INDUSTRY
TUBERCULOSIS
SILICOSIS
COMPENSATION



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INDUSTRY
TUBERCULOSIS
SILICOSIS
AND
COMPENSATION

A Symposium

Current papers for physicians and administrators interested in industrial medicine and workmen's compensation

Prepared by

COMMITTEE ON TUBERCULOSIS IN INDUSTRY
of the
NATIONAL TUBERCULOSIS ASSOCIATION
and
AMERICAN TRUDEAU SOCIETY

LEROY U. GARDNER, M.D.
Editor

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Preface

FOUR YEARS have elapsed since the National Tuberculosis Association published the last Saranac Symposium on Tuberculosis in Industry. The war has prevented another Saranac gathering. Meanwhile, great strides have been made in industrial mass radiography and large numbers of patients have been referred to their personal physicians by medical departments in industry. Many physicians who heretofore were only mildly interested in industrial medicine find themselves called upon to pronounce judgments that may have industrial significance and legal implications.

The new symposium is intended to give useful information on tuberculosis, pneumoconioses with particular reference to silicosis and workmen's compensation, not only to those who specialize in industrial medicine but also to those generally interested in a subject that lately has commanded much attention.

The idea for this symposium was born at a gathering of the National Tuberculosis Association and American Trudeau Society Joint Committee on Tuberculosis in Industry. Several committee members are experts in their respective fields and under normal conditions, they would have participated in a Saranac symposium. Several had recently published papers. By collecting these significant papers in a common cover, the National Tuberculosis Association hopes to render a service to the profession.

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This pamphlet is one of several monographs on the subject of

INDUSTRIAL HYGIENE

published by the

NATIONAL TUBERCULOSIS ASSOCIATION

Others are:

INDUSTRY AND TUBERCULOSIS, VIEWPOINTS OF MANAGEMENT AND LABOR, by LEVERETT D. BRISTOL, M.D. and MATTHEW WOLL, 1944

TUBERCULOSIS, LABOR AND MANAGEMENT, A GUIDE TO INDUSTRIAL RELATIONS, by WM. ARKWRIGHT DOPPLER, PH.D., 1944

In preparation there are:

TUBERCULOSIS, INDUSTRIAL NURSING AND MASS RADIOGRAPHY, by JULIE E. MIALE, R.N., 1945

TUBERCULOSIS AND INDUSTRIAL EMPLOYMENT, a report of the Committtee on Tuberculosis in Industry of the American Trudeau Society, the medical section of the National Tuberculosis Association, by O. A. SANDER, M.D., to be published soon.

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Tuberculosis and Industry

W. P. SHEPARD, M.D., M.A.
SAN FRANCISCO, CALIF.

Third Vice President, Welfare, Metropolitan Life Insurance Company; President, California Tuberculosis Association; Clinical Professor of Public Health, Stanford University School of Medicine

SURPRISINGLY enough we have come through almost four years of war without a general increase in the tuberculosis death rate. During the last war our rate increased 8 per cent, rising from 138.4 in 1916 to 149.8 per 100,000 population in 1918 in the registration states. But even this was nothing compared to the appalling war rates in some of the European cities: Brussels in 1918 — 390, Warsaw in 1917 — 840, Cracow in 1917 — 908, Belgrade in 1918 — 1,400.[1] No one knows what the rate may be in those cities today. War and tuberculosis have always been inseparable. What has happened in the United States in this war?

Since 1918 the decline in tuberculosis in this country has been rapid and almost constant. The death rate for 1945 will be close to

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40 deaths per 100,000, a reduction of almost three-fourths in twenty-seven years.[2] Instead of being the leading cause of death it is now seventh. Over 200,000 people survived 1943 who would have succumbed to tuberculosis had the death rate remained the same as in 1900. This decline in tuberculosis is one of the most profound biological phenomena of the age. Even war has not yet upset it seriously in the United States. How long will it last? Is there anything we can do to assure its continuance? It is the purpose of this article to review briefly some of the responsible factors and to suggest special attention to those of greatest importance to industry during wartime.

Of course, many factors are operating which might account for this phenomenon. Increasing resistance of the race and decreasing virulence of mycobacterium tuberculosis are hypothecated by some. Lengthy arguments are advanced on both sides with little scientific evidence to date.

STANDARDS OF LIVING

A more tangible and obvious factor is the standard of living. No nation in modern times has enjoyed such high standards or has increased its standards so steadily. Tuberculosis increases with poverty for the same reasons it increases with war: overcrowding, inadequate nutrition, overwork and fatigue, inadequate medical care including public health safeguards. Yet, during the late depression there was no marked increase in tuberculosis. Even among the unemployed then, however, there was no general prevalence of overcrowding, inadequate nutrition, overwork and fatigue, or lack of health protection. The abundance of relief measures and the effectiveness of health protection generally prevented this. Some years ago the close correlation between "real wage" and tuberculosis death rates was pointed out.[3]

HOUSING

There is little doubt that adequate housing, proper food, sufficient rest, and adequate health protection have much to do with control of tuberculosis. These depend largely on wages and prices,

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what a man may purchase for his labor. Whether we can control wages and prices enough to prevent dangerous degrees of inflation remains to be seen. Failure to do so would certainly increase the danger of an increase in tuberculosis.

ISOLATION

Perhaps the most tangible factor in the decline of tuberculosis is our own effort. Tuberculosis is a contagious disease. It comes from but one source: the infected person or animal. It can be prevented by breaking the chain of transmission from the sick to the well. We must therefore find the case early enough to prevent extensive contact, and having found him, provide adequate facilities for his isolation and treatment. This is the epitome of the tuberculosis control program.

Its effectiveness is obvious. Contagious diseases spread in geometric ratio. Theoretically, in a uniformly susceptible population one primary case will produce x number of second generation cases, each second generation case will produce x^2 third generation cases, each third generation case will produce x^3 fourth generation cases, and so on. The same is true with control of contagious diseases. Each case found and isolated will reduce the potential number of new cases in geometric ratio. As control measures approach perfection, the rate of decline approaches a geometric ratio.

MASS RADIOGRAPHY

While still far from perfection, our control measures are more effective today than ever before. The portable X-ray, taking miniature films of the chest, which has proved so successful in the armed forces, has revolutionized case-finding methods. In some places the fluoroscope is used to good advantage. If these facilities are used to their utmost, there is every reason to expect an even closer approach to a geometric ratio in the rate of tuberculosis decline.

Portable X-ray units on trucks, complete with dressing room, developing facilities and supplies are now in general use. In California, several county tuberculosis associations own such trucks and

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the state association owns one truck and two fluoroscopes available to counties on a share-cost basis. We will soon be taking 6,000 X-rays a week. In many states such units are available to war industry through the United States Public Health Service and state departments of health. Of course, all such units are operated under proper medical auspices and the films read by physicians who are expert in this field.

Mass X-rays may or may not be preceded by tuberculin testing, depending on the age group involved. They should always be preceded by an educational program[4] designed to arouse interest in tuberculosis control and to increase the number who accept the offer of an examination. It is solely a "screening process" intended to find the small percentage who need further investigation by their private physician or by clinics, and to identify the still smaller percentage who have active, open tuberculosis.

THREE MINUTES PER EMPLOYEE

When well organized,[5] the X-ray examination takes but three minutes per employee, including dressing time. In another one and one-half minutes blood for a serology test can be taken. Four and one-half minutes is less time than it takes the average employee to go to the toilet. Findings are kept confidential between the plant physician and the employee. Every employee whose findings are negative is so notified. Those whose findings are positive or suspicious are followed up by the plant nurses or nurses from the health department who make every effort to get them into the hands of a physician of their own choice.

We have finally learned that early tuberculosis is usually symptomless. Therefore, our older method of trying to teach people the early symptoms and to seek a physician when those symptoms appear, is almost worthless. By the time the average case reluctantly admits that he has persistent cough and loss of weight, he is already in the moderately advanced stage and has been a menace to his family and associates for months.

Mass X-rays to be successful must be accompanied by the other

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facilities necessary to control tuberculosis. These include adequate sanatorium beds for isolation and treatment, a competent health department for follow-up of suspected cases and contacts, and a community-wide health education program which will teach families of the well and the sick what they need to know about tuberculosis control.

Modern case-finding methods are especially valuable in war industry. It is here that several serious dangers are manifest:

1. Many women are employed at their first job, often without the benefit of preplacement examination. Young women have higher tuberculosis death rates than young men.

2. Many very young are employed. Their greatest health handicap is their appetite for entertainment. Regardless of the shift or the hours worked they must have their quota of amusement, often at the expense of proper rest and the time it takes in crowded areas to obtain and prepare proper food.

3. Many who have been afflicted with tuberculosis and whose disease will flare up if they do not lead a well regulated life, are tempted by high wages and sometimes supposed climatic advantages to migrate and seek employment. Some even deliberately leave the sanatorium against the doctors' orders to work in war industry. Recently six pulmonary hemorrhages occurred in one West Coast shipyard area in a single week. A recent survey shows there are now between 300 and 500 known active cases of tuberculosis in California who are non-residents.

