INFLUENCE OF CHEMICAL/THERMAL PRETREATMENT ON THE CYTOTOXICITY OF COALMINE DUSTS

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SUMMARY

Investigations of mine dusts have partly yielded great discrepancies between the effects in humans and experimental animals on the one hand and cytotoxicity in vitro on the other hand. With the aid of chemical and thermal pretreatment it was attempted to simulate the demasking and metabolic processes occurring in vivo. Furthermore it is demonstrated that an increased information can be obtained by using a wider spectrum of concentrations and modifications of culture conditions.

INTRODUCTION

The results of earlier studies and the related observations that

- Great discrepancies exist in the evaluation of the cytotoxicity on the one hand, and of the animal experiments on the other [1,2,3,4,5,6, 7] and that
- The cell toxicities determined for a series of dusts depend very heavily on the conditions in the cell cultures and the dust dose[8,9,10,11]

induced us to try to characterize the cytotoxicity of high-rank and low-rank mine dusts from the Saar and Ruhr coalfields more accurately via their dose dependence and the effect of chemical and thermal pretreatment.

MATERIALS AND METHODS

Two groups of dusts were selected for the chemical and thermal treatment:

Group A: Dusts which caused higher reactions for one parameter in the animal experiments than for two parameters in the in vitro test, and

Group B: Dusts which, in comparison to Group A, caused a lesser reaction for the one parameter in the animal experiment than in the corresponding two parameters of the in vitro test, which exhibited either the same or a stronger reaction.

The parameter for the animal experiment was the measure of the quartz-typical dust deposition area in the lymph node test as described by Hilscher.[14] The parameter in the in vitro test was the TTC test, i.e., the influence on the reduction activity of the cells to 2, 3, 5-triphenyl-tetrazole chloride (TTC) and the pO_2 test, i.e., the polarographic measurement of the oxygen consumption (Table I,[12,15]).

The dusts were subjected to ultrasonic treatment for a total of 70 hours at a temperature of 38°C in each of 30% H_2O_2, 100% acetone, 5 n HCl, 5 n NaOH, 5% RBS (detergent) and in double distilled water. Finally they were washed out four times at 3500 rpm (g = 1500 m/sec^2) in double distilled water + 0.01 RBS and dried at 100°C.

As cytotoxic parameter we used the release of cytoplasmatic lactic dehydrogenase (LDH) of guinea pig alveolar macrophages into the medium. Toxicity was expressed as enzyme activity/10^6 cells or as percent toxicity between control and the 100 µg/10^6 cells concentration of Doerentruper quartz No. 12 (DQ_{12}).

RESULTS

The following results were obtained from the in vitro tests:

- The toxicity of DQ_{12} is reduced by acetone, but is slightly increased by HCl and NaOH (Table II).
- Treatment with HCl and NaOH causes a sharp increase in the toxicity of the Gambach quartz (Table III).
- The toxicity of the Gambach quartz and DQ_{12} after chemical treatment was changed by the addition of small quantities of fetal calf serum (Table IV): The toxicity of HCl-treated Gambach quartz cannot be inhibited by 0.1% of fetal calf serum (FKS), as is the case for the untreated dust.[10]

The toxicity of acetone-treated DQ_{12}, on the other hand, can be slightly inhibited by FKS (Table IV).

- Tables V and VI show the LDH release after incubation with treated and untreated mine dusts:
- For the 3 dusts from Group A, an increase in toxicity is to be observed after the various types of treatment: The toxicity of mine dust U 120 is particularly increased by treatment with acetone, dust V 521 by treatment with H_2O_2 and with acetone, H 520 by treatment with HCl and particularly by treatment with NaOH.
- In Group B, only the acetone treatment caused an increase in the toxicity of mine dust Y 320, whilst the H_2O_2 treatment resulted in an increase in the toxicity of dust T 124.

Analysis of the change in toxicity after chemical treatment

Table I

Characterization of the Tested Mine Dusts

Group	Dust	QTA/LKA	100-TTC-RA	pO2	Quartz (%)
high-rank:					
A	U 120	14,16	36,0	0,240	7,3
A	V 521	-,-	37,5	0,229	7,5
A	H 520	8,68	29,0	0,200	1,0
low-rank:					
B	Y 320	0,87	41,0	0,268	7,5
B	N 220	0,62	54,5	0,348	9,3
B	T 122	0,60	40,0	0,200	2,8

Control dusts: Corundum, DQ_{12}, Gambach quartz

Table II

LDH-Release (mU/10^6 Cells) of Guinea Pig—Lung Macrophages 20 Hours After Exposure with Untreated and Pretreated Doerentruper Quartz

	µg/10^6 cells		
DQ_{12}	25	50	100
1 untreated	31	68	87
2 H_2O_2 (30%)	22	40	67
3 Aceton	16	23	65
4 HCl 5 n	43	77	85
5 NaOH 5 n	56	81	87
6 RBS 5%	31	59	85
7 Aqua bidest.	47	72	94

Table III

LDH-Release of Guinea Pig—Lung Macrophages 20 Hours After Exposure with Pretreated Gambach Quartz in Percent Toxicity (100 µg Corundum/10^6 Cells = 0%; 100µ DQ_{12}/10^6 Cells = 100% Toxicity)

	µg/10^6 cells		
Gambach quartz	100,0	200,0	300,0
1 untreated	14,1	53,5	80,3
2 H_2O_2 (30%)	14,1	54,9	83,1
3 Aceton	11,3	57,7	90,1
4 HCl 5 n	85,9	87,3	100,0
5 NaOH 5 n	100,0	100,0	100,0
6 RBS 5%	21,5	57,7	77,5
7 Aqua bidest.	15,5	47,9	77,5

