calculated as percent of reference values used at the laboratory. Values from the bronchial reactivity test were transformed to logarithms before analysis. Statistical analyses were performed by two-tailed Student's t-test for independent observations.

RESULTS

The individuals in the control group were older than in the exposed group. There were no significant differences in the previous smoking habits between the groups. One individual in each group had a mild bronchial asthma, but none of the participating subjects had considerable symptoms from the airways.

The controls had normal lung function values compared to the reference values. In the exposed group there was significantly decreased FEV_1 ($p<0.005$), MEF_{50} ($p<0.01$), and TL_{COSB} ($p<0.05$), whereas RV was significantly increased ($p<0.05$) compared to the control group. No other differences were significantly different between the exposed and control groups. Nor were there any differences in bronchial reactivity.

DISCUSSION

This investigation has shown an obstructive lung function impairment but no bronchial hyperreactivity in aluminum potroom workers. Further they had a reduced diffusion capacity compared to the control group. The control group was chosen from the same aluminum reduction plant as the potroom workers. Since the number of current non-smokers was limited it was not possible to match the groups for age, and the comparison of lung function tests between the groups was performed after that the values were expressed as percent of predicted values in order to abolish the confounding effect of age.

The results with obstructive lung function impairment is in accordance with several other studies,[1,2,4,6,7] but these studies have often shown a more pronounced reduction in lung function. Neither did we find any affection on the bronchial reactivity, which has earlier been reported.[5] These discrepancies from earlier studies can be explained in several ways. Only men without known lung or atopic diseases have been employed in the present industry. Further the exposure to dust and fluorides is low compared to many other aluminum reduction plants, and the use of respiratory protection equipment has been frequent.

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BLOOD PROLIFERATION TO BERYLLIUM: ANALYSIS BY RECEIVER OPERATING CHARACTERISTICS

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ABSTRACT

Chronic beryllium disease is a cell mediated granulomatous lung disease. Since testing of beryllium proliferation of bronchoalveolar lavage cells appears to be diagnostic of this entity, we re-evaluated the proliferative response of blood cells to beryllium to see if it could have utility for screening. Twenty-seven patients with chronic beryllium disease, documented by histology and a positive lung proliferative response to beryllium, were compared to 30 controls. Beryllium proliferative response (stimulation index or SI) was tested with 4 different concentrations (0.1–100 μM) of BeF_2 and $BeSO_4$ on day 3, 5 and 7 of *in vitro* culture (24 tests). A greater variance of the SI of the control cells by beryllium was noted with increased time in culture and decreased concentrations of beryllium. A significant difference was observed between beryllium patients and controls only with 100 or 10 μM beryllium salts. To evaluate the optimum stimulation index, receiver operating characteristic (ROC) curves (true positive vs. false positive) were generated. With a predicted maximum prevalence of 3%, a slope of 33 on the ROC curve would equate the gain of finding a case with the costs of misdiagnosis. Maximum sensitivity (31%) was observed by testing with 100 μM BeF_2 or $BeSO_4$ on day 3 and 5 using a SI of >3. This suggests that blood proliferation to beryllium may be useful in screening for chronic beryllium disease. Application of medical decision theory and the receiver operating characteristic curve should be useful for evaluating screening tests for occupational lung disease.

No Paper provided.

PATHOLOGIC AND IMMUNOLOGIC ALTERATIONS IN BERYLLIUM DISEASE IDENTIFIED AT EARLY STAGES BY FIBEROPTIC BRONCHOSCOPY AND BERYLLIUM-SPECIFIC LYMPHOCYTE ASSAY

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ABSTRACT

Beryllium lung disease is a chronic granulomatous disorder in which a beryllium-specific immune response plays a central role. Prior research has demonstrated that lymphocyte activation by beryllium salts, an *in vitro* measure of the cellular immune response, has high specificity and sensitivity for chronic beryllium disease. In the present study 20 beryllium-exposed workers underwent complete clinical evaluation, including chest radiograph, pulmonary physiology, exercise physiology, bronchoalveolar lavage (BAL), lung biopsy, and lymphocyte transformation tests (LTT) of blood and BAL lymphocytes. We identified 12 cases of beryllium disease each of whom had pathologic changes on biopsy, lymphocytic alveolitis on BAL, and positive LTTs. This group of patients was remarkable for its paucity of clinical findings. Five had minimal or no respiratory symptoms, four had normal physical examinations. Five had no increase in interstitial markings on chest radiograph. In nine cases, pulmonary function tests were normal or showed mild airflow limitation, normal diffusing capacity for carbon monoxide and normal oxygen exchange during exercise. Eight beryllium-exposed workers were found to have non-beryllium lung diseases; two of these eight demonstrated beryllium sensitization. We conclude that by using fiberoptic bronchoscopy with transbronchial biopsy and BAL to obtain lumphocytes for testing beryllium sensitization, it is possible to identify beryllium workers who have histopathologic and immunologic alterations consistent with chronic beryllium disease. These findings may precede frank clinical illness and physiologic impairment, having important implications for our understanding of the natural history of beryllium disease.

No Paper provided.

EVALUATION OF LUNG BURDEN IN STEEL FOUNDRY WORKERS

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INTRODUCTION

Pneumoconiosis, which has been regarded as silicosis is the best known occupational lung disorder of foundry workers. The main hygienic attention has been focused on silica. However, metal fumes and dusts are generated by several foundry activities. Inorganic material emitted from the furnace, ladles, and castings in iron foundries consists of compounds of iron, manganese, calcium, magnesium, aluminum and silica. Fumes and dusts generated from alloyed steel melting and cast cleaning contain in addition chromium and nickel compounds. Chromium and nickel compounds may cause a large variation of different reactions in the respiratory tract.

The quantity of magnetic material retained in the lungs can be estimated by measuring the remanent magnetic field of the chest area. Because the worker's exposure has often been heterogenous, an MPG instrument with a pulse coercive force unit was used to detect the magnetically dominating particle population in the lungs. The MPG instrument that senses dust quality has been described earlier by Kalliomäki and coworkers.[1,2] Urinary chromium and nickel excretions have been recently applied as a biological monitoring method in workers exposed to some chromium and nickel compounds.

The aim of the study was to estimate the levels of magnetic material retained in the lungs in steel foundry workers representing typical occupations. The MPG results are compared with urinary chromium and nickel values among a group of the studied subjects.