4. Many older people physically below par are being employed due to manpower shortage. They fall ready victims to tuberculosis especially when subjected to prolonged exposure to a fellow-worker who is expectorating tubercle bacilli.

5. Overcrowding in insanitary quarters often exists in areas surrounding new war industry.

6. Medical, hospital and public health facilities are often overtaxed, leaving these workers without the usual health safeguards.

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These dangers are real and they are serious. In one plant recently completing a mass X-ray survey, 6 per cent of those examined were found to have active tuberculosis. The usual ratio is about ½ of 1 per cent. Investigation disclosed that several of the cases had come directly from a midwestern sanatorium where they were convalescing. They had evidently been at work long enough to infect several fellow-workers.

We must depend upon physicians responsible for the medical work in industry to call these dangers to the attention of management and labor, and to introduce modern tuberculosis control measures in all industries. They will find ready assistance from local tuberculosis associations and health departments who are already deeply concerned over this serious threat to our defenses.

Having found and isolated the infectious cases in an industry, the plant physician's next task is to go as far as is safe with the employment of arrested or quiescent cases. War industry needs every person able to work, even though some are not physically perfect. The newly recovered patient needs vocational therapy and often vocational rehabilitation. The stigma attached to the recovered tuberculosis case especially with respect to his employment has been as unfortunate as it is unnecessary. There is no economy in relegating these people to the human scrap heap.[6]

The extent to which the non-infectious, quiescent tuberculous individual can be used in industry is well described in actual practice by Doctor William E. Russell, medical director of Boeing Aircraft Company, Seattle.[7] He finds much work on the modern assembly line is light, and that there are many positions disclosed by job analysis which are not inherently harmful to the person with arrested tuberculosis. It is clear, however, that a well organized medical department is essential to safeguard the individual. Furthermore, there must be a high degree of cooperation between the medical department, the personnel office and the various foremen and supervisors throughout the plant. Under these circumstances it is possible to handle such cases with impunity. They return to the medical department for recheck

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as often as necessary. They are given extra time off following respiratory infections. They are taught that their continued employment depends on close adherence to the recommendations of the medical department and their private physician. "Midnight jive" and breakfast of coffee and doughnuts are not for them.

THE PHYSICALLY HANDICAPPED

One thing we have learned already in this war is the extent to which the physically handicapped can be made useful in industry providing the industry is equipped with an effective medical department. Doctor F. E. Poole of Lockheed-Vega reports amazing experience with blind, deaf-mutes, cripples and even epileptics. A committee of the American Association of Industrial Physicians and Surgeons reported in 1940 the experience of a large industry with 685 disabled employees compared with an equal number of non-disabled.[8] The disabled showed a lower quit-rate, less absence, fewer accidents, fewer discharges for cause and slightly greater earnings. This is a field in which the medical department renders skilled and valuable service. It is of increasing importance to disabled war veterans. With modern methods of hastening the treatment of tuberculosis perhaps we can return the arrested case to economic independence sooner than we have in the past. .

The age-old war between man and the tubercle bacillus has killed more people than all the wars between nations. After centuries of bondage to this killer, man has begun to free himself in recent years Although certain biologic and economic factors may have aided, medical science has at last provided control devices which are effective against this enemy. He is in retreat, but not yet conquered. In fact, he threatens a successful counter-attack through conditions imposed by war and economic disturbance. This attack is aimed toward industry. We can contain the enemy and again throw him back if we concentrate our fullest forces in industry. The mass X-ray method of finding cases is our new rocket gun. This is the time and place to use it.

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2

Conquest of Tuberculosis in Industry

HERMAN E. HILLEBOE, M.D.
AND DAVID M. GOULD, M.D.
WASHINGTON, D. C.
Medical Director Chief and P. A. Surgeon (R), Respectively, Tuberculosis Control Division, U. S. Public Health Service

THE CONTROL of tuberculosis in industry has now become a real possibility with the development and practical application of inexpensive mass radiography. Standard X-ray procedure with 11 by 17 inch films, unanimously considered the most accurate method for the detection of lesions characteristic of early pulmonary tuberculosis, has been too costly in material and personnel for use on a large scale. Cheaper and more widely applicable technics have long been needed and have finally been provided through the use of rapid film methods. 35 mm., 70 mm., 4 by 5 inch celluloid films, and 14 by 17 inch paper films.

Extensive use of the small film technic by the armed forces has at last enabled X-ray examination to assume the role it deserves as a weapon in the fight against tuberculosis. Now the work must be extended on a grand scale among industrial workers and their families.

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SIZE OF PROBLEM

Tuberculosis strikes down the very ones who are most valuable as industrial workers — men and women between the ages of 20 and 45. Nearly one-half (44.8 per cent) of all deaths from tuberculosis in this country during 1943 occurred in this age group. From early adulthood to age 35, tuberculosis is the leading cause of death. It is one of the first three causes of death at ages 15-49. For ages 20-34 one out of every six deaths among white persons and one out of every three deaths among nonwhite persons are due to tuberculosis.

The death rate from tuberculosis (all forms) for males is higher among residents of larger cities than among residents of cities of intermediate size, and that of the latter, in turn, is much higher than the rate for residents of rural areas. For females the variation of the death rate by size of city is almost negligible.

When workers are attacked by tuberculosis (recent surveys show that 1.5 per cent of our manpower is affected) jobs are performed inefficiently, absenteeism is high, and disease is unwittingly spread to others.

Although there has been no apparent increase in the amount of tuberculosis in this country as a whole since the beginning of the war, tuberculosis has formed a higher proportion of deaths in both urban and rural "critical areas" than in urban and rural "noncritical areas."

In these "critical areas" the unfavorable objective circumstances of overcrowding, insanitary living conditions and unusual fatigue are strikingly apparent. Tuberculosis control efforts therefore should be concentrated on these areas in order to forestall the expected rise in tuberculosis mortality as a result of the war.

PURPOSE OF USPHS PROGRAM

The Public Health Service established a tuberculosis control division in 1944 for the express purpose of assisting state and local health departments in the development of tuberculosis control programs as a part of emergency health and sanitation activities. The principal objectives of this office are as follows:

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1. Mass chest X-ray examination of workers in industry and of families in industrial communities, in cooperation with state and local health departments, voluntary tuberculosis associations and local medical societies.

2. Development of workable procedures, in cooperation with the Selective Service System and the armed forces, by which cases of tuberculosis discovered among rejected recruits will be reported promptly to health departments for follow-up by family physicians and local chest clinics.

This includes technical assistance in the establishment and preliminary maintenance of simple and efficient medical records systems so essential for follow-up activities. The real worth of any case-finding program must be measured in terms of completeness and adequacy of follow-up of newly discovered cases.

DEMONSTRATIONS

To demonstrate these new technics in mass radiography and at the same time actually to begin surveying large industrial groups, the Public Health Service procured eight transportable 35 mm. X-ray units and two for producing 4 by 5 inch films. By 1945 the number of units had increased to twenty.

In assigning these units to state and local health departments, preference was given to requests for service to ship yards, ordnance plants, air depots and other essential war industries where workers can be examined on a mass basis. It is not profitable to use rapid film methods in small plants. Too much time is spent in setting up and dismantling equipment. In such instances local X-ray facilities that produce films of regular size can be used advantageously. Local tuberculosis associations can be very helpful in developing programs in the large number of small yet vital plants.

These small film units are lent to health departments for limited periods to demonstrate the need for such services, to train local personnel and to help local health departments and industries establish their own mass case-finding programs. Small film units can now be

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purchased on the open market in increasing quantity. In addition, satisfactory home-made photofluorographs can be constructed locally at reasonable cost if X-ray transformers, control stands and tubes are available to complete the whole unit.

RADIOGRAPHY FIELD UNITS

Each of the field units of the Public Health Service consists of a medical officer trained in interpreting small films, two technicians, a record clerk, and complete equipment for exposing and processing several hundred films per day. Recently developed automatic roll film cameras operated synchronously with the X-ray exposure from a single control stand have greatly speeded up both exposures and development. Over 700 chest films can be obtained on a 100-foot roll of film. This entire roll can be processed in one operation in a Stineman tank.

A significant contribution in mass radiography was made in 1943 when Dr. Russell Morgan of the University of Chicago (now of the USPHS Tuberculosis Control Division, Radiology Section) adapted his photoelectric timing mechanism or phototimer to 35 mm. photofluorography. The Morgan phototimer was given its first extensive trial with one of the Public Health Service field units in Washington, D. C. Over 110,000 films have been made with this phototimer equipped unit, and the results are remarkably consistent and eminently satisfactory.

This device greatly simplifies the whole technic of mass radiography. It is no longer necessary to measure or estimate the thickness of the chest of the individual to be examined. It is no longer necessary to set the milliamperage, kilovoltage or timer of the X-ray control stand. The controls are set at 200 milliamperes and 90 kilovolts at the beginning of the day's work; from then on the subjects are simply placed before the fluorescent screen of the machine one after the other. The technician merely closes the exposure switch and the phototimer does the rest, regardless of the size of the subject or the type of pathologic condition hidden within the chest. The photoelectric timing mechanism terminates the X-ray exposures at the

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instant the films have received the proper quantitiy of radiation to insure excellent chest films of uniform quality. This uniformity not only aids the diagnostic skill of the interpreters but also reduces fatigue when large numbers of films are examined.

