SILICO-TUBERCULOSIS : BURDENING LIVES OF MINERS

A research study on prevalence and prevention of silico-tuberculosis in stone mines

Gravis

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Conducted by

GRAVIS, 3/437, 458, M. M. Colony

Pal Road, Jodhpur 342 008, INDIA

Phones : 91 291 2785 116, 91 291 2785 317

Email : email@gravis.org.in

www.gravis.org.in

Author

Dr. Rajesh Mehta

Professor and Head, Department of Community Medicine

College of Medical Sciences, Amargadh, Ta: Shihor

Dist: Bhavnagar, GUJARAT (INDIA)

Edited by

Dr. Prakash Tyagi, GRAVIS

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MISEREOR

Postfach 101545, 52056 Aachen

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FOREWORD

Historically, the trade of mining has been severely impacted by occupational health hazards. In many parts of the world, mines of various minerals have boosted industrial growth and have generated large revenues and employment opportunities. Consequently, millions around the world have earned their bread by working in the mines and have supported their families. Ironically, the standards of health safety in a lot of mines have remained an issue of great concern presenting potential threats to mineworkers. While change has taken place towards improvements in many regions, it has certainly been inadequate.

In the stone mines of Thar Desert of India, prevalence rates of silicosis and tuberculosis are high among mine workers. Due to consistent inhalation of silica over a long period of time and due to increased vulnerability towards mycobacterium tuberculosis as a result of poor nourishment, many, a large number of mineworkers suffer with either silicosis or tuberculosis, or with both. The combination of these two diseases, one of inflammatory in nature and infectious by origin, one irreversible and incurable and one curable, is a fatal condition causing high morbidity and mortality.

GRAVIS, as an organization working at the grass-roots, has always stood up for the development of mining community. Among many initiatives that GRAVIS has taken up for mineworkers, delivery of healthcare and advocating for occupational health safety have been of significant importance for our work. This study is an attempt to understand various aspects of silicotuberculosis looking into both history and future. The overall goal of the study is to prepare working in mines and people working with mineworkers to combat with this deadly threat.

The study has taken up a comprehensive approach by studying existing literature, reviewing ground realities, organizing extensive medical tests and taking expert opinion. I sincerely thank Dr. Rajesh Mehta and his team, colleagues at GRAVIS and the mining communities of Thar for their important contributions in completing the study.

Dr. Prakash Tyagi

Director, GRAVIS

PREFACE

While extraordinary research work is going on in various parts of the world, which includes medical field also & luxurious facilities are being created for diagnosis & treatment of various minor & major health problems, millions of children are becoming orphans just because of father & mother are not protected against deadly but preventable disease – silicosis. On top of that when this disease gets company of tuberculosis, death comes uninvited when the children are in greater need of father (and mother.) The irony is, father has no choice but to die of hunger on one side or die of silico-tubeculosis on other side while working in mines. Disease is an unavoidable choice because, hunger will kill in few days & disease will kill in few years. Taking advantage of this helpless situation, owners of mines & ignorance coupled with inhuman behavior & apathy of government officials, a large number of workers are suffering from multiplicative effect of silicosis & tuberculosis.

GRAVIS, a development organization, is working for mine workers issues for more than last 15 years. Out of experience & concern for mine workers & their family members, the organization has decided to prepare some preliminary report to base revolutionary actions for prevention of not only silico-tuberculosis but also reduce the sufferings of mine works & their family members. As a result of this I had accepted an opportunity given by GRAVIS to document the problem of silico-tuberculosis & set the ball rolling for concrete actions for prevention of this deadly combination of the evils.

The report narrates problems, situation & factors creating the problems & suggested solutions & strategy for solving the same.

Dr. Rajesh Mehta

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1. BACKGROUND

Stone mines of Western Rajasthan are famous worldwide for its sandstone and white marble. In the drought-stricken state of Rajasthan and in particular in its Western part, mining provides essential support to livelihood generation. Thousands of mines employ a large number of people with overall estimate for the state exceeding 2 million people. Mineworkers in these mines work in unsafe conditions, are unpaid and undernourished, and suffer with various health problems.

Silicosis and tuberculosis are two commonly found respiratory diseases that mineworkers suffer with. Silicosis is a dust-borne disease that causes irreversible and fatal changes to the lung tissue. Tuberculosis is infectious and caused by mycobacterium tuberculosis. Both silicosis and tuberculosis are potentially life threatening diseases. While TB can be treated completely with adequate medication, silicosis can only be provided palliative support. Mineworkers suffering with either of these diseases, have a great risk of developing the other disease. Co-existence of silicosis and tuberculosis is known as silico-tuberculosis, prevalence of which is high in stone mines of Rajasthan. Silico-tuberculosis over the years has affected mining community profoundly causing significant social and economic loss.

2. AIMS AND OBJECTIVES OF THE STUDY

The proposed research study aims on studying the prevalence of silico-tuberculosis and understand its genesis with following specific objectives :

1. Study the prevalence of silico-tuberculosis among mineworkers of Rajasthan
2. Understand the genesis of the disease and analyze precipitating, underlying factors
3. Study health safety arrangements and existing health services and underline gaps causing occupational health problems and their complications
4. Review of literature about situational analysis of the national, regional and global levels and draw lessons from other areas
5. Suggest remedial measures to reduce the incidence and prevalence of the disease
6. Analyze public health perspectives of silico-tuberculosis and initiate the process of comprehensive prevention of silico-tuberculosis

As an overall outcome, the study aimed at the following:

1. Increased awareness of the disease among mineworkers, mine owners, healthcare providers, government authorities and development agencies
2. Health safety measures to be practiced in stone mines.
3. Enhanced capacities of healthcare providers in detecting (Suspecting & investigating) the disease and supporting the patients.
4. Incidence and prevalence of silico-tuberculosis reduced

3. METHODOLOGY OF THE STUDY

3.1 Population sampling

Study area included desert districts of Rajasthan in general and stone mines situated in vicinity of Jodhpur city in particular. All mine workers of these mines were considered as the sample population. This included retired mine workers also. Here usually the word “retired” means worker had to stop working because of illness or incapacity to work. Due to inbuilt resistance of mine owners & pressing need of workers to work, it was not possible to take systematic random sample from a ready sampling frame. Also there is no list of all workers available as, often, it is rotating short term work assignments in particular mines. It is estimated that around 100,000 workers are working in mines in study area. Therefore it was decided to go ahead with self

selected sample of mine workers who responded to an appeal for health check up at the various mines and/or at the residential habitats by workers of GRAVIS. However it was decided to include all major areas where mines are located. Following mining areas were visited for the study:

Mandor, Kaliberi, Sursagar, Keru, Balesar, Gagari, 11 Mil, Bhat Basti, Belclor Basti and Ambedkarnagar.

There are all chances that either cooperative workers came forward or workers who felt need of check up came forward. Overall, 1086 mine workers interviewed by paramedical workers & 221 mine workers underwent medical check-up. As this is not strictly representative population based study of mine workers , word prevalence will be difficult to use in its strict scientific meaning , however as there is no systemic bias with its due limitation in this study we will use the term prevalence of various morbidity among the population of the workers who undergone the study.

3.2 Study design

It is a cross sectional study without any specific intervention or control groups. Duration - The study was conducted between August 2009 and April 2010. The main data collection for medical check- up was done in months of September and November 2009. Dataentry, data analysis & report writing were carried out in rest of the period. Review of literature was carried out thorough out the study period.

3.3 The team

The total 8 paramedical staff was divided into 4 teams as per the area to be covered. It was planned in such a way that each study subject (mine worker) at least gets optimum time required for interview or health check-up as per the respective tool. Although the doctor, medical students and paramedical staff - all were well trained, they were oriented by the community health expert, special additional training was given for respiratory function test to two persons. One of that was person was local who understands local language & had postgraduate qualification and other person was having medical background with more than 10 years experience. Both were together at the time of respiratory function tests. Proper explanation was given to mine worker before each test. In case of unsatisfactory result repeat test was carried out. The instrument used for respiratory function test was a computerized machine (Med Spiror – made by a company having research department approved by Department of science & technology of Government of India)

3.4 Tools

Detailed tools were developed and were pretested.

Study included five major components as under.

(I) Interview of mine workers by paramedics - Details of symptoms & allied conditions of 1086 mine workers.

(II) Medical check-up by doctor with help of medical students - Medical check-up of 221 mine workers.

(III) Respiratory function test by trained medical persons - Respiratory function test were carried out on of 77 workers out of 221 workers examined by medical team. It was possible to carry out respiratory test only in month of November as it was available only during that period.

(IV) Field visit to mines and interview with various categories of key informants by principal investigator with team members of GRAVIS

(V) Case study writing & informal discussion with mine workers and mine owners

The tools were developed by discussion with respective team members. Tool I was pretested by staff involved and it was used after due modification. In addition to examination at site, as per the necessity, patients were advised referral to nearby govt. or charitable health care facility. Appropriate advice for follow up was given. Patients were also advised for necessary investigations, but it was not possible to collect and incorporate additional findings in analysis.

3.5 Data-Analysis

The data collected was entered in excel and data was verified in minimum 10 % subjects in tool II. It was not possible for principal investigator to verify data-entry of tool I and therefore inconsistency in data-entry was pointed out and sent to GRAVIS team for correction. It was done and then final analysis was carried out on that data-set. Then the data was analyzed by EPI INFO - software prepared by the WHO. For diagnosis, judgment was taken based on the symptoms and clinical signs and mainly it was classified according to the system affected when it was not the focus of study. For respiratory diseases, help of X-ray findings, sputum for AFB and other investigations were used if already patient has report of the same. Support of respiratory function test was taken as additional tool for judgment. Case papers were also used for past history, when available, particularly for Tuberculosis.