MATERIAL

Subjects

We studied 61 workers representing various typical occupations in one steel foundry (Table I). Of the subjects studied, 32 persons worked in the foundry hall and 29 in the fettling shop. The lung functions (VC=vital capacity; $FEV_{1.0}$ =forced expiratory volume in ls; MMEF were within the normal limits).

Working Environment

This steel foundry produces a wide selection of acid resistant and stainless steel parts for the cellulose and chemical industry. The foundry also produces iron casting. The industry hall and the fettling shop are located in separate buildings. In the foundry studied, the working conditions have received considerable attention. The total dust levels, silica and metal concentrations decreased essentially due to the improvements in ventilation and working methods. In this foundry the average total dust levels in personal samples and general airborne samples were about 3-4 mg/m^3 during 1976–1980.

The steel cast cleaning is performed by flame cutting, carbon arc gouging and grinding. Manual metal arc (MMA) welding is also done. Dust concentrations measured by personal sampling in the fettling shop at different times varied from 2 to 20 mg/m^3 and the metal concentrations ranged from 1 to 7 mg/m^3 for iron, from 60 to 790 μg/m^3 for chromium, and from 50 to 1100 μg/m^3 for nickel. Chromium and nickel concentrations were determined in urine spot samples collected after working hours several times among the workers in the fettling shop during 1982 and 1984. The average urinary chromium and nickel levels expressed as umol/l were 0.60 and 0.32 for welders, 0.66 and 0.37 for flame cutters and carbon arc cutters and 0.08 and 0.08 for grinders.

Dust Samples

Preliminary magnetic measurements have been made for some dust samples collected from the foundry and fettling shops (Table IV). The samples were collected on millipore filters.

METHODS

The *in vivo* MPG measurements were performed with a magnetopneumograph instrumentation with dust quality sensing.[1,2]

Measurement of the coercive force of dust retained in the lungs is complicated: the object to be measured is substantial, the dust is quite low and the orientation of particles (relaxation) due to the static demagnetizing field creates errors.

The application of the static demagnetizing field can be avoided if a pulse coercive force (H_{cp}) is measured instead of the coercive force. The pulse coercive force is the amplitude of a short demagnetizing pulse, which demagnetizes a previously magnetized sample. Measurements of dust samples show that the pulse coercive force depends on the process generating the dust, in the same way as the coer-

Table I

Occupation, Number and Exposure Time and Lung Functions of the Studied Steel Foundry Workers

Group	N	Exposure time (a)		VC		$FEV_{1.0}$		MMEF	
		mean	SD	mean	SD	mean	SD	mean	SD
In the foundry hall									
1. Molders, core makers	9	24	7	97	17	97	19	91	41
2. Smelters, furnace men	6	13	6	95	10	99	6	91	26
3. Workers shaking out castings	4	21	7	90	6	98	9	100	18
4. Foremen, cleaners	13	8	5	98	13	101	13	101	14
In the fettling shop									
5. Flame cutters, carbon arc cutters	11	12	6	106	15	107	16	96	30
6. Fettlers (grinders)	13	18	8	100	16	102	21	94	28
7. Manual metal arc	5	16	9	101	14	107	15	107	18

cive force. As the duration of the demagnetizing pulse can be short (less than ls) the orientation error is minimized.

The pulse coercive force of the dust in the lungs is the first parameter to be measured. First the chest area of a subject is magnetized with a short pulse (50 mT, 0.5 s), and the remanent flux density of the lungs (B_{r1}) is measured several times. One minute after the magnetization, a fixed demagnetization pulse (15 mT, 0.5 s) is applied, and the remaining flux density (B_{r2}) is measured as earlier. The ratio B_{r2}/B_{r1} is the measure of the coercitivity or magnetic hardness of the dust. This ratio varies from 0.00 to 0.40 depending on the quality of the dust.

The measurements of the magnetic properties of dust samples were made by a microcomputer-controlled magnetometer.[3]

RESULTS

In the foundry shops the average magnetic field and pulse coercive force measured in different occupational groups did not differ essentially in the various group (Table II). These results indicate that the metal particles originate from the same source and that not only smelters, casters and furnace, men but also molders and core makers have lung retention of metallic dust. The figure of magnetic hardness indicated that dusts and fumes are magnetically "soft" material. In the fettling shop the highest remanent magnetic moment was observed among flame cutters and carbon arc cutters (Table II). The figure for magnetic hardness measured in different groups also varied. The figure for magnetic hardness differed significantly from that found in fumes from the melting and casting process.

The results for the magnetic properties of dust samples collected from the same working processes in the foundry and fettling shops are presented in the Table IV. The preliminary results indicated that the magnetic properties of the dust samples from the different working processes in the foundry varied remarkably. A systematic study for characterization of dust and fumes from different working activities would therefore be needed to find suitable calibration factors between the remanent magnetic field and the amount of dust, retained in the lungs.

Table II

The Results of the Magnetopneumograph (MPG) with Dust Quality Sensing of the Studied Steel Foundry Workers

Group	N	Number of smokers	Average magnetic field (B/nT)		Appr. amount of dust	Figure of magnetic hardness (B_{r2}/B_{r1})	
			mean	g	g	mean	SD
In the foundry hall							
1. Molders, core makers	9		0.5	2.0	0.1	0.09	0.05
2. Smelters, furnace men	6		0.5	1.8	0.1	0.07	0.12
3. Workers shaking out castings	4		0.4		0.1	0.07	
4. Foremen, cleaners	13		0.3	1.3	0.05	0.05	0.05
In the fettling shop							
5. Flame cutters, carbon arc cutters	11		5	4.4	0.2	0.27	0.09
6. Fettlers (grinders)	13		0.5	3.0	0.1	0.37	0.19
7. Manual metal arc (MMA) welders	5		3	2	1.0	0.28	0.14

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Table III

Individual Exposure Parameters: Average Magnetic Field (B), Urinary Chromium (U-Cr) and Nickel (U-Ni) Determined for Some Subjects in the Fettling Shop

Subject	Occupation	exposure time (a)	U-Cr (umol/l)	U-Ni (umol/l)	B lungco (nT)
1.	welder/MMA	10	0.55	0.22	3
2.	1. flame cutter 2. welder/MMA	9 3	0.85	0.43	5
3.	flame cutter and carbon arc cutter	9	1.07	0.74	2
4.	flame cutter and carbon arc cutter	12	0.51	0.69	7
5.	1. flame cutter 2. grinder	8 9	0.08	0.08	2
6.	flame cutter and carbon arc cutter	5	0.85	0.41	6
7.	flame cutter and carbon arc cutter	4	0.33	0.24	2
8.	1. grinder 2. flame cutter	6 3	0.12	0.12	1
9.	flame cutter and carbon arc cutter	10	0.09	0.13	0.2
10.	flame cutter and carbon arc cutter	13	0.33	0.33	15
11.	1. grinder 2. flame cutter	10 3	0.26	0.36	0.7
12.	flame cutter and carbon arc cutter	14	1.24	0.42	4
13.	grinder	11	0.2	0.19	0.2

