SILICOSIS IN PIT DIGGERS IN SERRA DA IBIAPABA, CEARÁ, BRAZIL

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A survey carried out by technicians from FUNDACENTRO, Pernambuco, showed that out of 134 pit excavators, 38 presented silicosis after clinical and laboratorial examinations. Out of these 38, 5 died during this survey. Environmental evaluations in workplaces were also made through dust measurements inside pits being excavated. A conventional water supply is bere considered a definite solution to these problems. Specific measures are also proposed as transient solutions.

We participated in the research on silicosis in Serra da Ibiapaba, approx. 350 km from Fortaleza, because of the professional concern and particularly because of the great social vision of the INAMPS pneumologist, Dr. Márcia Alcântara Holanda, who in her ordinary work as the coordinator of the apprenticeship in pneumology at the INAMPS hospital in Messejana, remembered Ramazzini and asked two patients: "What's your occupation?"

Today, only in Tianguá, a town with 40,355 inh. (IBGE 1980), 138 pit diggers have already been clinically and radiologically examined, and a very large number of workers suffering from the disease was found. FUNDACENTRO participated in this work through its Divisions of Occupational Medicine and Hygiene, its Regional Center in Pernambuco, supported by its National Technical Center, making clinical examinations, radiological comparisons based on OIT standards (International Labor Organization) environmental dust analyses and other risk analyses, general guidance in relation to occupational safety, hygiene and medicine, and chiefly in the proposition of solutions compatible with the serious nature of the situation, in order to solve definitely this crucial problem that affects seven towns in Serra da Ibiapaba, comprising approximately 200,000 people. None of these towns has a conventional water supply, and there is no natural water reservoir in the surroundings. The population has to dig water holes manually, one per family, keeping a large number of workers busy.

HAZARDS OF THE ACTIVITY—BACKGROUND

A pit is generally dug by two persons who substitute each other alternatively. While one worker is inside the pit, the other stays on the surface, helping with whatever is necessary. The pits usually have a diameter of 1,50m and they are around 12m deep. The geologic profile of the soil shows a stratum containing 10m of sandstone, which is easily excavated using tools. There is a hard silicified stratum below it that may only he removed with the use of explosives or mechanized tools. A sample of this silicified stratum was taken to be analyzed and it was found to contain 97.44% of SiO_2. After this stratum we reach the saturated zone, where the walls of the pit are then covered with premolded concrete rings. A bucket lifted with ropes through a drum fixed to a wooden girder set at the pit entry is used to remove the material. It can also be used by the worker to go up to the surface or down to the bottom. In February 1987, they used to charge the amount of US $10.00 for each "palm" (approx. 25cm) excavated or US $385.00 for a whole pit of any size.

Operational Hazards

Due to the poor conditions where the work is performed, it is easy to foresee the numerous hazards involved:

- Falls caused by rope rupture, drum break, rupture of drum fastening, rupture of drum supporting girder, slipping.
- Being buried in the earth by caving in of pit walls.
- Accidents caused by tools in the confined workplace.
- Ergonomic risks due to worker's posture because of confined workplace.
- Misuse of explosives.

Here we wish to focus on a number of irregular proceedings, starting with equipment and material purchase, which is traded freely, with no observance of current laws. The transport, storage and handling are also totally inappropriate. Explosives have been seen in worker's houses in places within children's reach. The preparation of explosives for detonation is done in a very primitive way, even the teeth are employed to fix the detonator to the fuse and it is done in the presence of ordinary people (even children) in residential areas, with no measure taken to isolate the area. Thus, besides the danger of an accidental explosion, there is the danger of stones being thrown at considerable distances, often causing physical and material damage.

Another circumstance which deserves attention is that the worker has only 2 minutes and a half to get out of the pit, after lighting the fuse of the explosive charge at the bottom of the pit. It is easy to imagine what may occur in case he falls because of any reason already mentioned. In the survey we found that at least one fatal accident had been caused by this reason.

Environmental Hazards

Undoubtedly, the biggest hazard of this type of work is the

dust produced by the excavation. In rainy weather, the aerosol is present almost exclusively in the operation of removing the silicified sandstone stratum through mechanical means or explosions (the usual manner). The situation is aggravated in dry weather when the dust is also present in the strata prior to the silicified sandstone. Therefore, the risk generating factors are:

- Low humidity of the soil above the saturated zone.
- Pit depth, making the dust reduction by means of natural ventilation impossible.
- Lack of any exhaustion device.

The concentration of dust is higher just after the silicified sandstone stratum is exploded and it remains like that for hours. The worker generally goes back to the bottom of the pit to remove fragments 3 hours after the detonation which is not enough time for the dust to have dissipated.