4. REVIEW OF THE LITERATURE

Silica is the name given to a group of minerals composed of silicon and oxygen, the two most abundant elements in the earth's crust. It occurs most commonly in a crystalline form, and more rarely an amorphous state. The three main crystalline forms are quartz, tridymite and cristobalite, the first being so abundant that it is often used in place of the general term crystalline silica (CS). Cristobalite and tridymite are found in rocks and soil and are produced in some industrial operations when quartz or amorphous silica is heated (such as foundry processes, brick and ceramics manufacturing and silicon carbide production). Quartz is a common component of soil and rocks and consequently workers are potentially exposed to quartz dust in many occupations and industries [1]. In 1990–93, Carex estimated 600 000 workers were exposed to CS in Great Britain [2] with 3 million in Europe [3]. Occupational exposure to respirable crystalline silica (RCS) is a serious but preventable health hazard. Prolonged exposure to RCS has long been known to cause one of the oldest known industrial diseases, silicosis, and it has been observed that there is a greater risk in workers exposed to very fine particles of CS, as found in quartz and cristobalite flours [4]. More recent epidemiological studies of occupational exposure to RCS have reported an increased incidence of (or mortality from) extra-pulmonary diseases such as rheumatoid arthritis [5], scleroderma [6,7], other autoimmune diseases [8,9] and non-malignant renal disease [10,11].

Silicosis is a fibrosing lung disease caused by inhalation and deposition of crystalline silica particles, resulting in a pulmonary response. It is the most prevalent of the pneumoconiosis. List of occupations posing the greatest risk include the following: mining and processing of stone; mining of gold and precious stones; well drilling; sandblasting; ceramic and glass production; and iron smelting. Clinically, silicosis can present in three different forms: acute; accelerated; and chronic. The acute form is caused by substantial exposure to silica and usually manifests within 2 years after the initial exposure. In the accelerated form, symptoms appear after 2 to 10 years. The chronic form develops more than 10 years after exposure, and is typically oligo symptomatic. However, it can evolve to progressive dyspnoea on exertion. In patients with the chronic form, the progression of the disease can be rapid, evolving to death within a few months or years. From a histo-pathological point of view, silicosis is characterized by the presence of granulomas, with collagen nuclei surrounded by epithelioid cells, giving rise to silicotic nodules, which are diffusely distributed in the lungs and, with the progression of the disease, can coalesce and form large masses, distorting the parenchyma.[12]

In addition to its importance as an occupational disease, silicosis—or even exposure to silica without established disease—is associated with increased risk of developing various pulmonary and systemic co-morbidities. Higher prevalence of chronic obstructive pulmonary disease, lung cancer, tuberculosis, non tuberculous mycobacterium-related diseases, glomerulonephritis, rheumatoid arthritis, scleroderma, and other autoimmune diseases have been documented among patients with silicosis.[12,13]

Although silicosis arises in obviously dusty environments, RCS dust is invisibly fine. It is breathed in through the nose and mouth and can stay in the lungs for many years. It can cause irreversible lung damage before any symptoms develop. The illness it causes may continue to worsen even after exposure stops.

To date, there is no evidence based specific treatment for silicosis. Research in eastern countries has shown improvement in pulmonary function and delay in disease progression with the use of tetrandrine, [14] an alkaloid derived from the plant Stephania tetrandra with antioxidant, antifibrogenic, anti-inflammatory, and immunomodulatory properties.[15] Corticosteroids and therapeutic bronchoalveolar lavage (BAL) have also been tested, both of which have produced less than promising results.[12] Therefore, the appropriate approach is elimination of source of exposure. In addition, health care workers involved in the treatment of patients with silicosis must attempt to prevent and detect associated complications early.

4.1 Etiology

As mentioned earlier it is caused by inhalation of Silica dust in its free state (SiO2). The size of the dust particles should be between 0.5-3 microns to cause silicosis. They enter the terminal bronchioles and are retained there to cause the damage. Silica dust is generated in work related to sand stone quarries, foundries, mining, ceramics pottery and many other industries. Various Processes that lead to dust production are grinding, stone crushing, stone breaking, etc. When the person involved in such work is simultaneously exposed to smoking, the damage caused is exaggerated. Various categories of workers who are exposed to dust in mines include miner, driller, hammerer, digger, Cutter, polisher, grinder, etc.

4.2 Clinical Features

There are three clinical forms:

1. Chronic (classic) form: One or more decades of exposure to silica containing dust; may progress to progressive massive fibrosis.
2. Accelerated: Short and heavier exposure for 5 – 10 years. Rapid progression leading to respiratory failure and death.
3. Acute form: Intense exposures to high levels of respirable dust with high silica content for periods that may be measured in months rather than years. Clinical picture resembles alveolar proteinosis.

4.3 Pathology

Pathological process starts only when the dust particles containing silica in a free state such as quartz (SiO2), reach the alveoli. Most of the dust inhaled is expelled by the ciliated epithelium and some part is eliminated by phagocytosis, which brings up the particles and discharges them to the ciliated epithelium and the cough mechanism expels them. However, when the fine particles are present in the atmosphere in a large quantity, some find way to the finer air passages. They first cause the inflammation of the ciliated epithelial cells with their subsequent destruction, reducing the first line of defense. Epithelial cells crowded with silica dust get aggregated into definite clumps around which fibrosis occurs. This damage produced in the lung is permanent. It is liable to activate the preexisting tubercular focus and develop tuberculosis. The disease finally produces emphysema and cor pulmonale. Very little can be done once the disease has set in and therefore, prevention is most important and pre - placement and periodic health examinations of the worker are also important. Chest X Ray is to be taken to see if the individual has pulmonary tuberculosis or any other lung disease. Basic lung function tests should be carried out, including measurement of the Vital Capacity and Forced Expiratory Volume in one second. Dust control is the most important engineering procedure to reduce risk. If a significant number of workers develop silicosis within 20 – 25 years of first employment, the dust control measures should be evaluated.

4.4 Silico-tuberculosis

Tuberculosis (TB) is a global emergency. Nearly two million people die every year from tuberculosis [16] and despite National Tuberculosis Control Programmes operating in many countries; eight and a half million new cases appear each year to challenge public health. The South-East Asia region bears the major brunt of the global TB burden harboring 38% of the world's TB cases. Poverty, increasing migration, homelessness and the compulsions to live and work in high-risk environments are making people increasingly susceptible to the disease. Each year the region sees three million new cases and loses 750,000 lives due to tuberculosis. [16]

The industrial sector bears a heavy load of these losses. In many workplaces, employees operate in closed spaces and unprotected environments, which carry high risk of the disease spreading from those having active TB to other employees working in close proximity. Those working in mines, construction work, and stone crushing and in other similar occupations where there is a greater level of exposure to silica dust are also especially vulnerable. The association of silicosis and tuberculosis has been suspected for several hundred years, but it was not until the discovery of the tubercle bacillus and the introduction of mortality statistics that this suspicion was confirmed by objective evidence.[17] In 1902 a Committee, with J.S.Haldane as a member was set up to investigate the high mortality among Cornish tin miners, it reported that “stone dust predisposes enormously to tuberculosis in the lung”. The work of Watkins-Pitchford from South Africa and Collis & Kettle from Britain, produced further evidence, later workers on this continent such as Riddell, Sander and many others added more information concerning the co-existence of these two diseases.

The classical experiments of Gardner demonstrated that exposure to silica causes a renewed multiplication of bacilli in the healing tuberculous lesions in guinea pigs. This susceptibility is not only confirmed to virulent tuberculi bacilli,but it occurs also with virulent strains such as BCG, with catalase negative isoniazide resistant bacilli and with atypical photochromogenic and nonphotochromogenic acid fast bacilli. [18]

4.5 Epidemiological aspects

The risk of developing pulmonary tuberculosis is reported to be 2.8 to 39 times higher for patients with silicosis than for healthy controls.[13,19,20] The risk of a patient with silicosis developing extra-pulmonary tuberculosis is also as much as 3.7 times higher than in healthy controls.[21,22] The pleural form is most common, accounting for 61% of the cases,[22] followed by the pericardial form and the lymph node form.[21] Regarding the relationship between mycobacteria-related diseases and the different forms of silicosis,

studies in the international literature have shown that the acute and accelerated forms present the highest incidence.[23] In Brazil, a 52% prevalence of pulmonary tuberculosis, in the form of progressive massive fibrosis, has been recently reported in patients with silicosis. Most of those cases were diagnosed by sputum smear microscopy or sputum culture.[24]

In a prospective study evaluating 1,153 gold miners, the annual incidence of tuberculosis was found to be 2.7% in those with silicosis, compared with 0.98% in those without silicosis. This incidence was proportional to the severity of the silicosis, reaching up to 6.3% in the patients whose chest X-rays showed intense nodule profusion.(21) In another study, in which the efficacy of chemoprophylaxis in patients with silicosis was evaluated (and, therefore, without healthycontrols), the annual incidence of tuberculosis was found to be 7% in the group receiving placebo.[22]

Study by Hnizdo E et al, among 2,000 gold miners for 27 years, showed that the risk of developing pulmonary tuberculosis is proportional to the severity of the silicosis and the intensity of the exposure. The workers with the highest cumulative exposure to dust were 3.22 times more likely to develop tuberculosis than were those with the lowest loads. The same study observed a mean interval of 6.8 years between the diagnosis of silicosis and the onset of tuberculosis.[19]

Various studies have evaluated the occurrence of tuberculosis in miners exposed to silica but without silicosis. The risk was 1.1 to 4.0 times higher than that found for controls. [13,19,20,25] In three of those four studies, the development of tuberculosis was directly related to the cumulative exposure, similar to a dose-response effect.[13,19,20,25] Longer time working in mining constitutes an additional risk factor in one of the studies but not in another.[20,25] In the largest of those studies,[13] the authors reviewed more than 4 million death certificates issued between 1982 and 1995 in the United States. For each case possibly related to silica, 5 controls were paired. The death certificates contained information on occupation, based on which a degree of exposure to silica was attributed, although it was not possible to determine the duration of exposure. Among the workers classified as having been exposed to very high levels of silica, there were miners and foundry workers. A total of 6,570 cases of pulmonary tuberculosis were identified, 22% of which presented exposure to silica. The mean odds ratio (OR) found was 1.47, being proportional to the degree of exposure and reaching 2.48 in the group in which exposure was more intense. However, in a second, cross-sectional, study, the cumulative exposure to dust and silica was calculated for each worker, based on environmental measurements and occupational history.[25] In that study, chest X-rays and histories were used in order to evaluate 520 gold miners for the presence of pulmonary tuberculosis. After excluding the miners with silicosis, according to the radiographic classification, the risk for tuberculosis was found to be directly related to the cumulative degree of exposure. The prevalence ranged from 20%, in those with the least exposure, to approximately 35%, in those with the greatest exposure. In isolation, length of time working in mining was not independently related to the prevalence of tuberculosis.