Further developments in the speed of screens and film and image size of small films may be expected because of the great interest in and growing application of mass radiography to tuberculosis control.

CHOICE OF EQUIPMENT

The choice of small film equipment for a particular industrial health program must be based on careful consideration of the extent of the problem, funds available, personnel obtainable, and specific objectives of the program in each proposed application. The relative diagnostic accuracy of different kinds of apparatus is now undergoing comprehensive and definitive comparative study. In our experience, all of these methods in the hands of competent and specially trained workers are effective in detecting early pulmonary lesions, with indications that the efficiency increases as one goes from 35 mm. up to 14 by 17 inch celluloid films.

Sound public health practice demands that the method used be one which benefits the largest number of persons in the industry or the community. When available funds are limited, it is of greater value to examine 100,000 persons with small films and miss a few minimal cases than to examine only one-tenth of that number at about the same cost, using large celluloid films and leaving 90,000 persons without benefit of any X-ray examination whatever.

PRODUCTIVITY OF SURVEYS

By March, 1945, the field units of the Public Health Service had surveyed 328 industrial and other population groups in 29 states, the District of Columbia and Mexico City. A total of 936,000 individuals have been examined, of whom 11,600 showed X-ray evidence of significant reinfection tuberculosis. This constitutes over 1 per cent of the persons examined. Of these 11,600 positive films, 70 per cent were minimal, 25 per cent moderately advanced and 5 per cent far



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advanced in extent. This distribution is of great interest in view of the fact that minimal cases comprise only 10 to 12 per cent of the tuberculosis case loads in the majority of communities.

Included in the surveys were two groups of particular interest. Over 110,000 government workers in Washington, D. C., were examined at the request of the District of Columbia Health Department. The prevalence of positive findings characteristic of reinfection tuberculosis varied from 0.7 per cent to 2.1 per cent, with an average rate of 1 per cent. These results are interesting when it is recalled that many of these persons are so-called white collar workers.

The other group consisted of Mexican laborers examined at the source of recruitment in Mexico, D. F., for the War Food Administration. Nearly 100,000 laborers have been examined to date. All those with abnormal X-ray findings were excluded from employment. As a result, many persons were prevented from bringing the disease unknowingly into the country and spreading it to those with whom they might come in contact.

As pointed out previously, it is essential to examine all present employees and all new employees and to make periodic examinations at reasonable intervals of the entire working force of an industry in order to discover new cases as early as possible. Careful clinical study will then provide a sound medical basis for the immediate and ultimate disposition of each person suspected of having pulmonary tuberculosis.

Depending on the extent of the lesion, evidence or absence of activity and work capacity of the individual, definite placement plans can be made for continued employment under medical supervision or interruption of work because of the need for isolation or treatment.

DETERMINATION OF ACTIVITY OF LESION

Care must be exercised in the diagnosis and determination of activity of minimal lesions. Many employees have been penalized unnecessarily because of hasty conclusions drawn from the interpretation of a single flat plate of the chest. The more one sees of so-called

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minimal lesions on X-ray films, the more cautious one becomes in the interpretation of their significance. It has been found that competent readers often do not agree on the status of activity of a lesion on a particular film. It is also true that the same reader will not always agree with his first interpretation of a single film when reading it another time. The only safe rule to follow is careful clinical study, including examination by gastric lavage and tuberculin tests for differential diagnosis before definite diagnosis is made. It may be necessary also to wait three to six months for comparative clinical study before final diagnosis can be made.

LABOR POLICY

An equitable labor policy must be established for those found to be tuberculous if the control program is to have permanent success. It has been found that health committees of labor unions are sympathetic to this type of health activity if they are informed of the full implications of the presence of a communicable disease in a fellow worker. A sick worker is a liability to himself, his family and his union, not to mention the industry and the community. When these facts are presented in their true light, rarely has there been difficulty in obtaining full cooperation.

REHABILITATION

If tuberculous workers are to be rehabilitated on a sound basis, industry and the community must accept the responsibility of providing both temporary and permanent sheltered employment for a certain number of workers. The English have demonstrated the effectiveness of practical measures such as the industrial colony, the training colony and the local workshop. This subject presents many difficulties, but these can be overcome if full use is made of our tremendous and varied resources.

COMMUNITY COOPERATION

Because tuberculosis is a social and economic as well as a medical problem, other groups besides the medical profession are sooner or later drawn into the picture. For this reason it is well to plan a

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program of cooperative enterprise right from the beginning. The local welfare agency, the voluntary tuberculosis association, management, and labor are soon involved with the health department and local physicians in the after-care and rehabilitation of tuberculous industrial workers and their families. It is much better to draw these other groups into partnership in the initial phases of the work than to come to them for help after they have been considered nonessential. Successful tuberculosis control requires careful long range, community-wide planning.

FINANCIAL AID

The time has come for the public to accept the responsibility of providing financial security for the tuberculous worker and his family under any circumstances associated with the control of his disease. Overcrowded living conditions, poor home hygiene and fear of want during the absence of the bread winner from the house all contribute to failures of arresting the disease in individual cases and play an important part in the continued spread of tuberculosis.

A comprehensive scheme will be required to deal with these problems, developed in close cooperation with the medical services. Grants should be available to patients during treatment and during after-care and rehabilitation, in some cases for prolonged periods of invalidism, and if necessary for indefinite periods should permanent disability render the person unfit for work. Provision will need to be made for the proper care of children when the mother is removed from the house for treatment of her disease. Unless there is freedom from want and adequate maintenance without anxiety, the best medical care program for tuberculosis control in industry and in the community will be only partially successful and in the long run very costly.

Consider what the new case-finding activities mean in terms of wartime tuberculosis control and ultimate eradication of the white plague. It is estimated that from 14 to 17 million persons aged 20 or more, or nearly 1 out of every 5 adults in the United States, had chest X-ray examinations by the armed forces, health departments,

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industry, or voluntary health agencies by the end of 1944. Therefore the case load of known tuberculosis has shown a significant increase. Ways and means must be found to furnish each patient with all the services successfully employed in the control of this disease. This will tax the ingenuity of those responsible for the care and supervision of this increasingly apparent army of the tuberculous.

Summary

The Public Health Service will assist state and local health departments in the development of control programs by setting up standards based on careful research in public health methods, by offering consultation, by demonstration of new technics, by limited grants for follow-up facilities, and by training much needed professional personnel. The state and local health departments will work in close cooperation with public and private industries and private physicians in the establishment of effective tuberculosis control activities as an integral part of the general industrial health program. State or county operated units can be used for joint operations in small industries. The industrial physicians and private physicians who supervise individual workers and their families will complete the medical team necessary to control tuberculosis in industry.

Here is an unequaled opportunity to do case-finding and follow-up among fifty million important citizens and their families, persons among whom the major share of deaths from tuberculosis is occurring in this country. Our principal task now is to extend tuberculosis control activities so as to reach the greatest number of workers and their families in the shortest possible time, and to make full use of all private and public resources. With energetic and concerted effort, the final eradication of tuberculosis from the United States is well within the possibility of accomplishment.

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3

The Attitude of Industry toward X-ray Examinations of the Chest

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COLLECTIVELY, industry has no defined attitude on the use of X-rays as an aid in diagnosing diseases of the thoracic organs in employees and applicants for employment. Certain committees of the National Association of Manufacturers and the US Chamber of Commerce favor the procedure and are promoting it, but they cannot be said to represent industry's attitude, although they do indicate the trend of industry's thinking.

Medical Advisor Influences Policy

Generally, the attitude of an individual plant in this matter is determined, or at least is influenced, by the position taken by the management's medical advisor who might be the doctor in charge of the plant medical department, the neighboring physician who treats the injured employees, the manager's own personal physician, or a close medical friend. Except for the differences in cost, the management's attitude on the purchase of X-ray equipment is about the same as it is on blood pressure outfits, electrocardiographs and other diag-

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nostic equipment. Usually the manager looks to the medical department, if he has one, for results in the form of health protection for the employees which cannot readily be valued and, as long as the doctor in charge retains the manager's confidence, decisions of this character are in accordance with his judgment. The attitude of industry can be said to be largely that of physicians in industrial and general practice. Industry is prepared to protect the workers against occupational diseases of a pulmonary nature and those arising out of nonoccupational causes which might be aggravated by the conditions of employment, of which the pneumoconioses and pulmonary tuberculosis are respectively well known examples. Through industrial hygiene engineering methods industry has endeavored with considerable success to control these. Nevertheless, in the absence of specific immunizing agents, industry recognizes the value of early diagnoses in these important diseases, and experience confirms the effectiveness and practicability of X-rays of the chest as a means toward that end.

MANAGEMENT BECOMES INTERESTED

In relation to jobs associated with certain forms of dust, there is usually no question as to management's attitude. On the other hand, there may be some question on the use of X-rays for purely diagnostic purposes in the nonoccupational diseases. However, management's interest has been aroused by some spectacular experiences occurring here and there, particularly in regard to pulmonary tuberculosis.