U-Cr < 0.05 umol/l, unexposed subjects
U-Ni < 0.10 umol/l, -"-

Table IV

Specific Remanent Magnetic Moment M_{rs} (Am^2/kg) and Pulse Coercive Force H_{cp} (kA/m) for the Dust Samples Collected from Some Working Processes in the Steel Foundry and Fettling Shops

Sample	N	M_{rs} (Am^2/kg)		H_{cp} (kA/m)	
		mean	SD	mean	SD
Sample collected from working area near direct arc furnace	4	0.23	0.11	24.9	11.4
Sample collected from breathing zone of carbon arc cutters of acid resistant steel casting	6	2.9	0.5	30.5	0.3
Sample collected from breathing zone of grinders of acid resistant steel casting	4	1.7	0.05	12.5	0.1
Manual metal arc (MMA) welding of acid resistant steel casting	5	0.6	0.06	20.5	0.9
Ambient air sample collected from the fettling shop		1.8	0.1	24.5	1.2

SCREENING LUNG FUNCTION USING SINGLE BREATH CARBON MONOXIDE DIFFUSION CAPACITY

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Routine pulmonary function testing as an industrial screening and diagnostic tool has been used for over 40 years within the beryllium industry. By today's standards, the first tests were crude measures of forced vital capacity (FVC) using instruments designed to follow post surgical patients. However, the relative inaccuracies of the methods and equipment were offset by a weekly frequency of testing. Using this crude data interpretation between individual tests was difficult, but utilizing mean changes or sliding means improved the sensitivity and proved a useful means of identifying or following employees with significant respiratory disease. Cases of acute beryllium disease were always associated with significant changes in the vital capacity, but those changes accompanied or followed the onset of significant symptoms or chest radiographic changes. However, this early experience proved that frequent testing is much more valuable than annual or even semi-annual determinations. Early pulmonary function findings in chronic beryllium disease (CBD) are frequently subtle and often not appreciated until symptoms or radiographic changes have already appeared.

Early reports by Gaensler et al.[1] indicated the functional changes in CBD are restrictive in type and the most marked changes were seen in the carbon monoxide diffusion capacity during both the steady state test and exercise. Ferris[2] also noted an increased alveolar-arterial oxygen difference. This finding was also noted by Gaensler.[1] In 1969 Andrews, Kazemi, and Hardy[3] reporting on 41 cases of CBD followed over several years observed that 39% showed an obstructive spirometric pattern while only 20% were of the restrictive type and only 36% showed an interstitial picture. Our own experience in over 60 cases of CBD covering over 40 years is similar to the findings of Rossman et al.[4] where gas transfer and/or increased oxygen alveolar-arterial gradient were the most marked and consistent functional defects.

In our series the major functional spirometric changes were of the restrictive type. When obstructive changes were noted they appeared either late in the course of the disease or when cigarette smoking was present as a confounding factor. In some cases the spirometric changes were minimal while in others there was a significant decline in both the FVC and the one second timed vital capacity (FEV_1). Our experience has not included a case where the FEV_1 declined more rapidly than the FVC. In selected cases the FVC declined more rapidly than the FEV_1, but the excess rate was not significant.

In view of the fact that the first pulmonary function changes frequently affect gas transfer before any appreciable changes are seen in spirometry values and overcome the shortcomings of spirometry alone single breath carbon monoxide diffusion (DLCO) studies were introduced as a routine screening measure in 1975. An arbitrary, routine frequency of twice a year was initially selected which, for our purposes, this has proven to be both an effective and workable frequency.

Despite the much greater technical difficulties associated with measuring DLCO accurately, this additional parameter has not only been technically feasible in the industrial settings but also very valuable as a screening tool for the early identification of interstitial pulmonary changes. As our previous experience with vital capacity determinations had shown, the frequency of measurement is paramount to provide the sensitivity to identify the early interstitial changes. The DLCO has shown a significant change in some cases before while the FVC, FEV_1, and flow rates have remained constant. Figure 1 shows the DLCO and FVC of a 30 year old male who eventually became symptomatic and had CBD confirmed by beryllium, lung lymphocyte proliferation studies and transbronchial biopsy. It is readily seen that his DLCO declined significantly while his FVC actually increased or remained constant for over a year before it commenced to fall.

Only one of our cases (Figure 2) which have been diagnosed since the initiation of DLCO measurement, has not shown a noticeable change in the DLCO. This case was initially identified by very subtler radiographic changes which in retrospect seem to have first appeared concomitantly with the introduction of DLCO determinations. This case has been asymptomatic and by older diagnostic procedures would probably still be only a suspected or questionable case; however, his pulmonary lymphocytes show an enhanced T-4/T-8 ratio, they proliferate upon stimulation with both beryllium sulfate and beryllium fluoride, and he has typical granulomas in his transbronchial biopsy. Both his spirometry and diffusion values have remained around 100% of his predicted values and declined at a predicted rate. (Figure 3)

Figure 4 represents a male who first became symptomatic in 1984 with bronchitis-like symptoms of cough and mid chest discomfort. It can be seen his spirometry values were not remarkable; however, over the next 1-1½ years he