Other authors monitored 2,255 gold miners for 27 years [25] and, in 115 cases; pulmonary tuberculosis was diagnosed by sputum smear microscopy or autopsy (histological finding). Similar to findings from another study,[13] the risk was proportional to the cumulative degree of exposure, which, in this cohort, was estimated based on the records on the number of work hours of each worker, reaching 4.01 in those with the greatest exposure. The diagnosis of tuberculosis was made, on average, 7.6 years after the end of exposure, which draws attention to the fact that, even after removal of or from the source of exposure, and regardless of the presence of silicosis, this population is still at risk.

In the last of the four studies mentioned above, 381 gold miners with positive sputum culture for Mycobacterium tuberculosis and their controls were evaluated.[26] The risk of tuberculosis was increased for those who had worked in mining for more than 10 years, with an OR of 1.9. For periods of exposure longer than 15 years, the risk was approximately 4 times higher than that found for controls. Having an occupation considered to involve higher exposure to dust (for example, underground work vs. surface work) at

diagnosis showed a non-significant tendency toward risk for tuberculosis (OR = 1.3; confidence interval: 0.82-1.94).

The occurrence of diseases caused by other species of the genus Mycobacterium has also been studied. One study compared miners with nontuberculous mycobacteria-related diseases and controls without pulmonary disease.[20] The following risk factors were associated with the development of mycobacteria-related diseases: having silicosis (OR = 5.0); having worked in mining for more than 10 years (OR = 2.6); having worked in mining for more than 20 years (OR = 7.1); being HIV infected (OR = 3.6); and having a history of tuberculosis (OR = 9.6). In another study, only miners with positive sputum culture for mycobacteria were included, and those infected with M. tuberculosis were compared with those infected with other mycobacteria. The risk factors for nontuberculous mycobacteria-related diseases were silicosis and previous treatment for tuberculosis (OR = 12.6 and 3.61, respectively).[26] In both studies, the most prevalent species was M. kansasii, which was responsible for approximately 67% of the cases.

A study from Brazil investigated the risk factors for tuberculosis in the city of Pelotas. All cases diagnosed between 1994 and 1995 were paired with controls in the general population. Rock quarrying showed an increased risk (4.7 times higher), whereas living less than 2 km from a rock quarrying site represented no statistically significant difference in risk. The intensity of the exposure to dust was not evaluated, nor was the presence (and severity) of the silicosis determined. [27]

Tuberculosis is 3 to 7 times higher in person with silicosis as reported by Gupta SP et al. (India J Med Res 1972; 60:1909-15.) Rajnarayan Tiwari conducted the cross sectional study among slate pencil workers and quartz stone crushers to assess the prevalence of TB and some associated epidemiological factors. It included 253 quartz workers and 102 slate pencil workers. Clinical history and chest radiographs were used for labeling the subjects as tuberculotic. The pulmonary functions of the subjects were measured using Spirovit SP- 10. Among stone crushers the prevalence of TB was found to be 10.7% while among slate pencil workers it was as high as 22.5%. Among the quartz stone-crushers the workers aged =35 years, those exposed for =3 years and those who were smokers had higher risk TB while among the slate pencil workers, only those exposed for =10 years had higher risk. Though the FVC and FEV 1 values of the workers having TB were lower than those having normal radiographs, the differences were found to statistically non-significant. [17]

4.6 Pathophysiology of tuberculosis in silicosis

Little is known about the mechanisms by which the risk of developing pulmonary and extrapulmonary tuberculosis in increased in patients with silicosis or patients exposed to silica. Evidence from experimental studies suggests that silica modifies the immune response of the lungs, impairs the metabolism/function of pulmonary macrophages, and, with frequent exposure, causes macrophage apoptosis.[19,22] These findings are consistent with observations that the incidence of tuberculosis is higher in dust-exposed workers, even in those without established silicosis, than in workers not so exposed.

Another element involved is surfactant protein A, which appears at high levels in the BAL fluid of patients with silicosis. An excess of this protein seems to be associated with higher susceptibility to tuberculosis, possibly because it allows mycobacteria to enter the alveolar macrophages without triggering cytotoxicity and inhibits the formation of reactive nitrogen species by the activated microphages.[28,29]

It is also believed that the bacilli can remain encapsulated within the silicotic nodules, which would be responsible for the reactivation of tuberculosis in such patients [19]

Iron hypothesis

- Mycobacteria are dependent on iron for growth and produce the iron chelators mucobactin
- Silica particles absorbed body iron and act as a reservoir of iron

- Silicoto-iron complexes may activate dormant tubercle bacilli

Influence of TB

- Exposure of silica has an unfavourable influence on the course of induced TB
- There is more fibrosis is produced by combination
- Synergistic effect of silicosis and TB –proliferative fibrous reaction
- TB may complicate simple silicosis as well as advanced disease
- It may develop massive fibrosis

4.7 Occupational conditions[30]

Living and working conditions are also a cause for concern. Mine shafts themselves are crowded and poorly-ventilated, but so are hostels where over a dozen men can share a small room. These conditions are highly conducive to infection; the rate of recurrent tuberculosis in a recent South African prospective cohort of 600 miners was about 8 per 100 person-years (as opposed to half of that rate or less in the general population, with 69% of recurrent cases attributable to reinfection rather than relapse.

4.8 Diagnosis

Pulmonary tuberculosis associated with silicosis

In patients with silicosis, it is extremely important to exclude the coexistence of active tuberculosis, a situation in which treatment, rather than chemoprophylaxis, would be indicated.[31] However, the diagnosis of active tuberculosis superimposed on silicosis can be very difficult, particularly in initial profiles, when the clinical manifestations can be benign and the radiological alterations can be indistinguishable from those resulting from the preexisting silicosis.[32] Therefore, in cases of clinical suspicion of concomitant active tuberculosis, an appropriate additional investigation should be performed so that the profile can be correctly managed.

As an initial additional evaluation, it is recommended that sputum smear microscopy and sputum culture (induced sputum culture, if necessary, since it has good sensitivity) be performed, as well as chest X-ray [33] Interpretation of the Chest X ray film of the silicotic is difficult. High degree of suspicion is based on:

- Radiographic abnormalities in the apical area of either lung
- Poorly demarcated infiltrates of variable size that do not cross the lung fissures
- Rapidly developing soft nodulation
- Conglomerate massive shadowing
- Opacities may surround pre-existing silicotic nodules
- Presence of a cavity in a nodule

Additional findings

- Rapid changes in the radiographic picture
- Development of pericardial or pleural effusion
- Bronchial stenosis especially right middle lobe

Immuno diagnosis

- Levels of total IgE and IgG
- Increased Fibronectin
- Increased CD4+ and CD20+ markers
- Decreased concentration of the mucinic antigen 3EG5

The use of a complex of immunological studies promoted the better early diagnosis of silicotuberculosis.

4.9 Treatment [33]

Selection of patients for treatment

- History of exposure to silica.
- X-ray film suggestive of actual silico-tuberculosis.
- Serial x-ray film evidence of progression of disease.
- Positive tuberculin test.
- Other evidence of activity, such as hemoptysis, silicosis, pleural effusion, or fever, elevated sedimentation rate,
- Silico-tuberculosis affects not only the parenchyma but also the arteries and the veins.
- There is a thickening of the intima, hyaline and lipoid degenerations, scars in the vessels, impeding the blood circulation.
- Moreover, tuberculous cavities often occur inside silicotic nodes, which can hardly be reached by chemotherapeutic drugs.
- Fibrotic scars can prevent the collapse and scarification of a cavities
- SCCT has been established in patients with silico-tuberculosis
- Prolongation of the continuation phase from 4 to 6 months decreased the rate of relapse from 22 to 7%. [38]
- Presently, a closely supervised eight to nine months treatment is recommended.

4.10 Chemoprophylaxis: efficacy and safety

In the past 20 years, numerous studies have validated the use of chemoprophylaxis against tuberculosis in HIV-infected patients and have established its efficacy. In immunocompetent patients, protection has been demonstrated in studies involving individuals with tuberculosis-related pulmonary sequelae, as well as contacts of patients with active tuberculosis.[34] Few authors, however, have studied tuberculosis prevention in silica-exposed workers, with or without silicosis.