Equipment was installed in the medical department of a plant employing 10,000 people, and the medical director invited the top management group to inspect it. From a mechanical standpoint they were interested and, observing this, the doctor volunteered a demonstration. An important official stepped forward, and when the quickly processed film was placed on the viewing box it showed an apical lesion. In this case a key man was involved and the disability, though fortunately temporary, came at a difficult time and it was somewhat staggering to the organization. Such experiences are not



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wholly uncommon for management is just as susceptible to pulmonary tuberculosis as hourly-rated workers and perhaps more so under present conditions. When experiences like this occur they are impressively capable of arousing management's interest.

There is another reason for management's interest, and it is much more common than skeptics admit. For lack of a better expression it can be called the humanitarian interest. It does exist and instances have occurred in which it has seemed to have received priority. The local tuberculosis society of an eastern industrial city was ineffectually endeavoring to promote chest surveys in local plants. The manager of the largest was approached with an appeal to lead off with a survey in the hope that others would follow his example. Despite the fact that equipment was on order for an X-ray laboratory in his own plant, this manager granted permission, incidentally at a cost of over $2,000, solely to forward what he considered to be a commendable effort. As a sequel several active cases were found, one of which was in the management group.

An equally good example was in a plant of 7,000, about half of the employees being women. On request of the medical director excellent X-ray equipment had been installed for chest work. Wishing to make its use voluntary, the doctor invited a young woman acquaintance to be the first, expecting that she would spread a favorable word through the plant. As she had considerable local athletic fame the result was unanticipated and startling, for she was found to have a minimal-apical lesion. She accepted the shock sensibly and asked the doctor to call in her sister, likewise employed in the plant. Her sister also had an early lesion. Subsequent investigation by the local health department traced the contact to the father of the girls. These cases attracted a great deal of attention as both of the young women were widely known and popular. Needless to say, volunteers quickly established the X-ray procedure. But that is not the point. In talking about the experience later on, which the manager often did, he expressed great satisfaction in the fact that he had made it possible, by purchase of the equipment, for these employees to have the benefit of an early

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diagnosis and consequently early treatment with good prospects for recovery.

PLANT PHYSICIAN'S ADVICE ESSENTIAL

Improvements in portable equipment and photofluorographic units have popularized mass case-finding surveys. While management usually follows the recommendations of the medical profession with respect to these, instances have occurred in which the advice and co-operation of the plant physician have not been sought. Needless to say, surveys are not wholly effective unless the findings are followed up with good medical procedures. There must be complete accord among the patients, the medical profession, the sanatoria, and the public health authorities, with the plant physician performing the functions of a coordinator.

INDUSTRY'S EXPERIENCE

Surveys serve the purpose of case-finding, and to that extent they are useful; but, if size permits, in-the-plant X-ray facilities, with suitable arrangements for roentgenographic consultations, are much more desirable for the permanent control of the respiratory diseases in industry. For this reason further interpretations of industry's attitude will be limited to considerations with regard to the operation of permanent plant X-ray installations.

At this point examples of industry's experience are appropriate. With due consideration to the prevalence of tuberculosis in various geographic areas the following may be regarded as fairly representative:

A plant engaged chiefly in the fabrication of military vehicles and airplane parts, located in the Great Lakes region, has a plant population of about 6,000, one third of whom are women. An analysis of 6,505 chest films gave the results presented in Table 1.

All original exposures were on 35 mm. films. Confirmatory 14 by 17 films were taken in 357 cases, of which 74 required follow-up films. In addition to the findings in Table 1 the conditions listed in Table 2 were observed.

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TABLE 1

Some Conditions Disclosed by 6,505 *Chest Films*

Active cases of pulmonary tuberculosis:	
Employees disengaged from employment and referred to their physicians for treatment	15
Cases of questionable activity:	
Employees remained at work under medical supervision	6
Arrested cases:	
Employees also remained at work under medical supervision	14

TABLE 2

Additional Conditions Disclosed on Further Study

Pneumonia	12
Pleurisy	53
Heart enlargement	42
Aortic enlargement	50
Chronic nontuberculous process	37
Congenital abnormality and scoliosis	25
Tumor	8
Arrested tuberculosis	161
Healed miliary tuberculosis	3

TABLE 3

Conditions Found Over Six Years in a Plant Employing	16,000
Pulmonary tuberculosis (active)	86
Pulmonary tuberculosis (healed)	158
Miliary tuberculosis (healed)	27
Calcified lesions —"Wheatena"— Dr. Gardner's classification	131
Pneumonitis	28
Pneumoconiosis	39
Calcified Ghon tubercle	7
Atelectasis	5
Chronic fibrosis	14
Pleural effusion	8
Pleura (thickened)	18
Pleura (calcified)	3
Unresolved pneumonia	17
Thoracotomy	7
New growth (chest)	11
Pneumothorax (spontaneous)	7
Pneumothorax (treatment)	27
Empyema	6
Heart:	
Mitral lesions	19
Generally enlarged	38
Aorta enlarged	43
Aneurysm	9

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A plant located in southern Michigan which manufactures small parts for a great variety of war material has been offering X-rays of the chest as a regular feature of pre-employment and health examinations for the past six years. In that period 47,424 chest exposures were made. The average plant population is 16,000. The findings are given in Table 3.

In establishing chest diagnostic service, industry desires good relationships with all of the parties who are concerned. These parties are the employees, the medical profession, radiologists, official public health agencies, and voluntary health organizations.

THE EMPLOYEES

Diagnostic chest service can be mutually beneficial to management and the employees, but for obvious reasons the employees are primarily the most concerned and the success of the service depends on their willingness to go along with the program. Measures for obtaining their cooperation need not be discussed; it suffices to say that the employees must be convinced of the justice of all medical decisions affecting them and their employment. As a feature of preplacement examinations for selective placement, diagnostic chest service can be obligatory; for health maintenance it may be voluntary. If the chest work is regarded as a regular feature of all examinations, as are other diagnostic aids, it is accepted without question as long as the employees have faith in the integrity of the physician in charge of the plant medical department. With respect to the employees, industry's attitude is characterized by a desire to obtain acceptance of a service which can be and should be mutually beneficial to both management and the employees.

THE MEDICAL PROFESSION

Industry does not ordinarily furnish treatment for pulmonary tuberculosis or any other of the conditions that are brought to light by case-finding programs unless, of course, they are the results of employment. It is, however, a distinct advantage to the patients if the relationships between their personal physicians and the industrial



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physicians are those of good mutual understanding. With special reference to pulmonary tuberculosis, these relationships can advantageously be extended to include studies of the places of employment by the attending physicians and on-the-job conferences with the plant doctors. This applies particularly when the patients are thought to be ready for re-employment to safeguard them on their jobs and to plan health maintenance procedures for them, such as how often and how extensively they should be periodically examined. With respect to the medical profession, industry's attitude is characterized by a desire for good mutual relationships between the plant physicians and the attending physicians. The former are expected to take the initiative in effecting these good relationships.

THE RADIOLOGISTS

In industry the diagnoses of pulmonary tuberculosis and other lesions of the thoracic organs are usually based on interpretations of the films and are necessarily tentative. No such diagnoses are complete until substantiated by clinical observation, which is the function of the patients' own physicians and their consultants. Nevertheless, as considerable dependence is placed on the X-ray films, their interpretations should be supported by X-ray knowledge and experience. Hence the radiologists have an important role in the operation of industrial X-ray laboratories. In this respect their relationships can be made to involve responsibilities as follows:

1. Responsibility for the X-ray technic and the reading of all films, or
2. Responsibility for the reading of films only, or
3. Responsibility limited to the reading of films which are not obviously negative.

The first category is the most desirable, with the consultant giving part-time service to the plant but it is not always the most practical. Usually, as plant medical personnel gain experience the consulting radiologists are content to leave routines to them, reserving for themselves the reading of questionable films. Experience has proved that this arrangement is effectual and workable.

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With respect to the radiologists, industry's attitude is influenced by that of the medical directors of the plants who are permitted to make their own arrangements with the radiologists.

THE PUBLIC HEALTH AUTHORITIES

When industrial diagnostic studies of the chest disclose pulmonary tuberculosis, it is essential that the public health authorities be notified. Usually they follow up contacts and perform the other public health functions essential in such cases. Varying in different localities, these need not be discussed here. It is enough to say that industry's attitude in relation to the public health authorities is characterized by a desire for complete cooperation. Just what form the cooperation should take is not always clearly defined, however, and there is often doubt as to whether the plant physician should notify the department or the family doctor. Usually the plant physician does so if the family doctor does not.

THE VOLUNTARY ORGANIZATIONS

Local tuberculosis and public health societies are frequently quite active and influential. One or more plant managers and other industrial officials may be on their boards of directors, in fact often are, and with such support these organizations are likely to influence the whole local situation, including the attitude of industry. Their principal functions are to promote case-findings in tuberculosis, better care of patients and their occupational rehabilitation. In these activities industry generally wishes to cooperate as far as is practical.