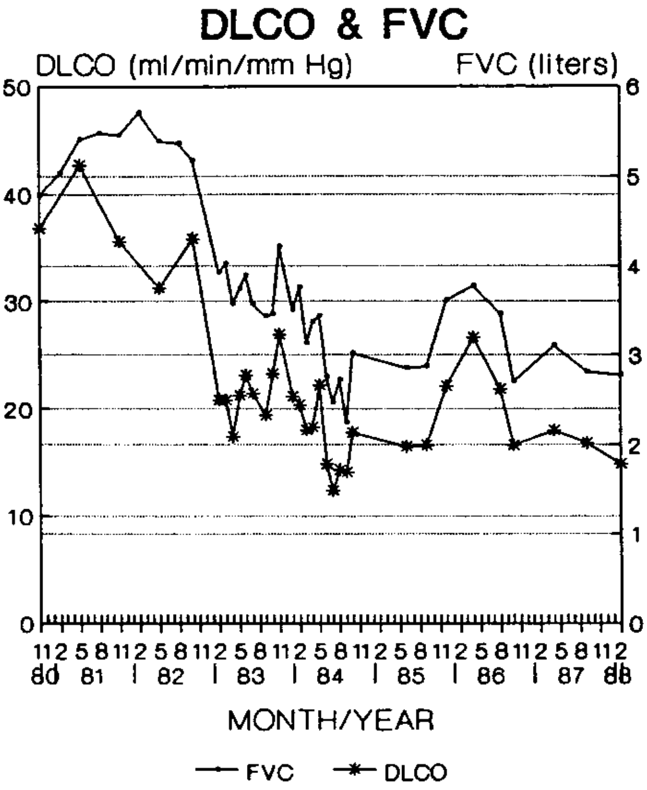

Figure 1

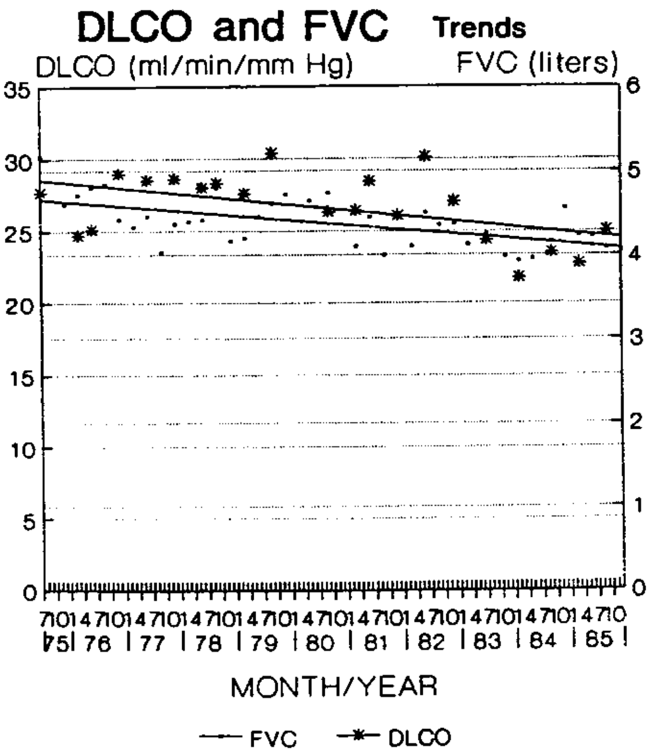

Figure 3

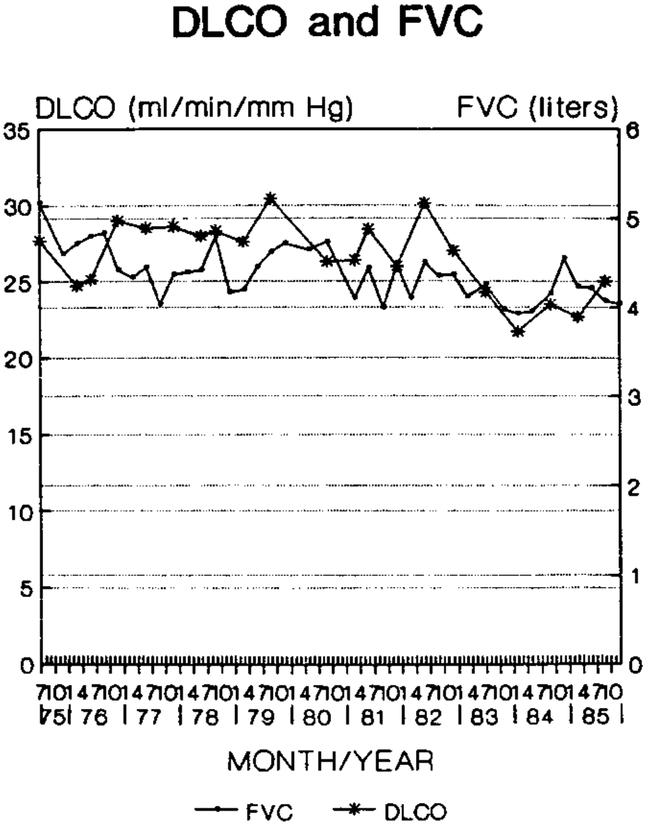

Figure 2.

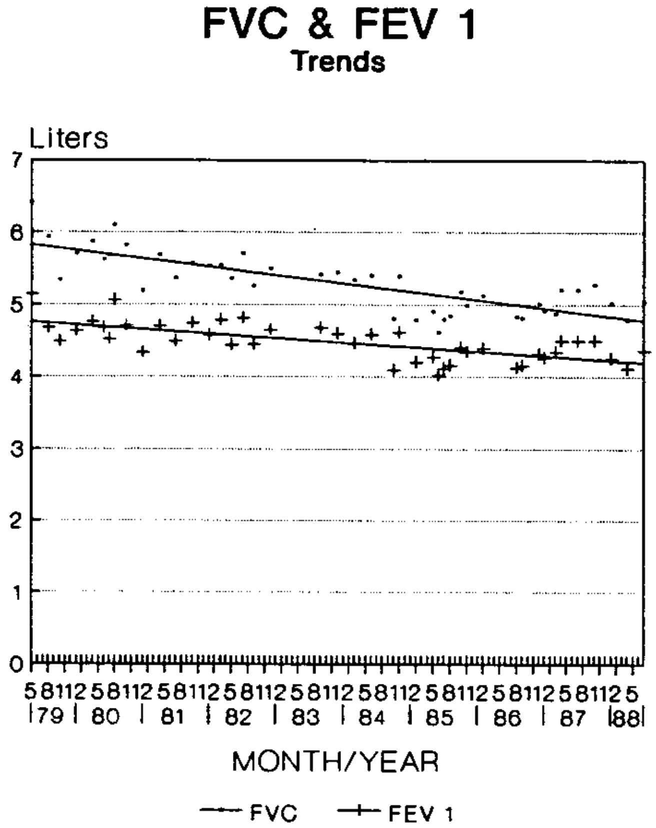

Figure 4

showed a steady but not drastic decline in DLCO. (Figure 5) The patient has continued to have some vague chest discomfort, but his DLCO and spirometry values have remained greater than 100% of predicted. Nonetheless, he underwent bronchoalveolar lavage and a transbronchial biopsy which confirmed his pulmonary cells were sensitive to beryllium stimulation and he had granuloma in the biopsy. At the present time his most significant physiological finding is an arterial blood oxygen of 79% saturation.