A randomized, double-blind, placebo-controlled trial evaluated the effect of three chemoprophylaxis regimens in 652 patients with silicosis who did not have active tuberculosis and had never been treated for tuberculosis.[22] Tuberculin skin test reactivity was not an exclusion criterion. However, 94% presented a reaction (induration) > 10 mm at the study outset. The individuals were randomized to receive, in an unsupervised manner, one of the following regimens: 300 mg/day of isoniazid for 24 weeks; 300 mg/day of isoniazid and 600 mg/day of rifampicin for 12 weeks; 600 mg/day of rifampicin for 12 weeks; or placebo for 24 weeks. After 5 years, the use of chemoprophylaxis reduced the risk of developing tuberculosis by approximately 50%. The proportion of patients with active tuberculosis in the placebo group was 27%, compared with 13% in the groups using chemoprophylaxis (combined result of the three different

regimens; $p < 0.01$). The annual incidence was 7% in the placebo group and 4% in the groups using chemoprophylaxis. Even when the individuals who did not comply with the regimen proposed were included (intention-to-treat analysis), the difference in favor of chemoprophylaxis still remained (proportion of patients with tuberculosis, 27% vs. 17%; $p < 0.05$). There was no significant difference among the three chemoprophylaxis regimens in term of efficacy.

In that same trial, treatment discontinuation due to adverse reactions occurred in 4% of the individuals randomized to receive chemoprophylaxis and in 2% of those in the placebo group. There were two cases of symptomatic hepatitis, one in the group receiving isoniazid and one in the group receiving isoniazid and rifampicin. An isolated increase in the serum levels of alanine aminotransferase (ALT) occurred in up to 30% of those using isoniazid, although those levels returned to baseline values after discontinuation of the drug. There was no difference between those receiving rifampicin only and those receiving placebo in terms of ALT levels. No induction of resistant strains was associated with the use of the chemoprophylaxis regimens. [22]

Chemoprophylaxis safety was evaluated in a study involving 77 patients with silicosis who had no history of tuberculosis and who had a tuberculin skin test induration = 10 mm.[35] The individuals were allocated to receive a two-month course of rifampicin at 600 mg/day plus pyrazinamide at 1,500 mg/day or a six-month course of isoniazid at 300 mg/day. The incidence of hepatotoxicity (defined, in the study, as an increase in ALT to at least 1.5 times above the upper limit of normality) was higher in the group receiving rifampicin and pyrazinamide than in the group receiving isoniazid only (47.5% vs. 13.9%; $p < 0.01$). When the analysis was limited to those presenting an increase of greater than 5 times, the incidence was, respectively, 35% and 2.8% ($p < 0.001$). Symptoms suggestive of hepatitis were seen in 15% and 2.7% of the patients receiving rifampicin plus pyrazinamide or isoniazid, respectively. However, viral hepatitis was excluded in only 4 of the 7 patients in question. Similarly, the treatment was interrupted due to hepatotoxicity in a greater number of individuals in the group receiving rifampicin plus pyrazinamide (35% vs. 5.6%; $p < 0.01$).

Compliance with long-term and potentially toxic regimens represents one more difficulty of chemoprophylaxis. In the group allocated to receive rifampicin plus pyrazinamide for two months, compliance was 55%. Among those randomized to use isoniazid for six months, 63.9% completed the regimen. The difference among the groups in terms of compliance was not found to be statistically significant. [35]

4.11 Prevention

- ✓ Engineering measures to reduce or eliminate the exposure to silica dust [33]
- ✓ Legal provisions
- ✓ Compensation
- ✓ Medical measures
- ✓ Active surveillance of the workers in both pre-employment and post-employment Periods
- ✓ Monitoring of the environment

5. OBSERVATIONS AND DISCUSSION

As discussed in the methodology section, a team of medical doctors, para-medics and field workers carried out an extensive medical and socio-economic survey of mineworkers. This section summarizes the findings of the survey and gives a picture of mineworkers' health and prevalence of silico-tuberculosis.

5.1 Analysis of information collected with help of Tool I from 1083 mine workers

Although total 1083 mine workers were interviewed for detailed information, some of the information was not available or not recorded and in such cases, analysis is done out of records in which information is available and percentages were calculated as per relative denominator.

Table 1 - Age of mineworkers

Age group	Frequency	Percent
<=17	371	34%
18-20	118	11%
21-30	118	11%
31-40	342	32%
41-50	122	11%
51-60	12	1%
Total	**1083**	**100.0%**

Age analysis clearly shows that 45 % of mine workers are below the age of 20 years and hardly 1 % is above 50 years of age. During field visit also it was seen that mostly young people work in field. Hardly any person can continue to work very long, mainly due to illnesses setting in.

Table 2 - Education and Gender distribution status

Education	Male (No and %)	Female (No and %)	Total (No and %)
12th Grade	3 - (0.3%)		3 (0.3%)
11-12th Grade	23 (2%)		23 (2.1%)
8-10th Grade	143 (14%)		143(13.2%)
Elementary	26 (2%)		26 (2.4%)
Literate	329 (31%)	3 (10%)	332 (30.7%)
Illiterate	530 (50%)	26 (90%)	556 (51.3%)
Total	**1054 (100%)**	**29 (100%)**	**1083 (100%)**
%	97%	3%	100%

Most of the workers (51.3 %) were illiterate, only 2.4 % had studied beyond 10th standard and not a single worker had education of college level.

Table 3 - Caste wise distribution

Caste	Frequency	Percent
General	388	36%
Scheduled Castes (SC)	557	52%
Scheduled Tribes (ST)	25	2%
Minorities	108	10%
Total	**1078**	**100%**

Majority (52 %) of the workers belong to schedule caste, followed by general category (36 %), minority (10 %) and schedule tribe.

Table 4 - Distance between mine and house

Distance group	Frequency	Percent
<1	85	8%
1 to 4	685	64%
5 to 10	141	13%
11 to 20	143	13%
30 to 45	19	2%
Total	**1073**	**100.0%**

72 % workers were staying within 4 kilometers of work place. This is an additional reason for exposure to dust particle at the time of wind.

Table 5 - Age at the time of starting particular number of job

Year	1 Job	2 Job	3 Job	4 Job	5 Job	Total
<17	263 (26%)	243(77%)	143(71%)	81(68%)	8(35%)	738 (44%)
18	252(25%)	37(12%)	15(7%)	7(6%)	1(4%)	312(19%)
19	41(4%)	32(10%)	19(9%)	10(8%)	2(9%)	104(6%)
20	366(37%)					366(22%)
21 to 25	66(7%)					66(4)%
26 to 30	7(1%)	2(1%)	13(6%)	7(6%)	1(4%)	30(2%)
>31	3 (0.3%)	2(1%)	12(6%)	15(13%)	11(48%)	43(3%)
Total	**998(100%)**	**316(100%)**	**202(100%)**	**120(100%)**	**23(100%)**	**1659(100)**
%	60%	19%	12%	7%	1%	100%

26 % of worker started their first job before completion of 17 years. Only 8 % of workers started their first job after completion of 21 years of age.

Table 6 - Reason of leaving work from various place

Reason	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Total
Disease & Others	4(5%)	3(6%)			1(9%)		1(100%)	9(4%)
Low Payment	84(95%)	50(94%)	32(100%)	21(100%)	10(91%)	3(100%)	3(100%)	200(96%)
Total	**88(100%)**	**53(100%)**	**32(100%)**	**21(100%)**	**11(100%)**	**3(100%)**	**3(100%)**	**209(10%)**
%	42%	25%	15%	10%	5%	1%	0.5%	100%

96 % of worker left job because of lower payment & none of them consider disease as an issue for leaving or changing job.

Table 7 - Duration of job

Working Since year	Male	Female	Total
1	179(17%)	2(7%)	181(17%)
2 to 5	290(28%)	2(7%)	292(27%)
6 to 10	400(39%)	16(57%)	416(39%)
11 to 20	160(15%)	5(18%)	165(16%)
21 to 40	6(1%)	3(11%)	9(1%)
Total	**1035(100%)**	**28(100%)**	**1063(100%)**
%	97%	3%	100%

Table no.7 shows duration of jobs by male & female workers. Around 16% of male & 29% of females are doing this job for more than 10 years. It is suggestive that workers are not able to continue work generally beyond a decade. This point is very crucial because workers join at young age and cannot continue for long. That means productive years of life is minimized to a large extent.

Table 8 - Who informed you for the job

Who informed	Frequency	Percent
By Family member & In laws	890	82%
By Others	128	12%
Self	64	6%
Total	**1083**	**100%**

For 82% workers, the source of information for present work was their family members & inlaws.

Table 9 - Why did you start this work

Type	Frequency	Percent
Interest	9	0.8%
Interest and no other work available	110	10.2%
Near and no other work available	47	4.3%
Near, no other work available and traditional work 1	0.1%	
No other work available	916	84.6%
Total	**1083**	**100.0%**

The most common reason (99.2 %) to start the present work was lack of any other kind of labour work in nearby area.

Table 10 - Working hours

Working Hours	Frequency	Percent
7	32	3%
7.5	156	14%
8	669	62%
8.5	12	1%
9	148	14%
9.5	1	0.1%
10	40	4%
10.5	1	0%
11	14	1%
12	7	1%
Grand Total	**1080**	**100%**

79 % workers have to work for 7- 8 hours daily, 15 % of workers are working for 8.5 to 9 hours and around 6% workers have to work for 10 hours or more than it. Looking at this extended hours of working with absence of any kind of leave , It is very clear that chances of occurrence of silicosis will be increased as well as it will appear much earlier. None of the worker has to work at night except 2% of workers.