Table IV

Influence of Fetal Calf Serum (FKS) on the Cytotoxicity of Untreated and Treated Gambach Quartz and DQ_{12} in the Guinea Pig—Lung Macrophages Culture Measured by the LDH-Release (mU/ml)

	without Serum	+ 0,1% FKS
Gambach quartz		
200 µg/10^6 cells		
1 untreated	69	29
2 H2O2 (30%)	82	40
3 Acetone	45	20
4 HCl 5 n	114	112
5 NaOH 5 n	-	-
6 RBS 5 %	63	38
7 Aqua bidest.	64	27
DQ_{12}		
100 µg/10^6 cells		
1 untreated	138	136
3 Acetone	89	36
Corundum 1 untreated		
100 µg/10^6 cells	21	20
200 µg/10^6 cells	32	30

of mine dust N 220 is difficult. At a dust concentration of 100 µg/10^6 cells, the cytotoxicity drops after treatment with HCl, RBS and double distilled water. This effect can no longer be observed, however, with higher dust concentrations.

DISCUSSION

The chemical and thermal treatments resulted in a change in the toxicity of a number of the mine dusts, and generally towards an increase in toxicity; in view of the altered dust surfaces, however, these changes do not permit a direct assessment of the membrane toxicity. It can be assumed that the dust surfaces are altered in such a way by the treatment with the organic and inorganic compounds, either by the leaching out of surface constituents or by absorption, that it is very difficult to draw conclusions with regard to the original dust, even if the cytotxicity is increased as a result. The treatment can result in the removal of impurities from the dust surface; with quartz, the treatment can also result in a change in the basic crystal structure, and therefore in the electron structure. A notable feature is that in Table I, the mine dusts from Group A differ more widely than those of Group B with regard to their quartz-typical deposition areas in the lymph node test than the quartz contents of the dusts. During the in vitro test, this difference is not apparent in the untreated dusts. Only the chemical and thermal treatment of the dust surfaces caused an increase in the toxicity in the mine dusts from Group A, but less so for the dusts from Group B. Since the quartz contents of the dusts in the

Table V

Influence of the Chemical-Thermal Treatment
Group A: Reaction in Animal—High;
Cytotoxicity —Low
LDH Release of Guinea Pig—Lung Macrophages 20 Hours After Dust-Exposure in Percent Toxicity
(Corundum = 0%; DQ_{12} = 100% Toxicity)

		100	200	300		
		µg/10^6 cells				
Corundum		0	0	0		
DQ_{12}		100	100	100		
U 120	- 1	26	53	73	untreated	
	- 2	22	58	77	H_2O_2	30%
	- 3	33	89	105	Acetone	100%
	- 4	32	76	80	HCl	5 n
	- 5	38	68	80	NaOH	5 n
	- 6	21	58	65	RBS	5%
	- 7	16	51	73	Aqua bidest.	
V 521	- 1	23	47	73	untreated	
	- 2	36	82	87	H_2O_2	30%
	- 3	34	76	90	Acetone	100%
	- 4	22	50	68	HCl	5 n
	- 5	18	43	62	NaOH	5 n
	- 6	17	43	58	RBS	5%
	- 7	20	36	45	Aqua bidest.	
H 520	- 1	11	17	30	untreated	
	- 2	9	11	33	H_2O_2	30%
	- 3	6	15	42	Acetone	100%
	- 4	13	35	57	HCl	5 n
	- 5	41	89	105	NaOH	5 n
	- 6	7	3	5	RBS	5%
	- 7	8	22	40	Aqua bidest.	

Table VI

Influence of the Chemical-Thermal Treatment
Group B: Reaction in Animal—Lower;
Cytotoxicity —Similar or Higher than in Group A
LDH Release of Guinea Pig—Lung Macrophages 20 Hours After Dust-Exposure in Percent Toxicity
(Corundum = 0%; DQ_{12} = 100% Toxicity)

		100	200	300		
		µg/10^6 cells				
Corundum		0	0	0		
DQ_{12}		100	100	100		
Y 320	- 1	23	46	74	untreated	
	- 2	45	74	65	H_2O_2	30%
	- 3	63	84	84	Acetone	100%
	- 4	36	73	79	HCl	5 n
	- 5	40	73	85	NaOH	5 n
	- 6	29	80	80	RBS	5%
	- 7	35	69	76	Aqua bidest.	
N 220	- 1	42	91	89	untreated	
	- 2	69	92	92	H_2O_2	30%
	- 3	63	83	81	Acetone	100%
	- 4	22	77	82	HCl	5 n
	- 5	55	89	88	NaOH	5 n
	- 6	18	62	67	RBS	5%
	- 7	22	72	81	Aqua bidest.	
H 520	- 1	14	42	56	untreated	
	- 2	48	75	79	H_2O_2	30%
	- 3	20	63	72	Acetone	100%
	- 4	15	48	56	HCl	5 n
	- 5	15	52	67	NaOH	5 n
	- 6	11	28	47	RBS	5%
	- 7	46	46	56	Aqua bidest.	

two groups are less than 10% and differ widely from one another in only two cases, other factors must be responsible for these differences in the size of the quartz-typical dust deposition areas in the lymph node test and in the level of the toxicity. In the lymph node test, a shift in the mean particle size of the quartz content could play a role, since the filtering of the dust particles in the lymphatic system results in a trend to smaller particle sizes and higher toxicities. More likely, however, is that the reactions and toxicities depend on the rank of the dusts from the Saar and Ruhr coalfields. An interesting fact is that the mine dusts in Group A originated from high-rank seams, whilst those in Group B originated from low-rank seams, i.e., from younger seams.

Conclusion correlates with the investigations into the specific noxiousness of the respirable dusts from the Ruhr coalfields by Reisner and Robock,[16] Robock et al.[12] and the more recent studies by us[17] which revealed that for dusts originating from different collieries and different stratigraphic horizons but with comparable mineral content, the cytotoxicity increases with the age and rank of the seams.