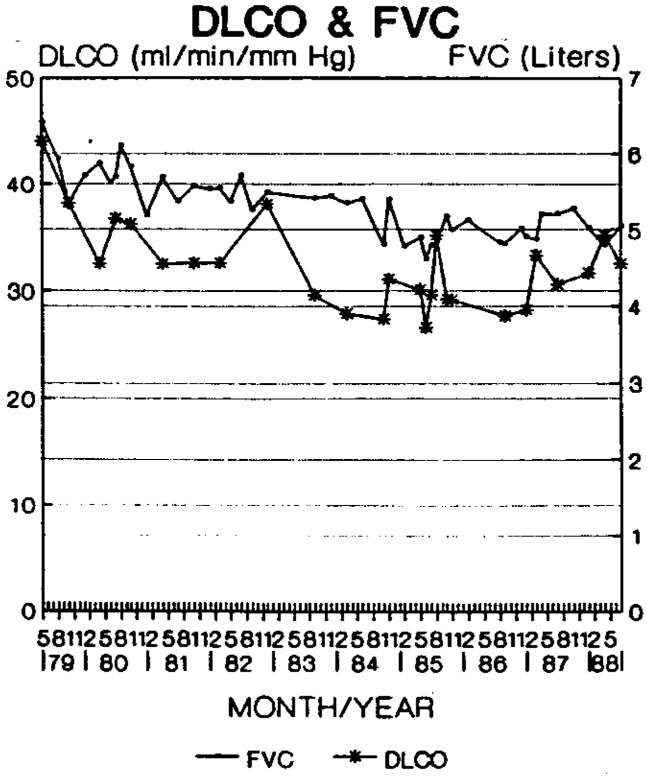

Figure 5.

The next case (Figure 6) is a 42 year old female who presented in August 1984 with persistent respiratory symptoms and a significant initial drop in both FVC and DLCO. Her physical examination and chest radiograph were clear. We elected to follow her for a few months before proceeding with further diagnostic testing. When she first became symptomatic, we had not had any experience with pulmonary lymphocyte proliferation studies and still had to rely upon chest X-ray to indicate significant changes were occurring. For the next year her FVC fluctuated but seemed to stabilize; however, the DLCO continued to decline. Early in 1986 in view of the significant decline in both FVC and DLCO, further studies including bronchoscopy and biopsy were being planned. At the same time her annual chest X-ray showed bilateral interstitial infiltrates. The proliferation studies and biopsy confirmed a diagnosis of CBD which had been suspected earlier based upon the DLCO screening studies. This case is unusual in that the rate of decline in DLCO has been greater than the decline in spirometry. (Figure 7) In nearly all of our other cases the regression curves for both these values are parallel over time.

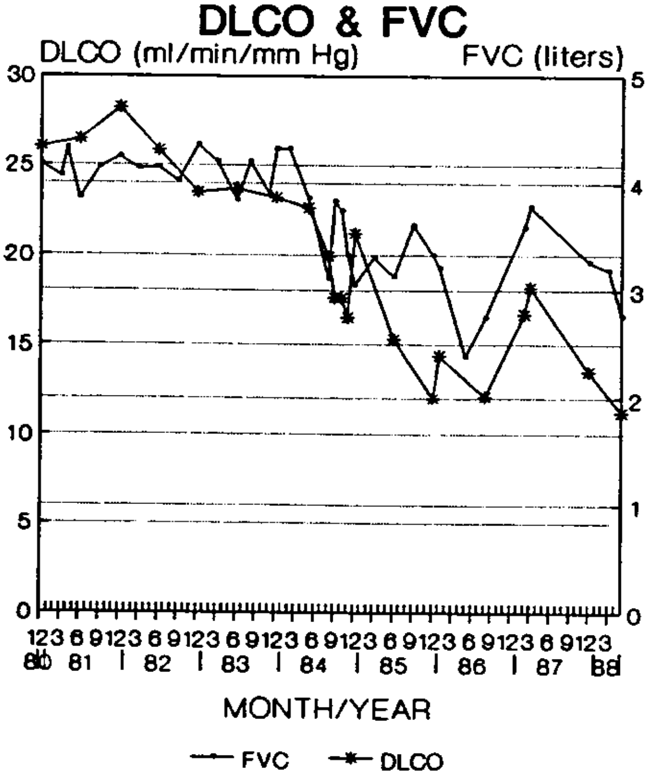

Figure 6

Figure 8 is a 55 year old male who became symptomatic several years before DLCO testing was introduced to his plant site. Despite repeated diagnostic studies which did not include lung biopsy a firm diagnostic conclusion could not be made. His FVC was declining at an excessive rate, and the scattered DLCO studies which were available further indicated pathology existed. In 1985 he underwent bronchoalveolar lavage with beryllium proliferation studies and transbronchial biopsy confirming the working impression of CBD. Steroid therapy was introduced and he has stabilized with a moderate amount of pulmonary impairment.

The last case (Figure 9) is a 30 year old male who worked in the beryllium reduction process where beryllium hydroxide is reduced to beryllium metal. An intermediary step in the process involves the melting of beryllium fluoride. Over a period of several days there were episodic releases of BeF_2. A few months later he developed marked pulmonary symptoms and a profound drop in both spirometry and DLCO. (Figure 10) However, the DLCO changes were the earliest and most dramatic. He was immediately removed from the beryllium reduction process and showed a rapid, significant improvement in his pulmonary function values. In view of a normal chest X-ray and the dramatic recovery, there remained a serious question concerning a beryllium etiology to his physiological changes; therefore, he returned to work in the original work area. Almost immediately, he again demonstrated a drop in spirometry and DLCO, and he was immediately removed from all further exposure to beryllium. Again his pulmonary functions significantly im-