Table 11 - Type of work

Describe work	Frequency	Percent
Skilled	775	72%
Semi-skilled	21	2%
Unskilled	287	27%
Total	**1086**	**100.0%**

72 % workers were doing skilled job & 27% were doing unskilled job. The reason behind less number in semi-skilled was rapid learning process from unskilled work to skilled work.

Table 12 - Accidents during the work

Hazards	Frequency	Percent
Blasting	17	2.2%
Blasting and Minor injury	3	0.4%
Injured	337	43.3%
Injured and Blasting	146	18.7%
Injured and Disease	1	0.1%
Injured and Major	33	4.2%
Injured and Minor	109	14.0%
Injured, Blasting and Major	64	8.2%
Injured, Blasting and Minor	23	3.0%
Injured, Blasting, Major and Minor	2	0.3%
Injured, Major and Minor	8	1.0%
Major	2	0.3%
Major and Minor	2	0.3%
Minor	32	4.1%
Grand Total	**779**	**100 %**

779 (71.9 %) of workers gave some or other kind of history of injury. Out of these blasting was blamed to be the most common reason for injury. All workers were ready for undergoing regular medical examination. 86% workers responded that government officers don't visit their work places. 4% workers were totally unaware about such visits & only one respondent mentioned that government officers visit sometimes. Most of the workers (88%) agreed that someone was asking their difficulties.

Table 13 - Relationship with owner

Type	Frequency	Percent
Bad	6	1%
Fair	1059	98%
Good	18	2%
Total	**1083**	**100.0%**

Majority of workers (98%) were having fair relationship with owner. Only 1% was having bad relationship & 2 % were having good relationship with their owner.

Table 14 - Facilities available at work place

Facility	Frequency	Percent
Drinking Water	844	77.93%
Toilet	31	2.86
Toilet for women	24	2.21
Chhaya (shadow)	17	1.57
Soap	3	0.28
Towel	2	0.19
First Aid Kit	3	0.28
Sugar	924	85.32

Table 14 reveals the facilities available to the workers. Only drinking water & sugar were available facilities as per the response of majority of the workers.77.93% workers responded about the availability of drinking water & 85.32 % responded about the availability of sugar. Only 2.86 % responded for availability of toilet, 2.21 % responded for availability of toilet for women & 1.57 % responded for availability of chhaya (Shadow at work place). Not more than three workers responded as availability of soap, towel & first aid kit facilities.

Most of the workers (88%) were having clean & cut nails as against 12 % as unclean & uncut.

Table 15 - Habit of washing hands before eating food

Type	Frequency	Percent
Ash and Soil	1	0.1%
Don't wash	14	1.3%
Soil	3	0.3%
Sometime	2	0.2%
Water	1062	98.1%
Water and Soil	1	0.1%
Total	**1083**	**100.0%**

Almost all workers were having habit of hand washing before food. 0.2% workers wash hands only sometimes. Only 1.3% workers don't wash hands before food. 98.1% workers were washing hands with water, 0.1 % with ash & soil, 0.3% with soil & 0.1 % with water & soil. None of the worker was using soap.

Table 16 - Addictions among workers (out of 1083)

Age Group	Frequency	Percentage
Tobacco	886	81.8
Smoking	340	31.4
Alcohol	234	21.6

Out of 1083 workers, 81.8% workers were addicted for tobacco chewing, 31.4% were addicted for smoking & 21.6 % were addicted for alcohol.

Table 17 - No. of family members

Number of family members	Frequency	Percent
1	19	2%
3	37	3%
4	140	13%
5	320	29%
6	217	20%
7	190	17%
8	82	8%
9	40	4%
10	18	2%
11 to 15	23	2.4%
Grand Total	**1086**	**100%**

The table shows the total no. of family members of the worker. Around 75% workers have 5 to 8 members in their family.

Table 18 - Household income per month

Income – per month (in Rs.)	Frequency	Percent
1500	3	2%
2000	2	1%
2500	3	2%
3000	31	21%
3500	3	2%
4000	58	39%
4200	1	1%
4500	27	18%
4600	2	1%
4900	1	1%
5000	14	9%
6000	1	1%
7000	4	3%
Grand Total	**150**	**100%**

39% workers have monthly income of Rs.4000 per month. 26 % of workers reported monthly income Rs. 3000 or less. Less than 4 % workers have income more than Rs. 5000 per month.

Table 19 - Health Problems of mine workers

No.	Type	Number of workers Suffering at Present	Percentages (out of 1083)
1	Body Ache	436	40.3%
2	Chest Pain	330	30.5%
3	Eye Problem	64	5.9%
4	Fever	292	27.0%
5	Muscle pain	250	23.1%
6	Cough	219	20.2%
7	Breathlessness	64	5.9%
8	Cold	183	16.9 %
9	Dental Problem	77	7.1%
10	Digestive Problem	93	8.6%
11	Ear Problem	115	10.6%
12	Diabetes	3	0.3%
13	Injury	127	11.7%
14	Malnutrition	9	0.8%
15	Accidents	38	3.5%
16	Others	114	10.5 %
17	Piles	11	1.0 %
18	Bleeding from any site	14	1.3%
19	Skin	12	1.1 %
20	Urinary System	118	10.9 %
21	Weakness	85	7.8 %
22	Do not feel like working	9	0.8 %
23	Menstrual Problem	5	17.2 %
24	Menorrhagia	4	13.8 %
25	Dysmenorrhoea	6	20.7 %
	Total	**2678**	**2.47health problems per person**

Health problems as perceived by mine workers and as communicated to paramedical staff during interview is shown in table no. 19. All data suggest point prevalence at the time of interview. Answers to question pertaining to period prevalence is not presented here for the sake of avoid recall bias. On an average there were 2 to 3 symptoms per patient. Most common symptoms were body ache (40.3 %) , chest pain (30.5 %) , fever (27 %) , cough (20.2 %) and muscle pain (23.1 %). Other significant symptoms include Injuries (11.7 %), Accidents (3.5 %) , urinary system problems (10.9 %) and piles (1 %) . Among the women workers menstrual problems (17. 2 %) were prominent.

Table 20 - Choice of place for treatment of health problems

No.	Type	Treatment										
		Govt. Hospital		Private Hospital		Both Hospitals		No treatment		Home remedies & others		Total
		No	%	No	%	No	%	No	%	No	%	No
1	Body Ache	244	64%	128	34%	1	0.3%	6	2%			**379**
2	Chest Pain	139	59%	87	37%	2	1%	6	3%			**234**
3	Eye Problem	13	46%	8	29%			7	25%			**28**
4	Fever	359	54%	296	44%	1	0.2%	10	2%			**666**
5	Menstrual Problem	3	75%	1	25%							**4**
6	Menorrhagia	3	100%									**3**
7	Dysmenorrhoea	1	100%									**1**
8	Muscle Pain	109	52%	95	45%			5	2%			**209**
9	Cough	110	52%	98	46%	1	0.5%	2	1%			**211**
10	Breathlessness	13	57%	9	39%			1	4%			**23**
11	Bleeding from any site	44	92%	2	4%	1	2%			1	2%	**48**
12	Dental Problem	40	71%	15	27%			1	2%			**56**
13	Digestive Problem	78	68%	15	13%			2	2%	20	17%	**115**
14	Ear Problem	21	53%	8	20%			11	28%			**40**
15	Diabetes	4	80%	1	20%							**5**
16	Injury	76	55%	58	42%			2	1%	2	1%	**138**
17	Malnutrition	3	75%	1	25%			4				
18	Accidents	16	64%	9	36%							**25**
19	Others	16	70%	7	30%							**23**

No.	Type	Treatment										
		Govt. Hospital		Private Hospital		Both Hospitals		No treatment		Home remedies & others		Total
20	Piles	6	60%	3	30%			1	10%			10
21	Cold	203	49%	204	49%			10	2%			417
22	Skin	3	38%	5	63%							8
23	Urinary System	16	30%	33	62%			3	6%	1	2%	53
24	Weakness	13	41%	15	47%			4	13%			32
25	Do not feel like working	2	67%	1	33%							3
	Total	**1535**		**1099**		**6**		**71**		**24**		**2735**
	%	56.1		40.2		0.2		2.6		0.9		100%

5.2 - Details of findings of Medical check-up of 221 mine workers with respiratory function test of 77 workers

The work was done in two phases. In September, Health check up of 124(56.1%) workers was carried out and in November, Health check up of 97(43.9 %) workers was carried out.

Table 1 - Age distribution of mine workers

Age group	Frequency	Percent
15- 20 years	9	4.2%
21-30	52	24.4%
31-40	60	28.2%
41-50	41	19.2%
51-60	37	17.4%
more than	60	14 6.6%
Total	**213**	**100.0%**

*(*Information not available for 8 workers)*

Youngest person was aged 15 years & eldest worker was having age 84 years. 28.6 % of workers were below the age of 30 years. 24 % of workers were above 50 years of age, but many of them were not working at present.

Table 2 - Addiction of Tobacco and Alcohol

Type	Yes	No	Total
Tobacco	164 (80%)	41 (20%)	205 (53%)
Alcohol	95 (52%)	87 (48%)	182 (47%)

Addiction is highly prevalent in mine workers and table shows that 80 % are having addiction of tobacco & 52 % are having addiction of alcohol. This is an important factor. Both kind of addiction leads to increase in occurrence of silicosis as well as tuberculosis due to decrease in resistance and poor nutrition.

Table 3 - Past History of medical investigations

Type	Number	%
CBC	9	7%
Sputum	54	42%
X-ray Chest	64	50%
X-ray Knee joint / neck	2	2%
Total	**129**	**100%**

Past history of investigations suggest that there were more cases of cough with expectoration (sputum in 42 % of cases & x-ray chest was done in 50 % of cases.)