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QUANTIFICATION OF ANTHRACOSILICOTIC GRANULOMAS IN LUNGS AND LYMPH NODES OF RATS

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ABSTRACT

In the past, the extension and the degree of fibrotic reactions induced by quartz containing dusts were estimated, and the results were documented as a certain number of +++ or different degrees of fibrosis. It was in the early seventies, that our group succeeded in quantifying the dust induced nodules and their particular components.

Within the last years the hit method has been improved with the aid of semi-automatic and fully-automatic apparatuses which are able to identify histological structures and transform the data into binary signals.

One group worked as well with the Analysis System Manual ASM (Leitz), as the Inter Active Immage Analysis System IBAS (Zeiss/Kontron) and the Quantimet 970 (Cambridge Instruments). By these instruments (1) the sizes of dust induced alterations and their particular components (a. dust particles, b. connective tissue) or (2) the chord lengths of reticular or collagen fibres can be measured. It is by this possible, not only to quantify larger or smaller fibrotic lesions and their particular components in the different organs (lungs and lymph nodes) but also—in optimizing the method of BELT & KING (1945): the degree of fibrosis.

No Paper provided.

RESPIRATORY MORBIDITY IN AGATE WORKERS

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ABSTRACT

342 agate workers in a household industry in Khambhat were studied along with 149 controls. Ornamental and decorative items are made from agate stones. Processing of agate stones is by heat treatment, chipping, grinding, drilling and polishing processes. Prevalence of all lung diseases was 63.4% in workers and 35.6% in controls. Percentage of pneumoconiosis, pulmonary tuberculosis, chronic bronchitis, bronchial asthma, and tropical eosinophilia was 18.4, 15.5, 2.6, 7.3, and 3.2 respectively in agate workers. Agate dust seems to be precipitating pneumoconiosis and asthma. Pneumoconiosis was the same in both sexes, although tuberculosis was higher in female workers. 50% of pneumoconiosis cases had no symptoms. Age groups 20, 21–30, and 31+ showed an increasing trend in prevalence of all lung diseases, as compared to controls. Pneumoconiosis is increased with increase in dust exposure. Exposure to dust for as little as 2 years precipitated pneumoconiosis of category 'p'. Pneumoconiosis was 22.1% in grinders and 8.3% in chippers. Mean age of categories pqr, stu, and ABC was 26.7, 30.2, and 34.1 years respectively. In child workers, both pneumoconiosis and tuberculosis were 14.3 percent. Lowest age detected in pneumoconiosis cases was 11 years. Healthy grinders showed lower lung function values than healthy chippers. These values had decreased in all categories. Dust concentration in grinding was more than in chipping process. Free silica was 83% in respirable dust.

No Paper provided.

AIR POLLUTION INVESTIGATIONS IN SOME PLANTS FOR PRELIMINARY PROCESSING OF VEGETABLE FIBRES (COTTON AND HEMP) —AIRBORNE DUST AND MYCOTOXICOLOGICAL CONTAMINATION

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ABSTRACT

The preliminary processing of vegetable fibres generates considerable dust concentrations in the working environment. The dust pollution in two plants for cotton and hemp processing was investigated. For all technological processes used, the time-weighted-average dust concentrations and the mycotoxicological pollution were determined. It was found that the dust concentrations are above the adopted standards for occupational exposure limits and that a high degree of contamination with spores of microscopic fungi (Cladosporium, Alternaria, Aspergillus, Penicilium, Fusarium) exists.

The proved mycotoxic and allergenic effects of this mycoflore in combination with the high airborne dust concentratiions are prerequisite, imposing a reassessment of the approaches for evaluation of the occupational hazard, an action of great importance for the prophylaxis of a significant contingent of workers.

No Paper provided.

IMPAIRMENTS IN FUNCTIONAL SUBSETS OF T-SUPPRESSOR (CD8) LYMPHOCYTES, MONOCYTES, AND NATURAL KILLER CELLS AMONG ASBESTOS-EXPOSED WORKERS

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ABSTRACT

Asbestos exposure has been shown to be associated with a variety of aberrations in both cell-mediated and humoral immunity.

In order to clarify cellular immunological mechanisms of asbestos associated effects functional and developmental stages of lymphocyte subsets were studied in a group of 70 workers with a high prevalence of asbestos related chest radiographic abnormalities.

An increase in the number of T suppressor cells was closely associated with a decrease in T lymphocyte functions while numerical defects in activated monocytes (Leu M3 Ia) and natural killer cells (Leu 7) were correlated with a depressed Th/Ts ratio. Furthermore, among asbestos-exposed workers with depressed T cell functions we have demonstrated a significantly higher number of the effector Ts (Leu 2 Leu 8) subset which regulates both the Th/Ts lymphocyte system as well as B cells and NK cell activities.

The findings suggest one mechanism for the association between asbestos exposure and immune dysfunction.

Changes in the T suppressor feedback regulatory loop were identified causing this immunoregulatory imbalance.

No Paper provided.

ON THE USE OF LIGHT MICROSCOPY FOR THE RECOGNITION, EVALUATION AND CONTROL OF RESPIRATORY DISEASE

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ABSTRACT

Over the years in our laaboratory light microscopy has been a valuable tool for the recognition, evaluation, and control of a variety of respiratory hazards. In this presentation we will review some common uses as well as describe a few new applications.

In the area of recognition we will describe two case studies in which petrographic applications of light microscopy were utilized to identify possible etiologic agents responsible for specific respiratory ailments. Under the area of evaluation we will describe how the microscope is used for identification and quantification of components in bulk and air samples. Examples will include both asbestos as well as the lesser known technique of focal screening for the estimation of % silica in various matrices. In the area of control we will describe a method in which the microscope can be used for identification of trace amounts of airborne colored chalk dust for the purpose of evaluation of the overall performance of a ventilation system.