In conclusion it can be said that industry has no well defined attitude toward X-ray examinations of the chest, that its position with respect to this matter is influenced by the opinions of physicians who are accustomed to advise with management on medical affairs, and that industry's attitude is therefore in reality the attitude of the medical profession.

In making X-ray chest service available to the employees, industry wishes the relationships which necessarily result from case-finding to be professionally ethical, suitable to the best interests of the employees and in conformance with local public health regulations and practices.



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4

Control of Tuberculosis in an Industrial Group

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THE ROLE of industry in the control of tuberculosis has become increasingly important as many millions of industrial workers have passed through the screening processes of case-finding surveys. While these surveys have, to a considerable extent, been stimulated by the war, a number of industries have had tuberculosis control programs operating for many years. The Metropolitan Life Insurance Company inaugurated its program in 1927, at a time when there was little in the way of similar experience to serve as a guide, either in the actual procedure of case-finding or in the subsequent disposition of the individual found to have tuberculosis. However, the results of the program appraised over the ensuing 17 years indicate that the methods employed have been efficient inasmuch as there has been a very satisfactory decline in the incidence of new cases of tuberculosis and these cases are predominantly in the minimal stage when discovered. The methods by which this control has been achieved are as follows:

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1. A careful pre-employment examination to detect tuberculosis in applicants for employment.

2. Persistent, vigilant observation of the employees to detect new cases of tuberculosis.

3. Management of the employee with tuberculosis, providing hospitalization for the active case and medical supervision of the arrested case.

THE PRE-EMPLOYMENT EXAMINATION

It has been adequately demonstrated that the most satisfactory case-finding method is radiography. Applicants for employment are not apt to disclose symptoms of illness or history of past or familial disease; abnormal physical signs — even in advanced pulmonary tuberculosis — are frequently absent. Screening by some form of X-ray is a necessary procedure.

At the onset of the program, when we were examining about 4,000 applicants for employment yearly, it was decided to fluoroscope the chest of each individual following the usual history and physical examination, and to take roentgenograms only when indicated by suspicious symptoms or signs or fluoroscopic findings. The fluoroscopic method is economical, easy to install and to use, and rapid; the objections are lack of permanent record for future reference and an error of possibly 10 per cent in detecting sub-minimal lesions. We used this method from 1928 to 1935 and among 19,498 applicants, found an incidence of tuberculosis of 1.2 per cent. Since 1936 we have added to the above examinations, routine radiography with the standard 14 x 17 celluloid film and in 19,115 applicants so examined, from 1936 to 1944, we have found a tuberculosis incidence of 1.1 per cent.

If a significant lesion is detected, the applicant is recalled for an interview with the chest physician of the medical department. In this interview the single film is checked with a stereo roentgenogram, the applicant is informed of the probable nature of the X-ray findings, and the importance of further study is emphasized. If he has a family physician he is advised to consult him; otherwise he is referred to the

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chest clinic of the board of health in his locality; the location and exact hours of the clinic session are given him. Whether he consults a private physician or attends a clinic, he is provided with a note stating reason for referral, his X-ray film, and a stamped addressed envelope which the physician uses to notify us that the individual has appeared for further study and is started on the way to the diagnosis and treatment of his pulmonary disease.

TABLE 1

Prevalence of Pulmonary Tuberculosis in Applicants for Employment
1928-1944 *Inclusive*

Year	Number of Applicant Examinations*	Cases of Pulmonary Tuberculosis			
		All Cases		Clinically Significant	
		Number	Per cent	Number	Per cent
1928	4,405	62	1.4	48	1.1
1929	4,780	52	1.1	34	0.7
1930	3,105	31	1.0	19	0.6
1931	2,175	21	1.0	12	0.6
1932	2,134	22	1.0	12	0.6
1933	1,166	19	1.6	9	0.8
1934	969	14	1.4	9	0.9
1935	764	10	1.3	8	1.1
1936	874*	18	2.1	7	0.8
1937	1,557	28	1.8	17	1.1
1938	1,697	16	0.9	11	0.7
1939	1,545	18	1.2	14	0.9
1940	1,849	23	1.2	14	0.8
1941	2,392	13	0.5	10	0.4
1942	3,383	32	0.9	18	0.5
1943	3,462	41	1.2	25	0.7
1944	2,356	22	0.9	11	0.5
Total . . .	38,613	442	1.1	278	0.7

*See page 29.

Since 1928 we have examined 38,613 applicants for employment and have detected 442 cases of pulmonary tuberculosis (an incidence of 1.1 per cent), of which we have considered 278 to be clinically significant (an incidence of 0.7 per cent). This rate has remained fairly constant through the years.

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TABLE 1A

1928-1935 Inclusive . .	19,498	231	1.2	151	0.8
1936*-1944 Inclusive . .	19,115	211	1.1	127	0.6

* From 1928 to 1935 inclusive, all applicants received a fluoroscopic examination following the usual physical; roentgenogram only when indicated by the previous findings. Since 1936, the roentgenogram has been a routine procedure on all applicant examinations. A comparison of the two periods is shown in Table 1A.

In addition to these cases of tuberculosis, we have detected many other chest conditions — lung tumors, aneurysms, non-tuberculous pulmonary diseases, and have, in like manner, referred them for further study.

CASE-FINDING AMONG EMPLOYEES

After an applicant has passed the X-ray screening process and is accepted for employment, he is continued under supervision. Experience has revealed that tuberculosis may develop in individuals with previously negative X-ray films. In order that these new cases of tuberculosis may be detected in their incipiency when the chances of recovery for the individual are increased and the possibilities of spread of the infection among his contacts are decreased, constant and vigilant supervision is necessary and is carried out in several ways.

TABLE 2

Medical Service	Stage of Tuberculosis				
	Number			Per cent	
	Minimal	Advanced	Total	Minimal	Advanced
Medical rest room . .	91	70	161	57	43
After absence . . .	42	30	72		
Symptoms	40	32	72		
Contact	4	1	5		
Other.	5	7	12		
Annual examinations	170	51	221	77	23
Total	261	121	382	68	32

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First, by annual examination — this has been routine for all employees for many years and the examination is as complete and as individual as time will permit. Since 1928 all employees have received a fluoroscopic examination of the heart and lungs in addition to the physical examination. Any suggestive symptom or illness or any abnormality noted in physical signs or by fluoroscope is checked with the standard 14 x 17 celluloid film. Such cases are then referred to the chest service of the medical department for further observation.

Second, by medical service in the rest rooms to which employees report for (a) medical approval before they may return to work after absences due to illness, or (b) for emergency treatment, or (c) because of symptoms, or (d) for examinations (laboratory or other) requested by their own physicians. Here roentgenograms are ordered on all employees reporting contact with a tuberculous individual, on employees reporting after absence due to significant respiratory illness, as pneumonia or pleurisy, and on employees having any suspicious symptoms, local or constitutional, or physical signs suggestive of pulmonary disease. In addition to the above precautions, the fluoroscope is used freely by our rest room physicians on other cases such as those reporting after surgical operations, illness other than cardiorespiratory, vague symptoms, etc., especially the symptom of pain in the chest, even though not pleuritic in type. All suspicious fluoroscopic findings are checked by roentgenogram and the medical record of the individual is then referred to the chest service for further observation.

Third, visiting nurse service — when our nurses visit employees and find they are ill with respiratory disease it is then reported to the chest physician who may contact the employee's physician to arrange for sputum or X-ray examination or hospitalization or in other ways assist with the diagnosis and management of suspicious cases.

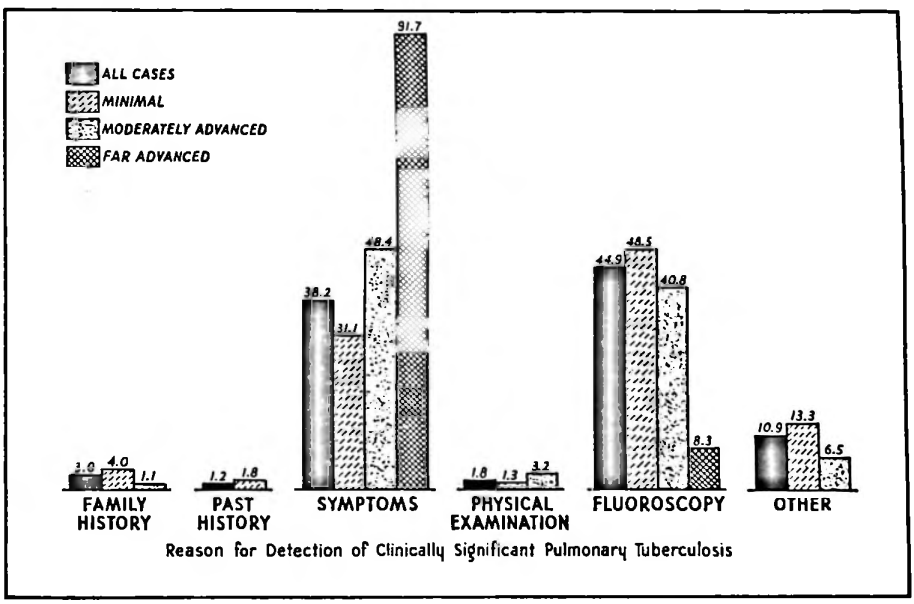
Since 1928 we have detected 382 clinically significant cases among our employees. Slightly more than half have been found as a result of the annual examination — the remainder have been detected in the rest rooms because of symptoms or following absence; over three-

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fourths of the cases detected at the annual examination have been minimal, whereas only one-half of the cases from the rest room have been minimal.