Past history of Treatment of Tuberculosis was available in 56 cases of Mine workers. Out of that 47 patients had completed treatment or they have taken treatment for more than or equal to six months. 9 patients had taken treatment for less than 5 months.

88 (74.6 %) workers out of 118 had poor hygiene. This is suggestive of ample scope of improvement.

Average pulse rate was 82. (Out of 215, 8% had pulse rate more than 100 which suggest poor health)

Average respiratory rate – Average is – 20 (Out of 182, 26% had respiratory rate is more than 20 which is suggestive of poor respiratory system or general conditions like anemia)

Table 4 - Height of workers

Height (cms)	Frequency	Percent
120 to 140	5	7%
141 to 160	27	36%
161 to 180	43	57%
Total	**75**	**100.0%**

Only 7 % of workers were having height less than 140 centimeters and it seems that over all stunting was not evident. (Further detailed analysis showed that only 2 % workers had height between 140 to 150 centimeters. It means that 91 % workers had height more than 5 feet, or 150 centimeters).

Table 5 - Weight of workers

Weight (Kgs)	Frequency	Percent
30 to 50	54	49%
51 to 60	40	36%
61 to 70	11	10%
71 to 80	5	5%
Total	**110**	**100.0%**

49(44.5%) workers had weight less than 50 kg & 5(4.5%) had more than 70 kg. Looking at range of height, it is clearly evident that moderate to severe malnutrition is rampant & workers are living just to continue to work for few years and then replace by younger generation to follow the path of hunger, infection, suffering & the darkness in life.

Table 6 - Body Mass Index (BMI) of workers

BMI	Frequency	Percent
14 to 20	42	57%
21 to 25	22	30%
26 to 30	8	11%
31 to 35	2	3%
Total	**74**	**100.0%**

BMI Average is 20.9. 57 % workers were having BMI less than 20 which is suggestive of rampant malnutrition. Lack of sufficient calorie balance in diet will lead to protein depletion as it will be utilized for giving energy at the cost of its primary function of production of immunity and other vital functions.

Table 7 - Eye problems

Problems	Frequency	Percent
Cataract	16	10.2%
Night blindness	2	1.3%
Refractory error	64	40.5%
No problem	76	48.1%
Total	**158**	**100.0%**

Out of 158 workers examined, 16(10.2%) had cataract & 64(40.51%) had refractory error.

Ear problems

Out of 114 workers examined for deafness , 1 (0.9%) worker had total deafness & 8(7.0%)workers had mild deafness.

Dental problems

Out of 135 workers examined for dental problems 114 (84 %) had discoloration of teeth, mainly due to tobacco habits, 55 (40.7 %) had dental caries and 1 worker had bleeding gums.

Cervical lymph node

Out of 117, 14(12%) workers had enlargement of cervical lymph node & 1(0.8%) had cold abscess on right side of neck.

Limb pain and varicose vein

Out of 126, 25(20%) workers had pain in upper limb and 35 (27.7 %) had pain in lower limbs. Out of 119 workers, 4(3.4%) had varicose vein.

Respiratory system

On examination of respiratory system, crepitation, rhonchi or reduce air entry were found in 80(36.2 %) patients.

Other findings

Out of 127, 1(0.9%) had some abnormal heart sound. 3.6% had reduced memory.

Investigations conducted

Total 69 patients were referred for x-ray investigation. Out of these 53 (76.8 %) patients required x-ray chest and rest of the patients mainly required x-ray of various joints. 39 patients were referred to undergo investigations for sputum AFB.

Table 8 - Referral of mine workers who required referral services in a few days

Referral	Frequency	Percent
Civil hospital	2	4.0%
Physician	8	16.0%
General surgeon	8	16.0%
Ophthalmologist	9	18.0%
Orthopedic	7	14.0%
Skin	1	2.0%
TB centre	15	30.0%
Total	**50**	**100 %**

Out of 50 patients, 15 (30 %) were referred to TB centre, 9 (18 %) patients were referred to Ophthalmologist and 8(16.0%) patients were referred to physician and equal number to surgeon.

Table 9 - Major symptoms in mine workers

Symptoms	Number	Percents out of 221
Breathlessness	71	32.1%
Chest pain	54	24.4%
Cough	70	31.7%
Fever	30	13.6%
Giddiness	10	4.5%
Headache	31	14.0%
Loss of appetite	14	6.3%
Weakness	25	11.3%
Total	**305**	**1.4 major symptom per person**

Breathlessness (32.1) was the most common symptom, followed by cough (31.7 %) and chest pain (24.4 %). All these indicate mainly respiratory system involvement. Headache (14 %) and fever (13.6 %) are also among the significant symptoms.

Table 10 - Morbidity in examined mine workers

Disease / condition	Number	% out of 221
ARTI	17	7.7%
Asymptomatic Respiratory tract problem	20	9.0%
Chronic Respiratory tract problem	47	21.3%
Pulmonary tuberculosis	13	5.9%
Silicosis	8	3.6%
Silico-tuberculosis (Diagnosed & suspected)	25	11.3%
All types of Respiratory problems	**130**	**58.8%**
circulatory system	9	4.1%
Hepatomegaly	24	10.9%
Joint problem	51	23.1%
Digestive system problem	54	24.4%
Eye problem	18	8.1%

Disease / condition	Number	% out of 221
Myalgia & Bodyache	26	11.8%
Nutritional disorder	28	12.7%
skin problem	8	3.6%
surgical problems	6	2.7%
Urinary tract problem	8	3.6%
Others	11	5.0%
Total	**373**	**1.69 illness per person**

It is clear from the table that major problem is that of respiratory system. (58.8 %) More important findings are pairing of pulmonary tuberculosis and silicosis (11.3 %). Absolute percentages of tuberculosis (17.2 %) and silicosis (14. 9 %) will be more if we further do follow up and investigate all cases of chronic and asymptomatic respiratory tract problem. Digestive system problems (24.4 %), joint problems (23.1 %) and Hepatomegaly (10.9 %) are also major problems.

Table 11 - Respiratory function test in workers having respiratory problems vs workers having other problems

Provisional diagnosis	Obstructive				Restrictive				Mixed (Obst and Rest)	Early small airway obstruction	Normal	Grand Total
	Mild	Moderate	Severe	Total	Mild	Moderate	Severe	Total				
Repiratory Problems	1	1	3	5	4	6	6	16	9	3	7	**40**
%	3%	3%	8%	13%	10%	15%	15%	40%	23%	8%	18%	**100%**
Other Problems	1	1	3	5	8	4	1	13	4	2	10	**34**
%	3%	3%	9%	15%	24%	12%	3%	38%	12%	6%	29%	**100%**
Total	**2**	**2**	**6**	**10**	**12**	**10**	**7**	**29**	**13**	**5**	**17**	**74**
%	3%	3%	8%	14%	16%	14%	9%	39%	18%	7%	23%	**100%**

Respiratory functions tests were carried out in all workers when it was feasible during second phase of medical check-up irrespective of symptoms or findings of patients. Interpretation was used by computerized value of Forced Vital capacity and FEV1/FVC. Looking at table, it is clear that respiratory function were normal in 29 % of workers having other complains, while it was normal only in 18 % of workers having respiratory problems. Indirectly this is suggestive of possibility of good validity of test. Most striking difference was seen in severe restrictive pattern which was present in 15 % workers having respiratory problems compare to 3 % of workers having other problems.

Table 12 - Respiratory function test in workers having different types of respiratory problems

Provisional diagnosis	Obstructive				Restrictive				Mixed (Obst and Rest)	Early small airway obstruction	Normal	Grand Total
	Mild	Mode rate	Severe	Total	Mild	Moderate	Severe	Total				
ARTI									1		2	**3**
%									33%		67%	**100%**
Asymptomatic Respiratory tract problem		1	1	***2***	1	4	1	***6***				**8**
%		13%	13%	***25%***	13%	50%	13%	***75%***				**100%**
Chronic Respiratory tract problem	1			***1***	2		2	***4***	2	2	2	**11**
%	9%			***9%***	18%		18%	***36%***	18%	18%	18%	**100%**
Dyspnoea											1	**1**
%											100%	**100%**
Pulmonary tuberculosis							1	***1***				**1**
%							100%	***100%***				**100%**
Pulmonary Tuberculosis with Suspected silicosis									2	1		**3**
%									67%	33%		**100%**
Silicosis									1		1	**2**
%									50%		50%	**100%**
Suspected Pulmonary tuberculosis			1	***1***	1			***1***				**2**
%			50%	***50%***	50%			***50%***				**100%**
Suspected silicot-uberculosis			1	***1***		2	2	***4***	3		1	**9**
%			11%	***11%***		22%	22%	**44%**	33%		11%	**100%**
Grand Total	**1**	**1**	**3**	**5**	**4**	**6**	**6**	**16**	**9**	**3**	**7**	**40**
%	2.5%	2.5%	7.5%	12.5%	10.0%	15.0%	15.0%	40.0%	22.5%	7.5%	17.5%	**100.0%**

Among the various pattern of abnormal respiratory function tests, most common finding was restrictive pattern which suggest damage to lung tissues instead of simple obstruction. It was not possible to include more samples which would have given more clarification. Almost all asymptomatic patients of respiratory tract problems (found to be so based on clinical ground) had abnormal respiratory function test. This is clear indication that such non-invasive test which is cheaper and feasible in such set up can be used more extensively.

6. CASE STUDIES

ONE

On 22nd March 2010, our team visited the home of Ramu Ram. A 70 years old male, he resides near mines in Baba Ramdev colony of Keru area of Jodhpur district. Ramu Ram is suffering with multiple ailments and complains of breathlessness and gross fatigue. It has been many years that Ramu Ram is suffering. He had been visiting the nearest health facility run by the government, but so far has not seen any improvement in his health. He has a long history of working in the nearby stone mines.