Although widely neglected in this age of high technology, the simple light microscope remains a highly utilitarian device in the practice of the craft of industrial hygiene. We hope that this presentation will serve to promote its use.

No Paper provided.

DESIGN AND CALIBRATION OF A MULTI-PURPOSE AEROSOL SAMPLER

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ABSTRACT

A new aerosol sampler suitable for a variety of industrial hygiene sampling applications has been designed, built, and evaluated. A distinctive feature of the design is the use of impactor stage modules that can be used separately for various single-stage applications or in combination for multi-stage uses. The sampling modules are of two principal types: "standard curve" and "matched curve." The standard curve modules were designed to provide sharp cut points over a range of particle size from 1–20 μm. The matched curve modules were designed to conform to the aerosol mass fractions recently defined by the ACGIH.

When used for multi-stage sampling the modules can be arranged in both the series and parallel configurations. One particular parallel arrangement allows for the simultaneous measurement of respirable, thoracic, and inspirable mass. The sampler is small, light, and compact, making it well suited for personal sampling in each of its configurations. It was also designed to accept a variety of collection media, allowing for gravimetric, chemical, and microscopic analysis of collected dust. Additionally, a calibration chamber was designed and built and a calibration technique featuring sonic dust generation and microprojection analysiss was successfully employed.

No Paper provided.

COMPUTERIZED TOMOGRAPHY (CT) IN COAL WORKERS' PNEUMOCONIOSIS

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CWP is a common occupational disease and there have been many publications on the use of X-ray examination in this condition. But we have been unable to trace any publication on CT diagnosis of CWP. In order to investigate the diagnostic value of CT for CWP, 100 coal workers were examined by CT scanning and results compared with that of standard chest radiographs and pulmonary function tests.

SUBJECTS AND METHODS

The 100 male underground coal workers were selected at random. The age range was 40 to 75 years (mean 62) and coal dust exposure range was from 11 to 40 years (mean 20.15).

CT Scanning Examination

CT scans were obtained using a Toshiba TCT80A scanner at 1 cm intervals from the apex to the diaphragm at full inspiration appropriate for the lung (level −800, width 1000 HU) and mediastinum (level 40, width 400 HU).

Visual analysis

1. *Small opacity*. According to the principle of ILO Classification, the profusion of small opacities on each slice of CT was classified into four categories. A scoring system for the CT scans was devised. The two lungs were divided into six zones and CT score for small opacities for any zone was counted as the product of profusion of small opacities and the percentage ratio of the small opacity slices to whole slices on that zone. Then the scores of the left, right and two lungs might be counted. The starting point for diagnosing pneumoconiosis was considered to be the score '2' i.e., at least two lung zones were full of small opacities with category 1.

2. *Large opacity*. If a dense opacity with a diameter than 10 mm appeared in the lung fields of two adjacent slices, and was still observed at the mediastinum level then a large opacity was recorded.

3. *Emphysema*. Following Goddard's standard we considered areas of low attenuation and vascular disruption to be suggestive of emphysema. The emphysema was classified into four grades according to its extent on the CT films.[1] The scoring system for CT emphysema was counted as the product of the emphysema grade and percentage ratio of emphysema slices appearing to the whole slices on that zone. Emphysema might be diagnosed if there were characteristic appearances of emphysema on at least half slices on one lung zone.

Numerical analysis

The mean attenuation of the whole lung field density was measured at the three slices of the apex of the lung, carina and immediately above the dome of the right hemidiaphragm corresponding to the upper, middle and lower zones of the right lung for every subject. The mean attenuation values of the above three slices was also calculated.

X-ray Examination

Standard PA and lateral chest X-ray films were obtained on all subjects at the same time as CT scanning was carried out. The films were read using the 1980 ILO Classification and also according to the routine standard[2] did the diagnosis of emphysema.

Pulmonary Function Tests

The following tests were carried out for 80 subjects while having CT examination: VC%, FEV_1%, FEV_1/VC%, MBC%, RV/TLC. Loss of lung function was considered to be present if the FEV_1% was less than 60, FEV_1/VC% less than 60, MBC% less than 80 and RV/TLC more than 40%.

RESULTS

Visual Analysis

2175 slices of CT scanning were taken from 100 coal workers. Three had no small or large opacities present. 45 had small opacities present. Of these 34 might be diagnosed as simple pneumoconiosis with the CT score 2. 42 had complicated pneumoconiosis with large opacities present. 96 had changes with emphysema. Of these 87 could be diagnosed as having emphysema according to the CT criterion given above.

Small opacity

995 slices of scanning were taken from 48 subjects without large opacities. At any zone category 1 profusion was the most common (69.14%). Category 3 profusion was the least common (2.97%). Among the 497 slices showing small opacities were observed, mostly in the middle and lower zones. For the distribution of small opacities at anterior or posterior parts of the lung small opacities were observed at

the posterior part of the lung for 459 slices (92.35%) and at the anterior part of the lung for 324 slices (65.19%).

Large opacity

There were large opacities present on CT for 52 subjects. 88.3% of large opacities appeared at the posterior part of the lung. Only 11.7% at the anterior part of the lung. 84.1% of large opacities were mainly distributed at the medulla of the lung with a distance of 1–2 cm from the outer margin of lung amongst large small opacities distributed obviously at the medulla of the lung.

Emphysema

For all scanning slices 932 (42.38%) of the right lung, and 972 (40.09%) for the left lung showed appearances characteristic of emphysema. Emphysema appeared mostly in the lower lung zones (65.8%) and least at the upper zone (19.4%). Grade 1 was the most common (23.84%) with grade 4 accounting for only 0.54%. For most CT films (96.57%) emphysema was observed at the anterior part of the lung. 34 bullae were observed in 14 subjects. Most of the bullae were located in the upper lung zone and in the posterior part of the lung.