In a survey reported in 1940 we analyzed the reasons for the detection of our clinically significant cases, then 330 in number (Fig. 1.)

FIG. 1 PULMONARY TUBERCULOSIS IN HOME OFFICE EMPLOYEES
distribution according to method by which case was detected, 1930-1939

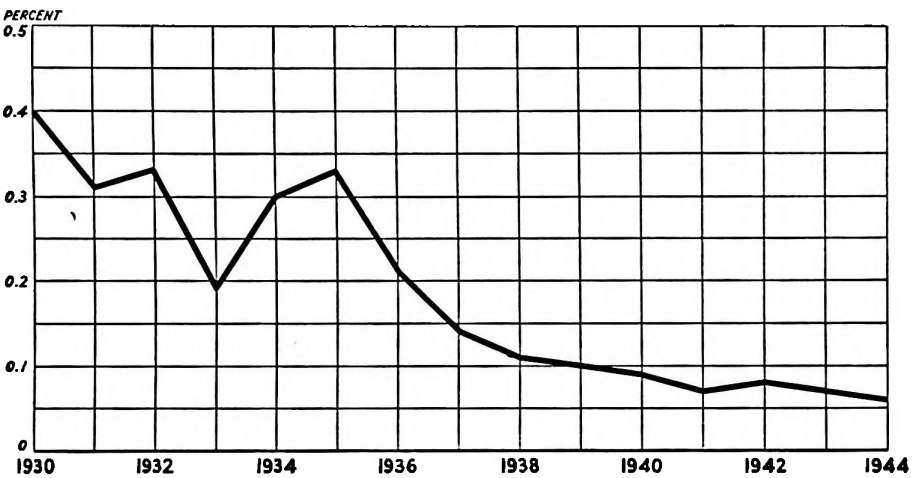


Further experience of the past five years confirms those figures and reemphasizes the importance of the periodic or annual examination including some form of routine X-ray procedure. Roentgenograms are the most satisfactory, but we feel that we do a satisfactory job by taking films on all suspicious cases and by frequently fluoroscoping the remainder whenever opportunity presents (each employee being fluoroscoped at least once every year). This procedure applies to all employees, irrespective of age, as we find new cases of tuberculosis developing in individuals over 40 as well as in the younger age groups.

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By these methods we have reduced our incidence of clinically significant cases of tuberculosis from 40 per 10,000 employees in 1930 (0.4 per cent) to 6 per 10,000 in 1944 (0.06 per cent). (Fig. 2.)

FIG. 2 PULMONARY TUBERCULOSIS IN HOME OFFICE EMPLOYEES
clinically significant cases detected, 1930-1944 *inclusive*



Not only has there been a decrease in the number of new cases among our employees, but there has also occurred a definite shift in the stage of disease at which the diagnosis is made. (Fig. 3.) Previous to 1930, less than one-third of our cases were minimal; since 1930 over two-thirds of our cases are minimal; the far advanced case is rare (only one in the past six years — a male, age 36, with a previously negative roentgenogram).

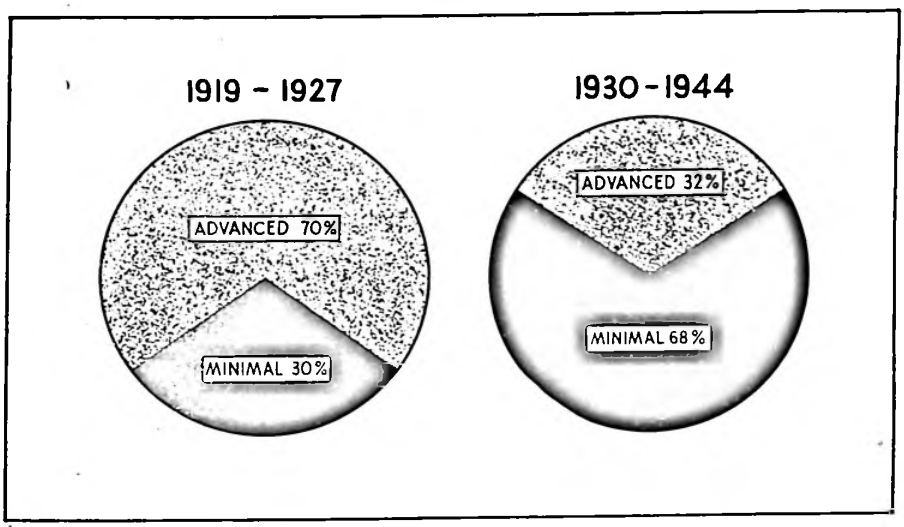
THE MANAGEMENT OF THE EMPLOYEE WITH TUBERCULOSIS

A — Newly Detected Cases

While the case-finding procedure is carried on efficiently as a mass survey, the management of the case when found becomes a problem of the individual. Some may remain at work under medical supervision; others must undergo treatment. To remove the former from his job may cause unnecessary hardships, financial, psychological. To delay

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FIG. 3 STAGE OF DISEASE AT DIAGNOSIS
clinically significant cases



treatment of the latter may result in progression of the disease and spread of the infection to others. Moreover, with case-finding programs revealing more individuals with tuberculosis than there are hospital beds available for their care, it is important that the most judicious use be made of these hospital facilities, reserving them for the isolation of the infectious patients and for the treatment of those with remediable disease. Therefore, the roentgenograms must receive careful scrutiny and the findings must be correlated with the clinical picture in order to make the proper disposition of the individual employee. The cases detected — whether in mass surveys or in control programs — appear to fall into three groups:

GROUP I: Individuals with roentgenograms that reveal lesions which have the characteristics of "healed" tuberculosis, i.e., fibrosis, calcification. These individuals, on further examination, do not reveal any signs or symptoms suggesting activity of the lesion.

GROUP II: Individuals with roentgenograms revealing disease which appears to be frankly active, i.e., cavitation, pneumonic areas and so forth. Symptoms and signs of activity may or may not be present.

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GROUP III: Individuals with roentgenograms revealing minimal lesions which require further study in order to determine their significance. These are usually asymptomatic.

Our method of handling these cases is as follows: All cases which have been detected on the basis of a single flat film are checked with stereo roentgenograms and the individual then receives a complete examination by the chest specialist.

The Group I — apparently arrested or healed cases — individuals do not present any symptoms of tuberculous activity; physical signs are absent; sputum, if present, is negative on repeated three-day concentrations (examined by smear, culture and guinea pig). These individuals are allowed to remain at work; roentgenograms are repeated at three- to six-month intervals, depending upon age and sex. The significance of the findings is discussed with the employees and they are advised regarding proper diet, adequate rest, physical activities. Their medical records are identified so that, on visits to the rest room for symptoms or following absence, they will be seen either personally by the chest physician or their records will be reviewed by this physician after they have been examined in the rest room.

The Group II cases present no problem as to management as they are obviously active and require treatment. Since the Metropolitan Life Insurance Company provides sanatorium treatment for its employees, there is no problem in hospitalizing our employees when the diagnosis of tuberculosis has been established. We think it advisable to postpone admission to a sanatorium long enough to make a reasonably tentative diagnosis of tuberculosis inasmuch as bronchopneumonia, atypical pneumonia, lung abscess, lung tumor, and other pulmonary conditions may simulate tuberculosis and require other than sanatorium treatment. While their cases are being studied, the employees either remain at home or may be sent to a local hospital and later transferred to a sanatorium.

In this category, we place also all cases known to be of recent development on the basis of a previously negative roentgenogram, even though signs or symptoms of activity are absent.

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The cases in Group III are the individuals who require good judgment in the appraisal of their X-ray shadows. We include in this group only those cases which are minimal in extent; however, the character of the lesion — insofar as one is justified in interpreting pathological nature from the roentgenological appearance of the lesion — varies from the so-called "exudative" (Group III-A), i.e. soft mottling or diffuse clouding, to the so-called "productive" (Group III-B), i.e. hard discrete, nodular densities or linear strands.

We feel sanatorium residence for a limited period (perhaps three months) offers the best conditions for this study. Facilities are here available for frequent roentgenograms, blood tests, examinations of sputum or gastric washings for guinea pig inoculation and culture; here the patients are under the daily observation of physicians and nurses trained in tuberculosis and here, also, the employees acquire the health education which residence in a well-regulated sanatorium provides. At the end of this observation period we believe that employees whose tests have been favorable may return to work under medical supervision; the others will remain for the needed treatment.

However, sanatorium facilities may not be available, or there are occasional instances in which an employee may not be able, because of some family or personal situation, to avail himself of this opportunity. In such cases the appraisal of the activity of the tuberculosis may be carried on in a satisfactory manner at home. This appraisal requires judgment and experience; therefore, if a competent tuberculosis specialist is not a member of the industrial medical department, the employee should be referred to a chest physician outside the plant, either private or clinic, for further study.