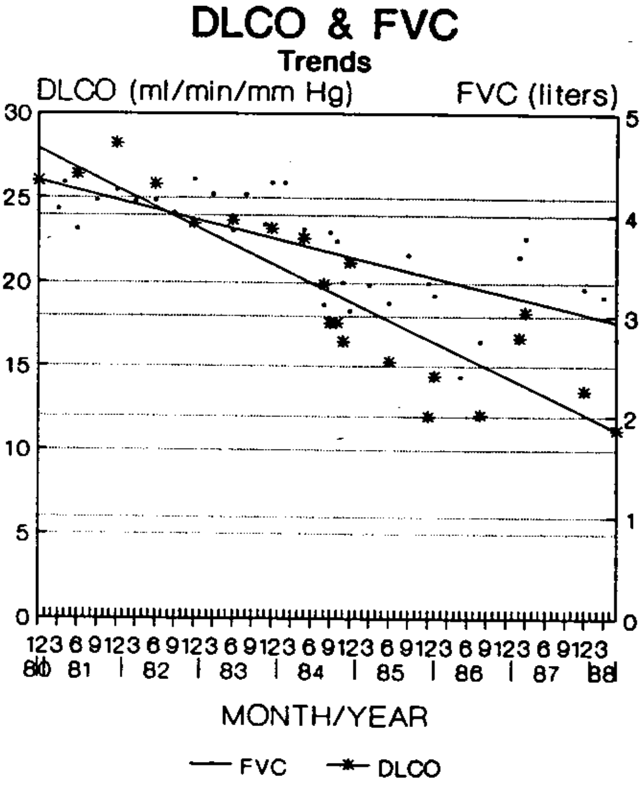

Figure 7

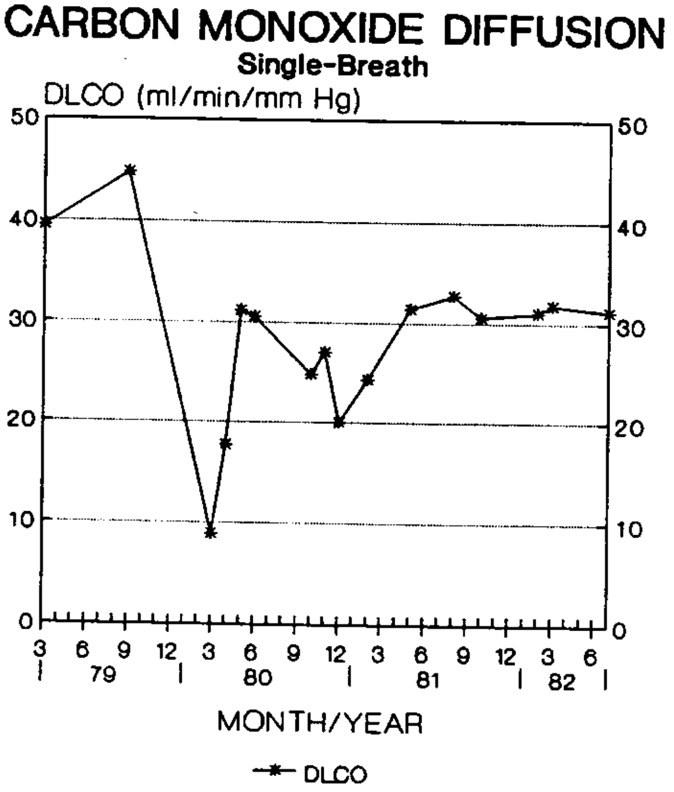

Figure 9

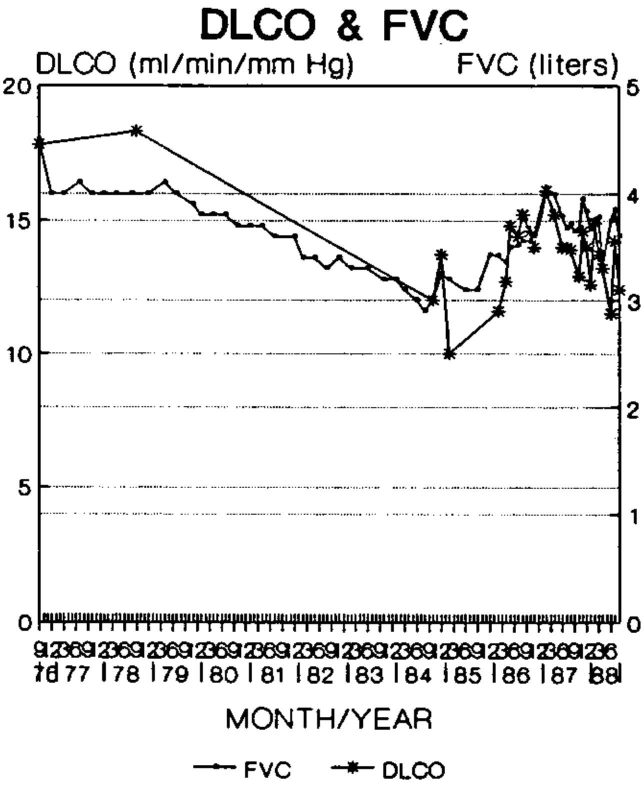

Figure 8

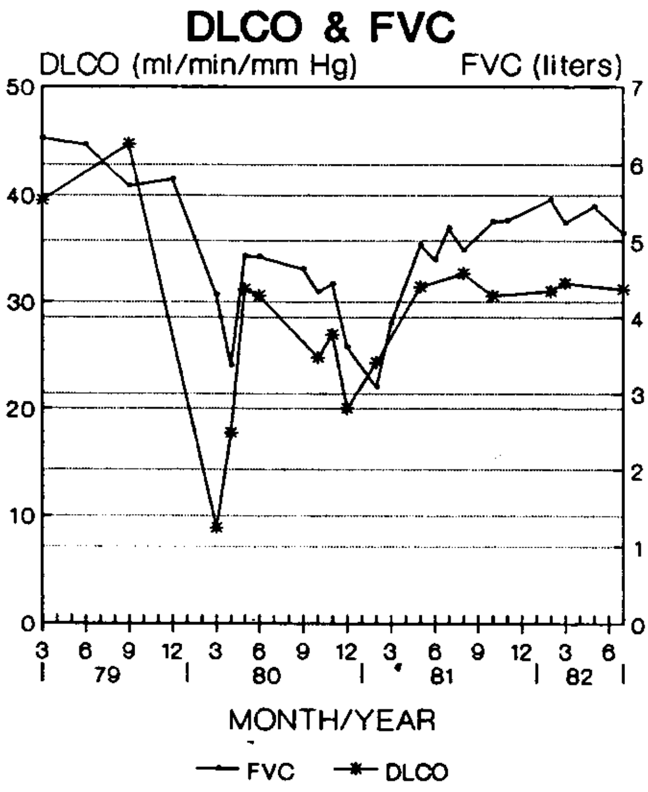

Figure 10

proved. Subsequent proliferation studies and biopsy have shown his pulmonary lymphocytes are sensitized to beryllium and his biopsy shows granulomas. He remains asymptomatic and works in an area away from potential exposure to beryllium.