Numerical Analysis

The mean attenuation value of lungs for 48 subjects, without large opacities, was -854.95 ± 47.92 HU. That for the upper, middle and lower zones were -846.49 ± 60.62, -871.7 ± 48.97 and -846.6 ± 49.33 HU respectively. No definite trends were discoverable. These values were calculated statistically for 0, ≤ 2 and >2 of the CT score for the profusion of small opacities and were -874.43 ± 45.11, -855.27 ± 34.45 and -856.11 ± 48.44 HU respectively. Again no definite rule was found. The mean attenuation value for the upper, middle and lower zones for the 100 coal workers were -839.43 ± 63.14, -857.47 ± 48.31 and -860.36 ± 47.79 HU respectively, all lower than the normal value. The mean value of the sum of attenuation values of three slices of the right lung for all subjects calculated statistically for ≤ 3 and >3 of CT score for emphysema were -849 ± 44.09 and -863.9 ± 39.73 HU respectively. There was a significant difference between the attenuation values of ≤ 3 score and >3 score ($t = 2.18$, $P<0.005$).

Comparison of CT and Chest Radiograph

Small opacity

For diagnosing pneumoconiosis either positively or negatively by CT and ILO Classification 41 subjects (85.4%) were agreed, 7 (14.6%) were not. This was within the acceptable extent of the difference of film examination. CT score for small opacities was also closely related to the complete twelve-point scale of profusion of the ILO Classification 1980 ($r=0.7357$, $P<0.01$).

Large opacity

For 52 subjects with CT showing large opacities, large opacities could be diagnosed on chest radiographs for 37. None of the subjects showed a large opacity on his chest radiograph, but not on CT. Thus the detectable rate of large opacity with CT was increased by 15% over that by chest radiography. For 30 subjects diagnosed as simple pneumoconiosis by their chest radiographs, according to the ILO Classification 1980, 12 (40%) had large opacities in their CT. CT was also to demonstrate calcification and cavitation in large opacities much more readily than chest radiography. For 52 subjects showing large opacity 28 of them (53.9%) had calcification on CT examination, with the mediastinum window level, but only 2 (5.4%) had calcification areas on chest radiograph. 18 (34.62%) of the subjects showed cavitation on CT but only 2 subjects showed cavitation on chest radiography.

Emphysema

Emphysema was diagnosed for 87 subjects by CT but only for 49 subjects by chest radiography. There were very significant difference between these two methods ($u=5.8$, $P<0.001$). The use of CT increased the rate of detection of emphysema by 38%. Bullae were shown by CT for 14 subjects but on chest radiography only 4 of them had typical bullae.

Comparison of CT and Pulmonary Tests

CT score for small opacities was not definitely related to lung function. The comparison of CT score of emphysema and the number of lung function tests showing decrements demonstrated: For 60 subjects with a score of ≤ 6 the mean number of positive items was 2.65. For 20 subjects with a score of >6 the mean number of positive items was 3.75. There was a very significant difference between the two cases ($t=2.77$, $P<0.01$).

DISCUSSION

Using standard radiography pneumoconiosis could be diagnosed with confidence by X-ray, and the ILO Classification was the generally accepted "gold standard" for the categorization of pneumoconiosis. In this paper it has been shown that there was an equal ability to diagnose simple pneumoconiosis using CT. The CT score of small opacities designed by us was very closely related to the ILO Classification and showed that CT might be used to diagnose pneumoconiosis reliably on chest radiographs. Although CT was better than chest radiography in detecting small opacities distributed at the anterior/posterior context or medulla part of the lung the additional cost involved in using CT did not justify the slightly superior advantage over chest radiography for diagnosing simple pneumoconiosis.

CT was significantly superior to the chest radiograph for diagnosing complicated pneumoconiosis. In this paper it has been shown that 15% more large opacity might be detected by CT than by chest radiography. It has been shown that in films showing simple pneumoconiosis by chest radiography large opacities could also be detected by CT for 40% of them. In addition it has been shown that CT is capable of detecting emphysema much more easily than chest radiography, and that the detection rate for emphysema is 38% greater for CT than chest radiography. It is common knowledge that the large opacity and emphysema were the important causes of deteriorating for patients of pneumoconiosis. Thus it was important to detect large opacities and emphysema early. In our opinion the main in-

dication for CT in coal workers is to detect these large opacities and emphysema undetectable by chest radiographs.

In recent years there has been a great deal of interest in diagnosing diffuse disease and emphysema of the lung by use of CT attenuation values.[1,3] Rosenblum reported that the mean attenuation value for whole lung for normal persons was -743 ± 58 HU.[3] Attenuation of the 100 coal workers described in this paper was lower than the above mentioned normal value and tended to decrease with increase of the CT score for emphysema. This appeared to be related to the fact that most of the coal workers had emphysema. Diagnosis of emphysema by measuring the attenuation value of lung was possible. On the other hand the attenuation value of lung had no definite relation to the CT score for small opacities. In our opinion this might be the result of mutual influence between pneumoconiosis with differing degrees of profusion and emphysema with varying degrees of severity. In the situation where there might be simultaneous co-existence of disease with decreasing and increasing density of lung, as is shown by the coal workers in this paper, precisely how to evaluate the mean attenuation values of lung measured also needs further study. For this reason we do not, at present, recommend diagnosing pneumoconiosis by measuring the attenuation value of lung. This is best done mainly by visual analysis.

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EXPERIENCIA EN EL USO DE LA CLASIFICACIÓN INTERNACIONAL DE NEUMOCONIOSIS OIT (1980) EN 40 CENTROS MINEROS DEL PERÚ

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ABSTRACT

Se efectuaron más de 12,000 Radiografías de Tórax de trabajadores mineros entre 1984–1988 (Febrero) de acuerdo a las recomendaciones técnicas OIT (1980) esto es: Equipo Rayos X (Condensadora de descarga), procesadora automática y pantallas intensificadoras de imagen Los Centros Mineros se situaban a diferentes altitudes sobre el nivel del mar, correspondiendo la mayoría (80%) a trabajadores que laboran entre 3,500–5,000 m.s.n.m.