Two sons of Ramu Ram, aged 38 and 35 years, also work in stone mines. They are the ones who earn money for the family. After working for over 15 years now, they have become weak. Ram Ram adds they both are taking daily medications to cure the tubercular infection. The extended family is large now with several grandchildren. The issues are complex with diseases, poverty and very little amenities around in the neighborhood. Ram Ram hopes that some of his grandchildren could go to school and do something else other than breaking rocks and stones.

Treatment of himself and his sons is also a dream that one could see in his old eyes. "The disease of dust (silicosis – as called by the community) is very cruel. I have seen many people suffering from it and many more will suffer" comments Ramu Ram.

NOTE – All names have been changed respecting confidentiality.

TWO

Forty-five years old Bhura Ram looks like a man in his 60s or 70s. He is thin, with pale eyes and is very weak. Difficulty in breathing is clearly visible even from distance. Bhura Ram, to support his family, has worked nearly 20 years in mines. The earning was never very satisfactory but at least gave the family to eat and to live under a roof.

20 years later, as a painful gift for all his work, he has both silicosis and tuberculosis. He has been eating pills to cure TB for last several months. But the situation has not improved. He remembers his visits to the government hospital, where he was explained he has TB and the dust diseases. Sometimes, he experiences sharp pain in his lungs which used to make him cry in the past, but now he is used to that. That pain is now part of life for Bhura Ram. His eldest son aged 26 also works in the mines. He is a strong man and on his shoulders is the responsibility of the family. There are three grandchildren who will hopefully make to a school and will get some education.

While Bhura Ram's health deteriorates further he is hopeful for his family. "I worked hard in my life and now I am sick. I have heard that people die from the dust disease. I just hope that my son and my grand children remain healthy".

"The-disease-of-dust" has many painful stories associated to it.

NOTE – All names have been changed respecting confidentiality.

7. CONCLUSIONS AND RECOMMENDATIONS

It is challenging to organize a systematic effort to reduce the problem of silico-tuberculosis to an acceptable level to an extent that it ceases to be a major public health problem. Looking at poverty, lack of opportunity for other employment for livelihood, lack of health & legal monitoring, absence of treatment for silicosis etc., efforts required to prevent silicosis in new generation and handle the old cases in a humane manner will be enormous.

But the hope is definitely there because of existence of many positive findings like good rapport of voluntary organization with workers, mine workers have opportunity to work in united manner in a small or large groups , unions are already formed , some of the employers are ready to listen to newer changes required, technology for reduction of dust production is available, legal action are likely to take shape in near future , national health insurance scheme for BPL families by government is likely to take momentum etc.

Looking at both negative & positive factors, following recommendations may be considered for further action.

1. Documentation of problem in a dynamic manner with a small but a constant format.
2. Keeping an account of positive and negative factors at monthly interval with help of ready to use check list.
3. Forming small groups of workers (10 to 30) and taking them to a position of taking sub contract themselves in united manner.
4. Starting a project of handling 8 to 10 mines (one in each area) by association of mine workers on cooperative basis for demonstration purpose. Or the same task may be done by collaborating voluntary organizations or some committed mine owners. If everything fails in this direction government may be approached.
5. Propagating engineering measures to reduce or eliminate the exposure to silica dust. Design of various machines is already developed by some organizations.
6. Legal provisions should be modified and implemented in such a way, so that each mine worker is to be enrolled at appropriate authority before starting work and irrespective of temporary or permanent status or place of mine. They are to be given compulsory 2 days training before starting work and regularly continuing education may be given at 3 years interval.
7. Compensation procedures are to be made easier and each worker must be given work book containing details of training, record of use of protective gears which are feasible, place of mine, residential address, photograph , summary of medical check-up etc. Based on this, If worker develops occupation related diseases like silicosis, accidents etc., s/he should be given completely free treatment along with necessary compensation. This will force both worker & mine owner to give attention to protective measures.
8. Medical measures

Active health surveillance of the workers in both pre-employment and post-employment Periods should be carried out. Health surveillance is collecting and using information about workers' health, related to their work. The early detection of breathing problems, weakness, cough etc suggestive of lung damage is must. By all means workers' health should be protected by reducing exposure to dust. Where there is a reasonable likelihood of silicosis developing, health surveillance will be necessary. Simple measures like respiratory rate, pulse rate, weight, mid upper arm circumference, recording of severity of symptoms etc can be very useful. A local graduate can be trained to do respiratory function test at regular interval. X ray is recommended as part of the clinical investigation of an individual who reports new or worsening respiratory or other symptoms for significant duration. Health surveillance is never an alternative to the proper control of exposure. In addition, periodic health screening and health promotion are definitely required. Baseline assessment is always appropriate where there is a risk of silicosis. Symptom enquiry is also needed where there is a risk of tuberculosis. In all cases of cough lasting for more than a month, sputum slides should be taken for examination of TB bacilli. The health professional must explain the test results to the individual and also assess the worker's fitness to work. Employer should keep a health record, and encourage workers to keep a copy of their results in case they change jobs. Ideally, assess workers' respiratory and other health before they start a relevant job, to provide a baseline. (Perhaps using a questionnaire and lung function assessment). Regular tests – this could involve a questionnaire and possibly lung function assessments. A responsible person should be appointed, supported by the health professional, to report any symptoms that occur between tests. Simple attendance records can help to find out sickness absenteeism & it can indirectly suggest further investigations.

9. Record keeping is very important, it should include

- List of ongoing activities that can cause exposure to RCS;
- Worker's name, address and Insurance number if any.
- products or process they work on, and how often;
- Protective measures provided and utilized.

- date of starting work with the product or process; and
- The fitness for work statement.
- Detail pre placement and periodic health examination records for each worker's should be maintained carefully.

10. Monitoring of the environment for hazardous dust particle as well as other parameters like wind direction, temperature, humidity etc.

11. Enough quantity of nutritious food can be ensured by subsidized food or better distribution of cereals through public distribution system. Small plants like "Poi – special varieties of green leafy vegetable" can be grown even in small mud vessels to provide protective vitamins like Vitamin A. In absence of availability of milk, fresh vegetables etc. sprouted pulses; alfa alfa etc could be a good source of vitamins.

12. Training should be made compulsory and imparted free of cost for day to day managers of mines. It may be of 2 to 3 days duration.

13. Mobile health & life support centre can be very useful. This may be deployed for 3000 to 5000 mine workers' family.

14. All kind of routine primary health care services are to be provided by stationary units by special allocation for this area. Routine PHC staff considers this work force as an additional burden and therefore appropriate redistribution of health services may be required.

15. Loan facility may be created by microfinance & banking system. This can lead to unnecessary burden of interest.

16. Appropriate operational research should be done in such a way so that it can be implemented at the earliest. Research in field of machinery should be accompanied by human behavior research also.

17. As this work requires huge manpower, local medical college staff & medical students along with other colleges should be assigned welfare activities as a part of learning process and it should be co-opted in curriculum. MCI (Medical council of India) has clearly given community oriented policy which includes this kind of situation.

18. Two cadres of health volunteers are to be developed within the work force of mine workers.

    (1) Volunteer with knowledge of "first aid and home remedies". This category of worker should be selected trained for 3 – 5 days , followed by monthly update for 2 – 3 hrs & should be given appropriate ready reference material and emergency kit. Each team of up to 30 to 50 workers should have this kind of volunteers. They may be paid Rs. 10 per worker per month.

    (2) Cadre of specially trained male and female health workers for mine area should be developed. If fund is not available for this cadre health tax may be charged for protection ofworkers. One male and one female worker will be required for 2000 worker's family.

19. General measures like formal education to children and non-formal education to all active workers, prevention of addiction and de addiction programmes, education about legal rights, social engineering to change their misconception like "work in mines is the sign of manhood" etc., technical skill development programme, sanitation education and problem oriented action programmes will be supportive to overall health of mine workers.

20. Standardized treatment for silicosis & other disease should be made available at free of cost or at reasonable rate. This will reduce the burden of extensive expense the mine workers are doing just to get temporary relief for their perceived symptoms without getting much benefit for overall health.

Stone mines will continue to benefit our lives, our homes and our building. Therefore, the trade will continue further and will grow further. However, the sufferings of the people working in it must reduce, if not completely eliminated. A systemic approach coupled with strong will is required to look into the occupational health safety standards, and to ensure that sincere and sustainable efforts are made.