In conclusion our experience over the past thirteen years has indicated that routine, single-breath, carbon monoxide diffusion studies are possible and feasible in an industrial clinic. In cases of interstitial disease the DLCO generally is the first parameter to change and, over a long term, closely parallels spirometric changes. The DLCO may be abnormal before either the chest radiograph or spirometry is affected. Furthermore, when abnormal in CBD cases, the spirometric pattern has been restrictive with obstructive changes have only observed where there has been a heavy concomitant use of tobacco. Also, frequent use of in-house diffusion measurements is a simple and convenient means of following a response to therapy.

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HEALTH EFFECTS OF HIGH DUST EXPOSURE AMONG WORKERS FROM MILLING PROCESS PULVERIZATION IN FOUNDRY GOLD-BARS ENTERPRISE

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ABSTRACT

All were men aged from 19 yrs to 72 yrs, of which 68% were from 20 yrs to 49 yrs and 30% were 50 years or more. ***Radiographic examination:*** Resumes X-ray findings according to the ILO standard. The 60.5% of the whole group had less than 10 years of exposure. This group showed 62% of NORMAL X-ray and 38% were abnormal by adding 27.5% of suspicious findings and 10.3 of positive findings. The second group had 10 to 35 years of exposure. This group showed 15.7% of NORMAL X-ray films and 82.3% of abnormal films of which 42.1% were suspicious and 42.3 positive. It is evident that the positive X-ray is closely related to the longer exposure time. ***Spirometric study:*** Table III, shown in the group of less than 10 years of exposure 28.5% of NORMAL FILMS and 71.5% of abnormal films composed by 32.1% of pure obstructive syndrome, 17.8% of pure restrictive syndrome and 21.4% as mixed syndrome. In other words, the syndrome of respiratory obstruction in total reached to 53.5% and the restrictive reached 39.2%. The group of workers with 10 to 35 years of exposure was 39.2% of the whole group from which only 11.1% were normal and 78.3% abnormal: 44.4% were pure obstructive syndrome, 16.6% of pure restrictive syndrome and 27.7% of mixed lung function. ***According to the smoking habit:*** X-ray findings. The group of NOT Smoking showed 51.4% of normal telefilms and 48.6% of abnormal films adding 34.3 of suspicious and 14.3% of positive X-ray findings. The group of smokers showed only 23% of NORMAL X-rays and 77% of abnormal test-films. We compare the same relationship, moving from the X-ray examination to the lung function tests, the latter being the major power of diagnosis. Unfortunately the lung function test has no specificity and only the X-ray finding together with the occupational history of work is of diagnostic value.

In order to complete the evaluation of the area of inorganic dust exposure, the National Pneumoconiosis Program scheduled the study of the workers population exposed to hard rocks' dust of golden miners at the south of the country.

Our study involved more than five groups of workers from both upper and underground jobs as from oldest to modern extraction-industrial processes.

Particularly we focused on one group of 48 workers exposed to high levels of breathable dust particles about five times above the permissible level from the primary trituration to the final pulverization workplaces.

They were all men aged from 10 years to 72 yrs, (Table I), 68% of them from 20 yrs to 49 yrs and 30% from 50 years or more.

During the time of exposure they were grouped in two main categories—those with less than 10 years (Group I = 60.5%) and those with 10 years up to 35 years (Group II = 39.5%). The number of smokers is written below that of the non-smokers, although this table is made in order to compare the effect of the time of exposure on the X-ray, spirometry and alveolar diffusion test.

Table I
Groups of Ages

AGE YEARS	NUMBER	%
< 20	1	2
20 - 29	13	16,5
30 - 39	7	15
40 - 49	13	26,5
50 - 59	7	15
60 y M.	7	15
TOTAL	48	100

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In order to see the effect of the smoking habit in this high dust exposed group of workers we reorganized them according to the NOT Smoking (NS) and smoking (S) for the effect on the X-ray, spirometric and diffusion test results.

RESULTS

Radiographic Examination

Table II, resumes X-ray findings according to the ILO standard. The 60.5% of the whole group had less than 10 years of exposure. This group showed 62% of NORMAL X-ray and 38% were abnormal by adding 27.5% of suspicious findings and 10.3 of positive findings.

The second group had 10 to 35 years of exposure—This group showed 15.7% of NORMAL X-ray films and 82.3% of abnormal films of which 42.1% were suspicious and 42.3 positive. It is evident that the positive X-ray is closely related to the longer exposure time.

Spirometric Study

The Lung function tests performed were VC, FEV_1, MEF 25, MEF 50, MEF 75, PF, MVV, TC, RV, RV/TLC and alveolo-diffusion test. This test allows us to classify the main function disturbances such as the syndrome of restrictive and ventilatory obstruction and the lung diffusion capacity diminution.

Table III—Showed in the group of less than 10 years of exposure 28.5% of NORMAL FILMS and 71.5% of abnormal films composed by 32.1% of pure obstructive syndrome, 17.8% of pure restrictive syndrome and 21.4% as mixed syndrome. In other words the syndrome of respiratory obstruction in total reached 53.5% and the restrictive reached 39.2%.

The group of workers with 10 to 35 years of exposure added 39.2% of the whole group, from which only 11.1% were normal and 78.3% abnormal: 44.4% were pure obstructive syndrome, 16.6% of pure restrictive syndrome and 27.7% of mixed Lung function syndrome.

Table IV—Shows the results of the application of the alveolo-diffusion test exploration (DLCO).

Only 14.8% of decrease DLCO was found in the group of less than 10 years of exposition.

The second group of 10 to 35 years of exposure showed 17.8% of DLCO decreases.

In order to make it easier for the reader to see the differences between the main groups we performed the following three Tables, V, VI and VII.