In our experience those cases (Group III-B) with small nodular or fibrotic lesions who present no evidence of activity at this first examination may continue at work during this observation period. Those cases (Group III-A) whose films reveal soft mottling or diffuse clouding, even though without signs or symptoms, we prefer to keep at rest until we have reached a decision as to their disposition. Decision as to the disposition of the case is reached after, first, an appraisal

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of the activity of the lesion and, second, an appraisal of the individual and his environment.

Appraisal of Activity of Lesion

The first step — the appraisal of the activity of the lesion — is determined by a correlation of clinical findings and laboratory reports. The chest specialist examines the employee to detect any physical signs of illness, but also in an interview — which must be unhurried — tries to elicit any symptoms. Frequently, employees state early in the examination that they feel perfectly well, but later admit to unusual fatigue or other significant symptom. The laboratory procedures most helpful are roentgenogram and sputum studies. In studying the X-ray films we note, first, the character of the lesion and, second, its behavior on serial roentgenograms. Nodular, strand-like or sharply circumscribed shadows are usually less harmful and less inclined to progress rapidly than soft, mottled or diffuse cloudy shadows. X-ray examinations are repeated at two- to three-week intervals to note any instability of the lesion.

Frequent and careful sputum examinations by guinea pig inoculation and culture are made in all cases. If there is no expectoration we obtain fasting gastric contents. The extraction of the gastric contents is carried out in our own laboratory by trained nurses according to the procedure described in the NTA Diagnostic Standards. Although very few people relish gastric lavage, we find very little resistance to the examination, provided sufficient time and patience are taken to explain to the employee the importance of the test. By using these methods tubercle bacilli have been demonstrated in 72 per cent of our minimal cases.

In handling the individual case we have not found blood counts or sedimentation rates particularly helpful; certainly, normal blood findings are not significant.

The tuberculosis is considered active if clinical examination reveals persistent increase in pulse rate or temperature, if suspicious symptoms are present, if serial roentgenograms reveal instability of

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the lesion, if sputum or gastric contents reveal tubercle bacilli, or if blood counts and sedimentation rates are definitely abnormal. Sanatorium observation is recommended for these employees without further delay.

Appraisal of the Individual

The tuberculosis is considered inactive if none of the above mentioned conditions exists. The further disposition of these employees with presumably inactive tuberculosis depends upon the second step in the analysis mentioned above — the appraisal of the individual and of his social and economic status. This involves investigation of his home situation (best done by a visiting nurse when the opportunity to visit presents), as poor living conditions, inadequate or improper diet, overstrain, are unfavorable factors. The age, sex, intelligence, and personality of the individual affect the decision as to further disposition. Tuberculosis tends to more acute manifestations in the young, but age does not offer protection. The employee who is intelligent and willing to submit to periodic examination, including gastric lavage, presents less of a hazard than an uncooperative employee, but we find that most employees cooperate if they adequately understand the reasons for the examinations, particularly as such tests are made without expense to them and on company time.

If we find from our investigation of the individual and of his environment that conditions are satisfactory, we permit these presumably inactive cases of tuberculosis to remain at work under close medical supervision. (As this supervision is the same as the follow-up supervision provided for our employees when they return to work after sanatorium treatment, it will be described later.) If, however, we find the environment unsatisfactory, we think it advisable to recommend sanatorium residence at least for a short period, not so much for treatment as for education; on his return the employee is better prepared to correct his home conditions, food habits and so forth.

In actual practice, our judgment regarding the Group III cases is as follows: We would like them all to go to the sanatorium for the

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necessary observation; those who will not or cannot go to the sanatorium are studied here. If this study reveals any evidence of activity, sanatorium treatment is advised. If the study appears to indicate that the tuberculosis is inactive, if the home environment is satisfactory and the employee cooperative, he is allowed to remain at work under close medical supervision.

We are not too apprehensive about permitting the cases in Group III-B to remain at work under the above conditions. We are less willing in the Group III-A cases; we would prefer that they go to the sanatorium.

Occasionally, an employee with X-ray evidence only of unstable tuberculosis refuses to follow our advice; it seems wiser to compromise and allow him to remain at work for the time being, as the observation he will receive here is probably better than he will obtain elsewhere. Meanwhile, during the subsequent interviews we have with him we may be able, gradually, to condition him to the idea that a stay at the sanatorium will be of benefit to him.

B — The Arrested Cases

On his return to work the employee reports to the office of the chest physician who assumes the responsibility of the follow-up of the individual. As this involves not only a knowledge of tuberculosis but of the individual with tuberculosis, it is necessary that a friendly physician-patient relationship be established; therefore, if a chest specialist is not a member of the industrial medical department, the observation of these cases should be assigned to one and the same physician in the department so that he will become sufficiently acquainted with each employee to recognize significant variations.

The first examination on return to work includes a physical examination and stereo roentgenogram; sometimes, also, blood count and sedimentation rate. At this examination an appointment is made for a gastric lavage. During the course of the examination, the employee is advised further about his activities. He is encouraged to report voluntarily to this office if he has any doubts as to his condition; he is

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also advised regarding the care of colds. While common colds are supposed to be well tolerated by the patient with arrested tuberculosis, we find results of gastric lavage more frequently positive at such times. The approximate date of his next examination is given him. His appointment file is kept in the office of the chest service and the employee is called for observation from this office. The frequency of the examinations will be determined by the individual requirement, but generally the routine is as follows:

First six months	examination every 4 to 6 weeks
Second six months	examination every 2 months
Second and third years . .	examination every 3 months
Fourth and fifth years . .	examination every 4 months
Sixth year	examination every (4 to) 6 months

After the sixth anniversary of his return to work, the employee receives only an annual examination (including X-ray), as we have found the recurrence rate after the sixth year to be insignificant. This is the general procedure. However, cases that have shown any instability will be examined as frequently as is indicated; cases that were advanced on admission to the sanatorium or had unfavorable episodes during their cure, those having had thoracoplasties or tuberculous complications, will be examined more frequently and also those employees who, when they have reached their sixth year, ask to remain on a six-month schedule.

FOLLOW-UP EXAMINATIONS

Several years ago we studied this question of the follow-up examination in order to determine those tests that were most valuable in indicating early onset of relapse. At each visit analysis of symptoms, physical examination, X-ray, blood count, and sedimentation rate were carried out; also sputum tests when expectoration was available. Since 1940, in the no-expectoration cases we have done gastric lavage. We found that the roentgenogram was the most reliable. Now, at each follow-up examination we question the employee about his health;

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examine sputum or gastric lavage* and have a single X-ray. We do not do sedimentation rate, blood count, stereo roentgenograms unless indicated. All these examinations are made during working hours and without expense to the employee.

In the intervals between these scheduled examinations, the employee is encouraged to report any suspicious symptom. His medical record, which is kept in the general medical files, is tagged so that he is automatically referred to the office of the chest physician whenever he reports to the medical rest rooms for any significant symptom; or, if he should be seen by another physician, the record will be referred to the chest department for review.

Also, the employee's absence card, which is kept in the visiting nurses files of the medical department, is similarly tagged so that any absence is immediately brought to the attention of the chest physician. If during the course of observation any suspicious signs or symptoms appear, we suggest that the employee remain at home on a modified cure regimen for a few weeks, pending further X-rays and other studies (sputum reports), results of which will determine the next step, either return to the sanatorium or return to work.

In reviewing the roentgenograms of our employees over a period of years we have observed many cases showing unstable lesions, i.e., retrogressive changes and progressive changes appearing at different periods in ex-patients who in other respects appear to be doing well. We have, therefore, adopted the above procedure of watchful waiting rather than immediate recommendation of return to sanatorium treatment.

Recurrences occur, but under the close observation that we have outlined, they are usually only slight in extent. However, resumption of sanatorium treatment is advised in all cases of definite recurrence.

Employees with arrested tuberculosis are allowed longer convalescence than are other employees following surgical procedures or illnesses of severe degree, particularly the pneumonias or other diseases of the respiratory system.

* The sputum (3-day pool) or gastric lavage specimen (two consecutive days) is examined by culture (guinea pig inoculation in doubtful cases).

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The chest service of an industrial medical department should be utilized by all the employees (tuberculous and non-tuberculous) as an information bureau. We have frequently expedited the sanatorium placement of relatives of our employees through our knowledge of sanatorium facilities and procedures; we have provided information regarding chest specialists to family physicians wishing consultations and have given employees location and specific hours of chest clinics for their families; we have advised regarding types of work suitable for arrested cases, and have frequently explained the significance of positive tuberculin tests in their children of school age, and of other procedures. We have had occasion to instruct employees who are in contact with tuberculosis at home in regard to hygienic procedures. While it is true that this is a function of the city board of health nurse and is performed by her in a most satisfactory manner, nevertheless, repetition of the instructions from another source seems to be profitable. We have interpreted to employees the reports made by their family physician or hospital attending physician regarding chest conditions in their families.

The chest service does not limit its field to tuberculosis, but follows up cases of bronchiectasis, lung tumor and other non-tuberculous pulmonary disease.