Dentro de los hallazgos radiológicos, se observaron anormalidades en cerca del 50% de los examinados. Hemos encontrado dificultades en la utilización de la Clasificación OIT. sobre todo en los trabajadores de altura. Se ha tratado de diferenciar las placas de los trabajadores expuestos y no expuestos a diferentes altitudes, evidenciando dibujo pulmonar diferente. El 20% de los examinados presentaron Neumoconiosis (Iqualmente el 20% de los mismos, presentaban asociación a TBC.).

Creemos necesario adoptar ciertas características en el patrón radiológico, sobre todo, en los mineros de altura.

Los resultados de Función Respiratoria (Flow-Volume) presentó muchas variaciones con respecto a los fenómenos restrictivos tradicionales. En este sentido requerimos nueva evaluación y probable reformulación de los parámetros utilizados.

Creemos iqualmente que los altos índices de Policitemia juega papel muy importante en los resultados obtenidos, siendo indispensable nuevas evaluaciones fisiológicas, anatomopatológicas que nos permitan esclarecer nuestros hallazgos.

No Paper provided.

INORGANIC PARTICLES IN COAL MINERS' LUNGS

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ABSTRACT

An automated scanning electron microscope-energy dispersive X-ray analysis-image analysis system was used to determine the total lung exogenous, inorganic particle concentrations for 21 coal miners. The particle data were determined from the analysis of a single, randomly selected, piece of formalin-fixed tissue from each subject. Over 28,000 individual exogenous particles from the 21 lungs were analyzed. The total exogenous particle concentration (average ± standard deviation) for the 21 miners was 3,003 ± 2,267 million particles per gram of dry lung with a range of 257 to 9,991 million particles/gram. As a point of reference, the average exogenous particle concentration seen in the lung of 87 subjects from the Cincinnati, Ohio urban area who had no overt pneumoconioses was 477 ± 380 million particles/gram with a range of 71 to 1,862 million particles/gram.

In General, silica and various aluminum silicates were the major particle types found in both the coal miner and the urban lungs. The miner lung silica contents ranged from 27 to 2,484 million particles/gram with an average of 823 ± 594 million particles/gram. The average miner aluminum silicate level was 1,734 ± 1,629 million particles per gram with a range of 138 to 6,943 million particles per gram. The average silica and aluminum silicate contents of the Cincinnati urban lungs were 94 ± 70 and 179 ± 144 million particles/gram, respectively.

No Paper provided.

CHARACTERISTICS OF LUNG-RETAINED COAL DUSTS RELATED TO MORPHOLOGICAL AND CLINICAL FINDINGS

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The role of the coalrank, quartz and other mineral admixtures in the pathogenicity of coal dusts is still not sufficiently elucidated. The relationships, established for coal sorts in definite coal fields are not always confirmed in others. Some authors give priority to quartz and the other mineral admixtures as determinants of the dust fibrogenicity, but others stress the coalrank itself.[1,3,10,14,15]

In the oldest coal field in Bulgaria—the Pernik one, in which brown coal has been extracted as long ago as since more than 100 years mainly by underground mining, clinical cases of coal dust pneumoconiosis have still not been detected up to now.[2] The field is set up of four strata with clay interlayers between them, situated in clay marl. The micropetrographic coal composition included mainly humanit and vitrinit—about 53–58% and mineral admixtures, mainly clay and quartz—22–43%. Since the last 20–30 years, intensive methods of extraction were introduced, which resulted in comparatively high dust concentration in the air of the mine.

The quartz content in the airborne dust was varied in a wide range, being in the total dust 7%, in average, and in the respirable fraction—4%.[9]

Taking into consideration the comparatively high dust concentrations with significant quartz content in the air of the mine, it becomes difficult to explain the absence of pneumoconiosis cases among the exposed workers.

The purpose of this investigation was to examine the quantity and composition of the lung dust of deceased exposed miners from the above mentioned coal field and to establish possible changes in their lung morphology. So we hoped to make a contribution in the elucidation of the pathogenicity of the dust from this coal field.

MATERIALS AND METHODS

A post mortem study of the morphological lung changes and the lung dust from 23 miners with continuous dust exposure (up to 30 years) in the Pernik coal field, but without clinical and radiographic data for pneumoconiosis while still livinq, was performed. The average life continuance of the investigated cases was from 32 to 79 years, all deaths under the age of 50 being due to labour or other accidents. The lung dust was isolated by the formamide-digestion method after Thomas and Stegemann. A constant weight of dust at 105° and the residue after ashing at 600° was determined.

The free crystalline silica content was determined by the spectrophotometric micro-method according to Polezhaev[4] and I-R-spectrophotometry,[11] the total silica quantity—by the method of Peregut and Gernet.[12]

For histological evidencing of collagen the method of Holusa was applied.[8]

The integral half-quantitative assessment of dust-related morphological changes and the extent and severity of lung fibrosis, in particular, was performed by the scoring system of Kolev[5] for the following indices: interstitial fibrosis, type and extent of granulatoma, hyalinization in nodules and conglomerative masses, presence and dissemination of aceptic necrosis, etc. According to this system, the maximum score of 24—rarely up to 28, is obtained at the presence of exclusively severe fibrosis, while the scores from 1 to 7 correspond to negligible reactions of the lung parenchyma to the lung dust retained in it, without relevant collagenogenesis.

RESULTS

According to the length of the exposure, the cases under study were divided into four groups: group I—2 cases with exposure up to 10 years, group II—from 10 to 20 years and group III—from 21 to 30 years. In group IV, 4 cases with unknown length of exposure were included. The data obtained in the examination are shown in Table I.