MATERIAL AND PROCEDURE

The measurements of these concentrations were carried out since then. The adopted procedures are described on Table I. The threshold limit values represent dust concentrations in workplaces under which it is believed that most of the workers may be repeatedly exposed to during their work-life with no harm to their health.

Procedures for Evaluation and Analysis

The dust sampling was collected by means of 37mm PVC filters, with 5μm porosity, where low flow rate suction pumps were used (pump BENDIX model BDx 44). A one-inch cyclone was used to select respiratory particles. It allows 90% of particles having a diameter smaller than or equal to 2μm to go through and it detains particles with diameters bigger than 10μm. The determination of dust concentration was made by gravimetry and an analytical balance of 0.000010 precision was used. The percentage determination of crystallized free silica in the dust samples was carried out through X-Ray diffractometry.

Note. The BENDIX sampling kit is an equipment for individual use, fitted out in the worker. The samples collected represent the circumstances of exposure to dust when performing any analyzed activity.

The flow rate used in the collection of total dust is 1.5L/min and in the collection of respirable dust it is 1.7L/min. The period for sampling varied according to environmental characteristics.

Procedure for Assistance

The procedure for assisting exposed workers has been the following:

Table I
Threshold Limit for Crystallized Free Silica Dust

THRESHOLD LIMIT		COLLECTED DUST	SAMPLING METHOD	PROCEDURE FOR ANALYSIS
$\frac{8.5}{\%SiO_2+10}$	MPPCD*	Total	Impinger	Field Count
$\frac{8.0}{\%SiO_2+2}$	Mg/m³**	Respirable	Gravimetric with Cyclone	Gravimetric (weighing)
$\frac{24}{\%SiO_2+3}$	Mg/m³**	Total	Gravimetric	Gravimetric (weighing)

(*) MPPCD = Millions of particles per cubic decimeter
(**) Mg/m³ = Milligrammes per cubic meter

1. Simple spirometry, measuring the forced vital capacity, measuring the forced expiratory volume in the first second of time and forced respiratory flow between 25% and 75% of forced vital capacity.
2. Effort tests (with arterial blood gases, exhausted gas sample and realization of ECG).
3. Fiberoptic bronchopy and collection of bronchiole-alveolar lavage (BAL). Patients with changes in effort tests and normal radiological examinations are subject to a transbronchial biopsy of the pulmonary parenchyma.
4. Determination of the immunological profile of each patient, including: Hemogram, plasmatic protein electrophoresis, serum immunogloblins, cutaneous tests for cellular immunity evaluation, rheumatoid factor.
5. Outdoor pulmonary biopsy, where transbronchial biopsy is not enough for a diagnosis.
6. Diagnosed patients are registered in their hometowns for attendance and especially for treatment of the associated diseases mentioned above.

These stages are carried out in Tiangua', by the team of Dr. Marcia' Holanda.

MEASUREMENTS

The evaluations were based on Tiangua'. The measurements were done in pits located in 3 different regions of the town. Pit No.1 (urban area), Pit No.2 (suburban area) and Pit No. 3 (rural area). The situation of this hard working population is very serious, as can be seen in Table II, The threshold

Table II

Concentration Measurement of Environmental Dust Inside Pits in the Town of Tiangua', Brazil

PLACE	SAMPLE WEIGHT (Mg)	VOLUME OF AIR SAMPLE (m^3)	$\%SiO_2$	CONCENTRATION (mg/m^3)	THRESHOLD LIMIT (mg/m^3)	EXCESS*
Pit no.1 Bairro Sto. Antonio	0,33	0,0066	18,2	55,0 TD	1,13	48
Pit no. 1 Bairro Sto. Antonio	0,96	0,0068	18,8	141,2 TD	0,41	344
Pit no. 1 Bairro Sto. Antonio	0.25	0,0034	16,0	73,5 RD	0,44	167
Pit no. 2 Rua das Almas	0,40	0,0045	10,0	88,9 TD	1,85	48
Pit no. 2 Rua das Almas	0,19	0,0075	10,5	25,3 TD	1,78	14
Pit no. 3 Health Center	0,11	0,0051	9,1	21,6 RD	0,72	30
Pit no. 3 Health Center	0,27	0,0085	3,7	31,8 RD	1,40	23

According to NR 15, Governmental Decree 3214/78 of the Ministry of Labor
TD = Total Dust
RD = Respirable Dust
* = Number of times the Threshold limit was exceeded

limit for silica dust occupational exposure was exceeded up to 344 times. The legislation considers these cases as maximum degree insalubrity. Dust concentration at these levels, inevitably causes silicosis. This was confirmed by a number of diagnosed cases in the region.