It is evident to see in Tables V, VI and VII that the increase of the risk has direct relationship with the time of

Table II

X-ray (Telefilm 14" × 17") Results

EXP. YEAR	NORMAL %			SUSPICIOUS %			POSITIVE %			ABNORM %	TOTAL %		
<10 YRS.	NS 15 S 3	18	62	NS 7 S 1	8	27.5	NS 2 S 1	3	10.3	38	NS 24 S 5	29	60.5
>10 to 35 yrs.	NS 3 S 0	3	15.8	NS 5 S 3	8	42.1	NS 3 S 5	8	42.1	.84.2	NS 24 S 8	19	39.5
TOTAL		21	43.7		16	33.3		11	22.9			48	100

Table III

Spirometry Results

EXPOSURE TIME	NORMAL %			OBSTRUCTION %			RESTRICTION %			MIXED %			T.. ABN.	TOTAL	
< 10 yrs.	NS 7 S 1	8	28.5	NS 7 S 2	9	32.1	NS 4 S 1	5	17.8	NS 6 S 0	6	21.4	71.5	28	60.8
10 to 35 yrs.	NS 1 S 1	2	11.1	NS 7 S 2	8	44.4	NS 4 S 1	3	16.6	NS 2 S 3	5	27.7	88.8	18	39.2
TOTAL		10	21.7		17	37		8	17.3		11	24.1		46	100

Table IV

Alveolar-Diffusion Test

EXPOSURE TIME	NORMAL %	DICREASE %	TOTAL %
< 10 yrs	NS 19 S 4 23 85.1	NS 4 S 0 4 14.8	27 60
10 to 35 Years.	NS 9 S 5 14 77.8	NS 2 S 2 4 22.2	18 40
TOTAL	37 82.2	8 17.8	45 100

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Table V

Radiology

EXPOSURE YRS.	% NORMAL	% ABNORMAL	TOTAL
< 10	62	38.0	100
>10 to 35	15.7	84.3	100

X^2 = 8.87 > 3.84 P= 0.005

Z = 2.9 > 1.95

Relative Risk = 2.2.

Table VI

Espirometry

EXP. TIME	% NORMAL	% ABNORMAL	TOTAL
< 10 YRS	28.5	71.5	100
10 to 35	11.1	88.9	100

X^2 = 2 < 3.84 P < 0.005

Z = 1.41 < 1.95

Relative Risk= 1.2

exposure and also to prove the importance of the diagnostic value of the chest X-ray.

According to the Smoking Habit

Table VIII: The group of NOT smoking workers was 73%, but only 27% for the smoking group, from slight to heavy smokers.

X-ray Findings

The group of NOT smoking showed 51.4% of normal telefilms and 48.6% of abnormal films was 34.3 of suspicious and 14.3% of positive X-ray findings. The group of smoking people showed only 23% of NORMAL X-ray and 77% of abnormal test-films.

Table VII

Diffusion

EXP. TIME	% NORMAL	% DLCO - DIMINUTION	
< 10 YEARS	85.1	14.9	100
10 to 35	77.8	22.2	100

X^2 = 0.762 < 3.81 P-0.005

Z = 0.872 < 1.95

Relative Risk = 1.5

Table IX: Spirometric Findings

The group of not smoking workers was 76%.

The percentage of NORMAL telefilms was 22.9 and the abnormal was 77%, composed of obstruction 37.1, restriction 14.2% and mixed syndrome 25.7%.

The group of smoking workers was 18.1% and the percentages of abnormal telefilms was 81.6 composed of obstruction 36.3%, restriction 27.2% and mixed syndrome 18.1%.

The total percentage for obstructive syndrome was 62.8 for the not smoking group and 81.6 for the smoking group.

The total percentages of restrictive syndrome was 39.9 for the not smoking group and 45.3 for the smoking group.

Table X: The alveolo-diffusion test showed 17.6% of diminution in the not smoking group and 18.2% for the smoking group.

In order to make it easy for the reader to view the results, we made Tables X, XI, and XII, which resume the percentages of NORMAL VERSUS ABNORMAL. The close relationship between the abnormal findings on X-ray and lung function tests for the smokers and the longest time of exposure is evident.

We compare the same relationship, moving from the X-ray examination to the lung function tests, the latter being the major power of diagnosis. Unfortunately the lung function test has no specificity and only the X-ray findings, together with the occupational history of work, is of diagnostic value.

Table VIII
According to the Smoking Habit

X-RAY - (TELEFILM 14"x17") RESULTS

	NORMAL		%	SUSPICIOUS		%	POSITIVE		%	TOTAL	
NO SMOKING	<10-15 >10- 3	18	51.4	< 10-7 > 10-5	12	34.3	<10-2 >10-3	5	14.3	35.	73
SMOKING	<10- 3 >10- 0	3	23	< 10-1 > 10-3	4	30.8	<10-1 >10-5	6	46.2	13.	27
TOTAL		21	43.7		16	33.3		11	23	48	100

Table IX
According to the Smoking Habit

	NORMAL		%	OBSTRUCTION		%	RESTRICTION		%	MIXED		%	TOTAL	
NO SMOKING	<10-7 >10-1	8	22.9	<10-7 >10-5	13	37.1	< 10-4 > 10-1	5	14.2	10-9	9	25.7	35	76
SMOKING	<10-1 >10-1	2	18.1	<10-2 >10-2	4	36.3	< 10-1 > 10-2	3	27.2	< 10-0 > 10-3	2	18.1	11	24
TOTAL	>10-8 <10-2	10	21.7	>10-9 <10-8	17	37	> 10-5 < 10-11	8	17.3	< 10-6 > 10-5	11	24	46	

Table X
According to the Smoking Habit

DIFFUSION

	NORMAL		%	DIMINUTION		%	TOTAL		%
NO SMOKING	<10-8 > 9 9	28	82.4	<10-4 >10-2	6	17.6	>10÷23 <10-11	34	75.6
SMOKING	<10-4 >10-5	9	81.8	<10-0 >10-2	2	18.2	<10-4 >10-7	11	24.4
TOTAL		37	82.2		8	17.8		45	100

Table XI
According to the Smoking Habit

RADIOLOGY

GROUPS	% NORMAL	% ABNORMAL	TOTAL
NS	51.4	48.6	100
S	23	77.0	100

X^2 = 3;84 - 3,84 $P < 0.005$

Z = 1.95

Relative Risk= 2.8

Table XII
According to the Smoking Habit

SPIROMETRY

GROUPS	% NORMAL	% ABNORMAL	TOTAL
NS	22.9	77.1	100
S	18.1	81.9	100

X^2= 0.63 < 3,84 $P < 0.005$
Z = 0.79 < 1.95
Relative Risk= 1.06

Table XIII
According to the Smoking Habit

DIFUSSION

GROUPS	% NORMAL	% ABNORMAL	TOTAL
NS	82.4	17.6	100
S	81.8	18.2	100

X^2 = 0 < 3.84 $P < 0.005$
Z = 0 < 1.95
Relative Risk= 1.02