The quantity of the isolated lung dust was varying between 0.8 and 9.1 g. For the cases of the group I it was under one g., for those of group II -2.8 g in average, for group III -3.9 g and for group IV—5.3 g.

The residue after ashing at 600°C for all investigated cases was varying from 34 to 62%, the total silica content—from 11.2 to 40.5, in average 22.6%, whereas the free crystalline silica content—from 2.9 to 10.7%, or 6.1% in average.

The absolute quantity of quartz in lungs for the two cases with comparatively short exposure period (up to 10 years) attained an average of 38.3 mg, or 22.5 mg/100 g dry tissue. For the two groups of longer exposure, significantly greater quartz quantities were found: for the group II—176.8 mg total quantity or, 110.4 mg/100g dry tissue; for group II—261.9 mg and 145.9 mg/100 g dry tissue; and group IV—404.0 mg or 140.1 mg/100 g dry tissue. At calculating the mean quantities in group II for both total lung dust and quartz, one case which was drastically different on the background of the other cases, was excluded.

Pathoanatomic Findings

In 14 of the lungs investigated macroscopic and microscopic

Table I

Characteristics of Dusts, Extracted from Coalminers Lungs, Post Mortem

Length of exposure years	Number of cases	Total quantity of dust, g average	Quartz content in dust % average	Quartz content mg/100 g dry tissue from... to	Quartz content mg/100 g dry tissue average	Grade of morphological changes
<10	2	0,85	4,5	20,5- 25,0	22,5	3, 4
from 11 to 20	8	2,8	6,6	28,3-156,1	110,7	3, 5, 5, 4, 5, 5, 4, 6
from 21 to 30	9	4,1	6,2	34,7-314,5	145,9	3, 1, 4, 3, 3, 5, 3, 4
unknown	4	5,3	7,9	80,8-190,7	140,1	5, 5, 5

signs of bronchitis with different severity and cell-proliferation in the interalveolar septa were seen. The nonhomogeneity of the distribution of the changes in both lungs as well as the involvement of the pleura with dust accumulations under it, should be noted. The dust was situated peribronchially, perivascularly and septally, only few dust granuloma being seen. No enlargement and confluence of lymph nodes was observed, in spite of the significant quantity of centrally situated dust, found both in macrophages and extracellularly—in an irregular net of collagen fibers.

According to the accepted scale for integral assessment of the dust-related morphological changes the cases were given estimates from 1 to 5 (with the exception of one i.e., in general the changes were assessed as poor.

Clinical data

While still living, neither of the cases was found to be carrier of dust-related disease. In three of them, after being pensioned off, severe bronchitis with respiratory and cardial insufficiency were established.

The cases under 50 y. died on occupational or other accidents and the rest of the cases—on different nonoccupational diseases, mainly of the cardiovascular sphere.

DISCUSSION

The data obtained in the present study showed great individual differences in the lung dust quantity for miners with approximately the same exposure—a finding, reported also by other authors.

The dust quantity and its ashed content, as well as the quartz content found in the lungs we investigated, was significantly lesser as compared with that found by other authors in the lungs of coal miners with manifested fibrosis changes.[1,6,7,13] This fact could be explained by the lower dust concentrations in the mines of the Pernik coal field, or to the lesser aggressiveness of the dust, leading most probably to a better clearance.

In support of the last explanation comes the fact that the difference in the lung dust quantity, accumulated in the groups of subjects with 10–20 and 20–30 year exposure were comparatively small—a little more than 1g of dust. On the other hand, in 10 of the cases the quartz quantity per 100g dry tissue exceeded that established by Einbrodt and Klosterkötter[6] and confirmed by other authors[5,7] critical level—150 mg, at residence time more than 30 years.

The clinical pathological data showed that the exposure to brown coal dust in the Pernik coal field, regardless of its continuance, did not lead to significant changes of fibrosis nature. The comparatively frequent morphological findings in the bronchial tree have no clinical correlate or are diagnosed as simple, non-obstructive dust-related bronchitis.

The score system we used for assessment of dust-related changes in the lungs allows a semi-quantitative categorization of the findings with good recurrence. The values obtained were between 3 and 5. Nevertheless, this study showed that when used for estimation of the reaction to non-fibrogenic dusts it is necessary for indices concerning the condition of the bronchial three to be added. The lung changes in the cases we studied differ and are more favourable than the described in literature "simple pneumoconiosis" in coal miners in FRG, Great Britain, France and USA. On the other hand, the dust quantity does not exceed that, corresponding to the 0 criterion in the coal fields mentioned above.[5,6,13 etc.] That's why, our hypothesis that the dust from the Pernik coal field is less harmful as compared with similar sorts of coal dust from other coal fields should be confirmed by further experiments.

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PREVALENCE OF PNEUMOCONIOSIS IN ZIMBABWE'S COAL AND HARD ROCK MINES

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ABSTRACT

Periodic X-ray examination has been required of all workers at Zimbabwe's mines since 1984; all films are centrally reviewed by the National Pneumoconiosis Medical Bureau, where files on some 27,000 workers now are housed. In order to establish a surveillance data base, random samples of first examinations performed under the new law—were selected for various mines. The X-rays were read by a NIOSH B-reader (MRC) blinded to prior reading or work history; subsequently job category and years service were abstracted from the file. Based on these cross-sectional surveyed prevalence roles of radiographic pneumoconiosis were established for the nation's single coal mine and large mines of copper, gold, chrome and nickel.

The prevalence of pneumoconiosis was determined using the ILO classification system. In coal workers, radiographic changes were rare prior to 15 years of service, after which CWP appeared in more than 20% of the films. Some cases of presumed silicosis appeared after 10 years, reaching a 20% prevalence among workers with 20 or more years exposure in gold, copper and chrome mines.