In Tiangua, out of the 200 pit diggers estimated, 134 were examined. Out of these, silicosis was confirmed in 38 through clinical and laboratorial examinations, and 5 workers, out of these 38, died within 60 days.

CONCLUSIONS AND RECOMMENDATIONS

As far as the workers already affected by the disease are concerned, consequently with no chance of cure, what could be done to help them is give them a monthly life annuity. Therefore, it is necessary that the workers be examined and considered disabled by means of a medical examination. The disease is known to exist and to be extremely serious, however, because it occurs in a deep poverty region, distant from the big cities, prevention is laid aside by the supervising, educational and medical assistance structures in charge of the matter.

It is common knowledge that silicosis prevention in general includes environmental control measures, such as:

- Product substitution
- Process alteration
- Dust suppression in the source by means of moistening
- Process insulation
- Dust removal through a general scattered ventilation, on/site exhausting ventilation or electrostatic precipitation
- Use of personal protective equipment

We consider a conventional water supply system a definite solution to the problem. A dam has already been built 18km from Tiangua', which is just waiting for a governmental decision so that supplementary works can be built and put in operation (water mains, water-treating plant and water supply system). In the rural area the solution would be the machine sinking of wells, with no direct participation of the worker in the process.

In addition to the benefits that these solutions could bring, they would also create jobs for the local population. However, these are not short term measures, thus while water-holes still need to be built as the unique source of potable water for the people, some specific measures could be carried out:

- For the use of explosives—Careful attention to safety instructions about transportation, storage and handling of these materials.
- Provide appropriate safety conditions in order to avoid falls when going down and up the pit. Provide appropriate dimensions for ropes, drums,sheaves and support beam.
- Keep the excavation site moist.
- Wait for at least 24 hrs after the explosion before entering the pit.
- Standardize a diameter for the water-hole of at least 2,50m so that the worker may have better working conditions.
- Limit the use of personal protective equipment, which should only be used as a transient solution for its several deficiencies and above all, its low efficiency and discomfort for the person who uses it.
- Cover the pit walls with pre-molded concrete rings as the excavation gets deeper.
- Make regularly the previously mentioned examinations in accordance with the current labor legislation at the expense of the Ministry of Social Welfare.

However, a question is to be asked: How are these pieces of information to get to the workers, and principally, how to make them understand how relevant they are? Dr. Márcia Alcântara has taken the first steps in relation to this. In Tiangua', on a daily radio program she talks about the general aspects of the problem attacking the pit diggers of the region. The workers themselves, after the first deaths, have mobilized to fight for better working conditions, but due to the fact that most workers are not educated, and need to support themselves and their family, they do not give attention to the matter. While definitive solutions are not adopted, it is necessary to make the transient measures known to mitigate the disease. For this to occur, we suggest the following measures be taken:

1. Campaign about silicosis prevention in the Tiangua' daily radio program. Fundacentro may cooperate recording cassette tapes with this information.
2. Fundacentro can prepare posters and booklets to be distributed to health centers, town halls, church communities and labor unions.
3. Educative lectures held at community centers, health centers, schools and churches, given by technicians from the Regional labor office, Welfare and State Health office.
4. Intensification of supervision by the Regional Labor Office of preventive aspects and of the work entailment between employees and employers. Orientation about the use of explosives by the Army.
5. Facilities for purchase of personal respirators or even their distribution free of charge to workers, hy the Ministry of Social Welfare together with the State Health office.

Nevertheless, we stand upon the point that the eradication of the problem will only occur completely, when there is the engagement of the federal, state and municipal governments in order to provide these populations with what they do not have so far: a potable water supply system.

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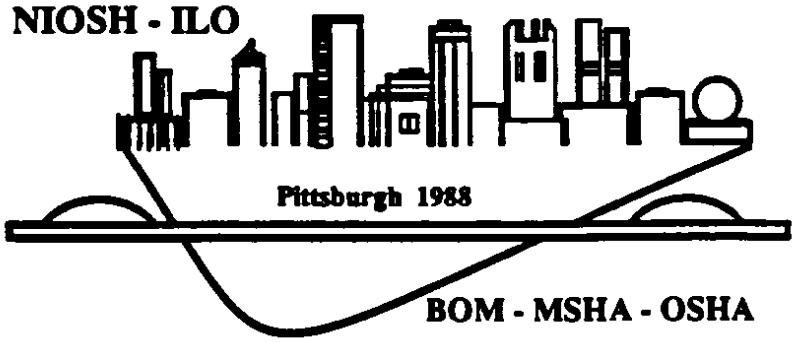

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