REFERENCES

1. Terry Brown:Silica exposure, smoking, silicosis and lung cancer- complex interactions: Occupational Medicine 2009;59:89–9
2. Pannett B, Kauppinen T, Toikkanen J, Pedersen J, Young R, Kogevinas M. Occupational exposure to carcinogens in Great Britain in 1990–93: preliminary results. In: Carex:International Information System on Occupational Exposure to Carcinogens. Helsinki, Finland: Finnish Institute of Occupational Health, 1998.
3. Kauppinen T, Toikkanen J, Pedersen J et al. Occupational exposure to carcinogens in the European Union in 1990–93: preliminary results. Carex: International Information System on Occupational Exposure to Carcinogens. Helsinki, Finland: Finnish Institute of Occupational Health,1998.
4. Pilkington A, MaclarenW, Searl A et al. Scientific Opinion on the Health Effects of Airborne Crystalline Silica. Edinburgh: Institute of Occupational Medicine, 1996; 1.
5. Rosenman KD, Moore-Fuller M, Reilly MJ. Connective tissue disease and silicosis. Am J Ind Med 1999;35:375–381.
6. Cowie RL. Silica-dust-exposed mine workers with scleroderma (systemic sclerosis). Chest 1987;92:260–262.
7. Bovenzi M, Barbone F, Betta A, Tommasini M, Versini W.Scleroderma and occupational exposure. Scand J Work Environ Health 1995;21:289–292.
8. Conrad K, Mehlhorn J, Luthke K, Dorner T, Frank KH. Systemic lupus erythematosus after heavy exposure to quartz dust in uranium mines: clinical and serological characteristics. Lupus 1996;5:62–69.
9. Brown LM, Gridley G, Olsen JH, Mellemkjaer L,Linet MS, Fraumeni JF Jr. Cancer risk and mortality patterns among silicotic men in Sweden and Denmark. J Occup Environ Med 1997;39:633–638.
10. Calvert GM, Steenland K, Palu S. End-stage renal diseaseamong silica-exposed gold miners: a new method for assessing incidence among epidemiologic cohorts. J Am Med Assoc 1997;277:1219–1223.
11. Steenland K, Rosenman KD, Socie E, Valiante DJ. Silicosis and end-stage renal disease. Scand J Work Environ Health 2002;28:439–442.
12. Barboza CEG, Winter DH, Seiscento M, Santos UP, Terra Filho M Tuberculosis & Silicosis: epidemiology,diagnosis & chemoprophylaxis.Jr.Bras Pneumol.2008;34(11):961-968
13. Calvert GM, Rice FL, Boiano JM, Sheehy JW, Sanderson WT. Occupational silica exposure and risk of various diseases: an analysis using death certificates from 27 states of the United States. Occup Environ Med. 2003;60(2):122-9.
14. Xie QM, Tang HF, Chen JQ, Bian RL. Pharmacological actions of tetrandrine in inflammatory pulmonary diseases. Acta Pharmacol Sin. 2002;23(12):1107-13.
15. Lai JH. Immunomodulatory effects and mechanisms of plant alkaloid tetrandrine in autoimmune diseases. Acta Pharmacol Sin. 2002;23(12):1093-101.
16. WHO. DOTS at the workplace. World Health Organization: New Delhi; 2003. p. 1-5.
17. Tiwari RR, Sharma YK, Saiyed HN. Tuberculosis among workers exposed to free silica dust. Indian J Occup Environ Med 2007;11:61-4
18. G.C.Brink,Grzybowski,Lane G B.Silicotuberculosis.Canad.M.A.J.,May 7 1960,Vol.82,959-965
19. Hnizdo E, Murray J. Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. Occup Environ Med. 1998;55(7):496-502. Erratum in: Occup Environ Med 1999;56(3):215-6

20. Corbett EL, Churchyard GJ, Clayton T, Herselman P, Williams B, Hayes R, et al. Risk factors for pulmonary mycobacterial disease in South African gold miners. A case-control study. Am J Respir Crit Care Med. 1999;159(1):94-9.

21. Cowie RL. The epidemiology of tuberculosis in gold miners with silicosis. Am J Respir Crit Care Med. 1994;150(5 Pt 1):1460-2.

22. A double-blind placebo-controlled clinical trial of three antituberculosis chemoprophylaxis regimens in patients with silicosis in Hong Kong. Hong Kong Chest Service/Tuberculosis Research Centre, Madras/British Medical Research Council. Am Rev Respir Dis. 1992

23. Adverse effects of crystalline silica exposure. American Thoracic Society Committee of the Scientific Assembly on Environmental and Occupational Health. Am J Respir Crit Care Med. 1997;155(2):761-8.;145(1):36-41.

24. Ferreira AS, Moreira VB, Ricardo HM, Coutinho R, Gabetto JM, Marchiori E. Progressive massive fibrosis in silica-exposed workers. High-resolution computed tomography findings. J Bras Pneumol. 2006; 32(6):523-8.

25. teWaternaude JM, Ehrlich RI, Churchyard GJ, Pemba L, Dekker K, Vermeis M, et al. Tuberculosis and silica exposure in South African gold miners. Occup Environ Med. 2006;63(3):187-92.

26. Corbett EL, Churchyard GJ, Clayton T, Herselman P, Williams B, Hayes R, et al. Risk factors for pulmonary mycobacterial disease in South African gold miners. A case-control study. Am J Respir Crit Care Med. 1999;159(1):94-9.

27. Sonnenberg P, Murray J, Glynn JR, Thomas RG, Godfrey-Faussett P, Shearer S. Risk factors for pulmonary disease due to culture-positive M. tuberculosis or nontuberculous mycobacteria in South African gold miners. Eur Respir J. 2000;15(2):291-6.

28. Pasula R, Wright JR, Kachel DL, Martin WJ 2nd. Surfactant protein A suppresses reactive nitrogen intermediates by alveolar macrophages in response to Mycobacterium tuberculosis. J Clin Invest. 1999;103(4):483-90.

29. Gold JA, Hoshino Y, Tanaka N, Rom WN, Raju B, Condos R, et al. Surfactant protein A modulates the inflammatory response in macrophages during tuberculosis. Infect Immun. 2004;72(2):645-50

30. Sanjay Basu, David Stuckler, Gregg Gonsalves:The production of consumption: addressing the impact of mineral mining on tuberculosis in southern Africa. Globalization and Health 2009, 5:11.

31. Sociedade Brasileira de Pneumologia e Tisiologia. II Consenso Brasileiro de Tuberculose: Diretrizes Brasileiras para Tuberculose 2004. J Pneumol. 2004;30(Supl 1):S1-86.

32. Snider DE Jr. The relationship between tuberculosis and silicosis. Am Rev Respir Dis. 1978;118(3):455-60

33. Silicosis and Silicotuberculosis Dr. Basanta Hazarika Department of pulmonary Medicine PGIMER, Chandigarh

34. American Thoracic Society. Targeted Tuberculin Testing and Treatment of Latent Tuberculosis Infection. Am J Respir Crit Care Med. 2000; 161(4): S221-S247.

35. Leung CC, Law WS, Chang KC, Tam CM, Yew WW, Chan CK, et al. Initial experience on rifampin and pyrazinamide vs isoniazid in the treatment of latent tuberculosis infection among patients with silicosis in Hong Kong. Chest. 2003;124(6):2112-8.

36. Balaan DR, Banks DE. Silicosis. In: Rom WN, editor. Environmental and occupational medicine. Boston: Little, Brown; 1992. p. 345-58.

37. Rees D, Murray J. Silica, silicosis and tuberculosis. Int J Tuberc Lung Dis. 2007;11(5):474-84.

38. Blumberg et al., Am J Resp & crit care Med , Feb 15- 2003.

ABBREVIATIONS AND GLOSSARY

AFB	Acid Fast Bacilli : Causative organisms of tuberculosis - Mycobacterium Tuberculsosis are having acid fast property
ALT	Alanine aminotransferase : This is an Enzyme, level of which is monitored to detect hepatotoxicity
ARTI	Acute Respiratory Tract Infection : Respiratory tract infection of short duration
Asymptomatic Respiratory tract problem	A condition where patient do not complain any symptoms of respiratory system like cough, cold, dyspnoea etc and yet on examination doctor detects problems in respiratory system while auscultation.
BAL	Broncho alveolar lavage
BMI	Body Mass Index
BPL	Below Poverty Line
Chemoprophylaxis	Use of drugs, usually antibiotics to prevent infection
Chronic Respiratory tract problem	Any kind of respiratory problem of long duration which is not categorised under tuberculosi or silicosis etc.
Cor pulmonale.	Hypertrophy of the right ventricle (part of heart) resulting from diseases of lungs.
CS	crystalline silica
EPI INFO	" Epidemiological Information" Software prepared by the WHO for data compilation and analysis .
FEV1	Forced Expiratory Volume in one second. Patient is instructed to breath out forcefully in a an instrument and instrument will detect volume of air expelled out in one second.
GRAVIS	Gramin Vikas Vigyan Samiti
Hemoptysis	Blood in sputum (expectoration) with cough
Hepatotoxicity	agent causing damage to liver
lgE	Immunoglobulin E
lgG	Immunoglobulin G
Incidence	Rate of occurrence of new cases of particular disease among the population at risk in specified period (usually one year)
Intention-to-treat analysis	All patients , which were included for treatment (Even if they drop out , result will be analysed for comparision with appropriate groups)
lung function tests	Please see Respiratory function test
MCI	Medical council of India a regulatory body for medical profession and education for Modern medicine
Med Spiror	A instrument to conduct respiratory function test with help of computer.
Pneumoconiosis	collective term used to describe all Lung diseases occuring due to inhalation of diffent types of dust incident to various occupations . It includes silicosis, bysinossis, asbestosis etc.
Prevalence (Point prevalence)	Number of person suffering from particular condition at particular point of time per thousand population.
Prevention	It includes primary prevention (health promotion & specific protection), secondary prevention (early diagnosis & treatment) and tertiary prevention (disabilty limitation & rehablitation)

Gramin Vikas Vigyan Samiti (GRAVIS) or Center of People's Science for Rural Development is a non-governmental, voluntary organization that takes a Gandhian approach to rural development by working with the poor of the Thar Desert to enable them to help themselves. Since its inception in 1983, GRAVIS has worked with over 50,000 desert families across 850 villages in Rajasthan reaching a population of over 1 million, and has established over 1,100 Community Based Organizations (CBOs). Through its dedicated field work, as well as its research and publications, GRAVIS has come to occupy a leading position amongst the voluntary organizations in the region.

GRAVIS
3/437, 458, MM Colony
Pal Road, Jodhpur, 342008
Rajasthan, India.

Phone: 91 291 2785 317,
2785 549, 2785 116

Fax: 91 291 2785 116

Email: email@gravis.org.in

www.gravis.org.in