Complicated pneumoconiosis was not seen, but this may be an anti-fact due to the cross-sectional methodology employed. However, the preliminary results provide a data base for developing preventive and protective measures and a surveillance programme.

No Paper provided.

PULMONARY MICA DUST LESIONS

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ABSTRACT

In Bihar state (India), there is a vast reserve of muscovite mica and associated mining and processing industry which employs a large number of workers. A high incidence of respiratory morbidity has been reported among them. The present report deals with studies made on pulmonary tissue of 667 domestic animals which were exposed to dust pollution in the mica mining area. Histological examination of lungs revealed focal deposits of birefringent dust particles predominantly in the parenchyma and adjacent to bronchioles and alveolar ducts. The predominant feature was the absence of any fibroblastic reaction in spite of heavy dust load. Experimental studies on rats injected intratrachelly with respirable mica dust (50 mg/animal) obtained from the mica mine revealed foreign body granulomatous reaction in lung at 15 days. The reaction had markedly regressed by 90 days with only tiny deposits of mica dust in the parenchyma, and which did not incite any fibrotic reaction by 270 days. Our preliminary studies with infection and mica dust suggest that the fibrotic lesions induced by mica in human cases may be due to an infective factor. The significance of present observations in domestic and laboratory animals on "pure mica dust granuloma" and "infective mica dust granuloma" has been discussed.

No Paper provided.

MAIN MEASURES FOR CONTROLLING COAL DUST IN PLACE AT THE LONGWALL SHEARERS IN CHINA

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ABSTRACT

To control coal dust in place at the longwall shearers faces have been one of the particularly difficult tasks. Several kinds of measures have been developed and used in this field in China. The technique of pre-injecting water into the coal seam at high pressure is most popular at the present and greatly benefitting almost all the nation's miners working at the longwall faces by reducing the dust concentration in the airflow in a large quantity. The experiences of mixing certain chemical materials in the injected water show obviously better effect. Another development to catch the fine coal dust produced in the cut-loading operation is the usage of a new water spring device called "Pneumatic-pressure water spring." By means of it the spring water particles with smaller diameter, higher initial flying speed and closer density lead to higher spring effect and lower consumption of water (down to 1/3 compared with the ordinary spring).

No Paper provided.

THE PNEUMOCONIOSIS CONTROL IN CHINA

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Since the founding of the People's Republic of China, Chinese government has attached great importance to protecting worker's safety and health in the production process and made safety production a basic national policy. It has improved worker's working conditions, obvious achievements have been made in occupational safety and health.

Chinese government pays more attention to preventing pneumoconioses and performs the policy of prevention as leading role. A lot of work have been done in inspection, scientific research, and publicity as well as education.

LEGISLATION OF LABOUR PROTECTION

In early 1956, China state Council published "The decision of prevention of dust hazards in factories and mines" and "The regulation of safety and health in factories." In recent years, the state has promugated "Standard of sanitation design of industrial enterprise," "classification of hazard levers due to exposure to industrial dust," "Methods for airborne dust measurement in working place" and other national standards. In 1987, Ministry of labour, Ministry of Public Health, All-China Federation of Trade Unions revised "The scope of occupational diseases and the regulation of treating patients on occupational diseases." There are 99 kinds of occupational diseases in it, and 12 kinds are pneumoconioses which include quartz lung, asbestosis, carbon-dust lung, anthracosis and so on. The stipulation of regulations and standards above mentioned provide a basis for pneumoconioses prevention and cure.

NATIONAL INSPECTION

In China, the labour department at all levels represents state to inspect the situation of occupational safety and health in enterprises. The Ministry of Labour of the People's Republic of China is in charge of comprehensively managing and conducting nationwide inspection work about safety and health. Inspection organizations of safety and health have been set up in the labour department at all levels. In order to develop inspection tasks, 174 testing and examination stations of occupational safety and health have been established, more than 15,000 inspectors have been allocated.

In order to reduce the dust hazard and control the pneumoconioses, nation's inspectors are carrying out examination and approval to the engineering construction projects, and dust-proof equipment is required to be simultaneously designed, constructed, put into production with the major building in the construction, rebuilding, extension projects. Meanwhile inspectors supervise and urge enterprises and factories to adopt activity prevention measures to improve working condition and reduce the dust density in workplaces, and to implement and perform the nation's regulations. At the 4th national conference on dust-proof and toxic-proof in 1985, the government clearly claimed to rapidly bring the dust hazard under control and improve labour conditions in policies and technical measures. They are as follows:

1. Resolving dust problem in some major trades which are coal mine, metal mine, building material trade, glass, ceramics, refractory, asbesting, casting, tunnel cutting engineering.
2. Control three most hazardous kinds of dust which are asbestos dust, quartz dust, carbon-dust.
3. Adopting advanced and comprehensive technical measures of dust-proof, such as wetting working, ventilating and airtighting.

The works above metioned play an important part in reducing dust hazard and controlling pneumoconioses.

SCIENTIFIC RESEARCH, PUBLICITY AND EDUCATION

Ministry of labour has formulated "The scientific and technical plan of labour protection in 2000." It has attached great importance to the engineering and technique of reducing dust hazard and controlling pneumoconioses in it. There are 23 institutes of labour protection in the whole nation. Many of their tests are researching techniques of dust-proof and dust detectors, stipulating standards concerning dust-proof, giving advice and suggestions to enterprises.

Seventy-two labour protection education and training centres have been set up. Labour protection education offices have been established in more than 3000 large and medium enterprises. A national science and technologic information network of occupational safety and health has an initial scale. They play an important part in pneumoconioses control.

In the past ten years, the problems involved in occupational safety and health have become more complex, with the implementation of reform and open policy, growth of economy and various types of individual enterprises. It is therefore indispensable for the Chinese government, while continuously developing its economy, to learn the advanced experiences from other countries and take further action to secure a decrease in occupational accident and to prevent occupational diseases.