Summary

We have outlined the procedures used in the control of tuberculosis at the home office of the Metropolitan Life Insurance Company. These procedures consist of:

1. Careful pre-employment examination to detect tuberculosis in applicants. The subsequent disposition of cases of tuberculosis is discussed in detail.

2. Persistent, vigilant observation of the employees — emphasizing the importance of some form of periodic X-ray examination — our method being radiography of all employees exhibiting symptoms or signs in any way suspicious of tuberculosis or having contact with

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tuberculosis, and in addition, fluoroscopy of all employees at each annual examination.

3. Sanatorium care without expense to the employee is provided for all cases of tuberculosis needing treatment. Observation at the sanatorium, to determine activity of a lesion found on routine X-ray, is also supplied. The follow-up observation of arrested cases and the measures used to avoid recurrence of the disease are outlined.

CONCLUSIONS:

By the methods described above the incidence of tuberculosis in home office employees of the Metropolitan Life Insurance Company has dropped from 40 per 10,000 employees in 1930 to 6 per 10,000 employees in 1944; 68 per cent of the cases are in the minimal stage at the time of diagnosis.

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Review of Silicosis for the Industrial Hygienist and Medical Practitioner

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Medical Director, American Brake Shoe Company

DURING the last twenty-five years, our knowledge of silicosis and other pulmonary conditions caused by dust has increased considerably, but many individuals whose work frequently brings them in contact with these diseases are confused about some of their characteristics. In many instances industrial hygienists, more concerned with the mechanical aspects of occupational fibrosis, have not familiarized themselves with the important clinical details necessary to a better understanding of the problem, while many physicians, previously engaged in private practice, have been called upon to enter the field of industrial medicine with insufficient knowledge of occupational disease. With the general conception of the effect of dangerous dusts on human lung tissue and an adequate working knowledge of the factors known to produce the reactions observed in the chest roentgenogram, the hygienist and medical examiner will be in a much better position to attack control problems and make recommendations which will produce results.

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The intensive study and investigation of the pneumoconioses in recent years have shed much light on a dusty subject. Some housecleaning has been done and earlier, unconfirmed ideas have been replaced by more definite facts established by the light of wider experience. In industry, management and labor, recognizing the danger to each, and the effect on production, lost time, health, safety, and the mutual pocketbook, have signified their desire to do something about it. They have put the problem squarely up to the industrial hygienist and the medical profession. Our legal friends have also come into the picture, sometimes rather willingly, a circumstance which makes it all the more desirable for those concerned to have a better understanding of the disease.

The Effects of Rock Dust

The effects of silicious rock dust on the human lung and its association with tuberculosis have been recognized for centuries, but only in comparatively recent years has an attempt been made to investigate and establish measures for regulating the hazard. Physical examinations on a group of 3,000 rock drillers in South Africa in the year 1902, of whom 300 were X-rayed, represent the first real comprehensive study of silicosis. Diagnostic standards, safe limits of particle concentration in the air of working places, and engineering methods for dust control were set up at this time. Subsequent studies in Great Britain, Australia, the United States, Canada, Germany, and Italy added greatly to our knowledge and later research. X-ray surveys and clinical examinations have yielded a vast amount of valuable information on the subject. They have demonstrated that the disease may vary in different locations and in various occupations, but while establishing beyond doubt the etiology, clinical findings and method of control, many questions still remain unanswered.

The earlier conception of the results of hazardous dust on the lungs has been changed in many respects. For instance, not many years ago it was assumed by a number of well-informed persons that anyone developing occupational fibrosis would inevitably die, or at

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least become totally and permanently disabled in a few years' time. We know that this is not so, and it is now generally conceded that silicosis, uncomplicated by infection, is a non-disabling disease except in comparatively rare instances of massive conglomerate fibrosis in which the presence of the tubercle bacillus may be suspected but not actually proven.

Too frequently today the physician, not sufficiently experienced in occupational disease, may designate a worker as disabled upon viewing a chest film which shows evidence of fibrosis. The fact that the man's occupation has exposed him to dust substantiates the diagnosis and offers an opportunity of which the legal mind may quickly take advantage.

Certain occupational dusts may cause irritation of the lungs, but only silica and asbestos thus far are known to produce definite proliferation of scar tissue or fibrosis. The pulmonary reaction resulting from exposure to fine particles of some of the other dusts may result in exaggerated markings on the X-ray, but these do not have the characteristic appearance of the shadows observed in the film of the silicotic.

Several definitions have been proposed for the term "silicosis," but the following one, suggested by Gardner,[1] is adequate. "Silicosis means a disease of the lungs due to breathing air containing uncombined silicon dioxide dust, characterized anatomically by generalized nodular fibrotic changes throughout both lungs, which are demonstrable by X-ray examination and by autopsy, and resulting from any process of occupation involving inhalation of silicon dioxide dust."

SAMPSON'S CLASSIFICATION

Various degrees of silicosis have been recognized but the lack of physical signs and symptoms makes any classification practical only when based on X-ray interpretations. The following grouping by Sampson[2] is a satisfactory one.

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A. UNCOMPLICATED SILICOSIS —
N — Normal Chest
P_1 — Stage of Peritruncal Exaggeration
P_2 — Stage of marked Peritruncal Exaggeration (pre-silicosis)
S_1 — First Degree Nodulation (linear markings obliterated and nodules up to 2 mm. in diameter present)
S_2 — Second Degree Nodulation (nodules 2 to 4 mm. in diameter)
S_3 — Third Degree Nodulation (nodules over 4 mm.)

B. COMPLICATED SILICOSIS —
1. Silicosis with Fresh Infection
2. Silicosis with Old Infection
3. Silicosis with Indeterminate Infection

Only free silica having a size range up to 3 microns is believed capable of producing pulmonary fibrosis, and the degree of exposure will vary according to the concentration of these particles in the atmosphere of working places and the percentage of uncombined silica they contain. The following table, set up by the Committee on Prevention of Silicosis through Medical Control of the National Silicosis Conference[3] offers a fair standard.

PERMISSIBLE DUST CONCENTRATIONS IN VARIOUS INDUSTRIES

Industry	*Percentage Silica in the Dust*	*Permissible Dust Concentration, Million Particles per Cubic Foot*
South Africa*	80	4.5
Ontario gold mines*	about 35‡	8.5
Australia sandstone*	90‡	6
Barre granite†	31 to 38	10-20
Pennsylvania anthracite coal mines†	35	5-10
	13	10-15
	5	50
Broken Hill, Australia*	10 to 17	14

* Based upon engineering practice.
† Based upon clinical studies.
‡ In the rock.

The importance of these factors in stimulating the production of fibroblasts has been amply demonstrated by means of animal experimentation, petrographic analyses, and X-ray diffraction tests, but it has also been observed that certain other substances, such as alumi-

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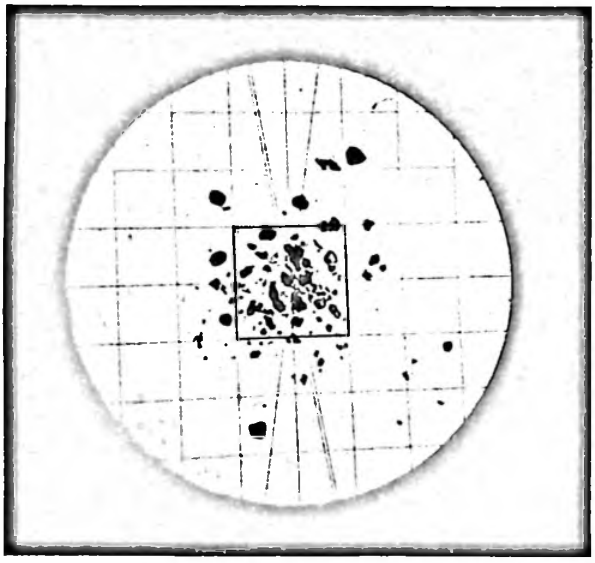
num, carbon, hematite, etc., appear to modify the action of free silica in the lungs. Gardner[4] has shown that while it is comparatively easy to produce nodular fibrosis by making small laboratory animals inhale pure free silica, they do not react in a similar manner to mixed dusts in which the silica is associated with considerable amounts of other minerals. This fact appears to be substantiated in industry. In the foundry the atmosphere is often dense and the various operations produce quantities of dust and fume containing fair amounts of silica. Molders and other workers have breathed this air over many years and one would expect to see evidence of silicosis in their chest roentgenograms. But while a few employees' X-rays *do* show evidence of nodulation, the amount of actual definite fibrosis is relatively low. Routine examination of a large number of chest radiographs of these individuals has led me to call this type of film "The Foundryman's Chest," to indicate a rather typical partial obliteration of linear markings and general lack of sharp detail without evidence of definite nodulation. X-rays of these men show changes which are more marked than normal, but they are not sufficiently definite to warrant a classification of silicosis. The shadows differ from the exaggerated markings normally seen in people of advanced age.

DANGER SPOTS

The cleaning room presents another picture. The air appears less cloudy but the X-ray survey reveals a much higher proportion of unmistakable, sharply defined, discrete nodular shadows in the chest films of workers in this location.

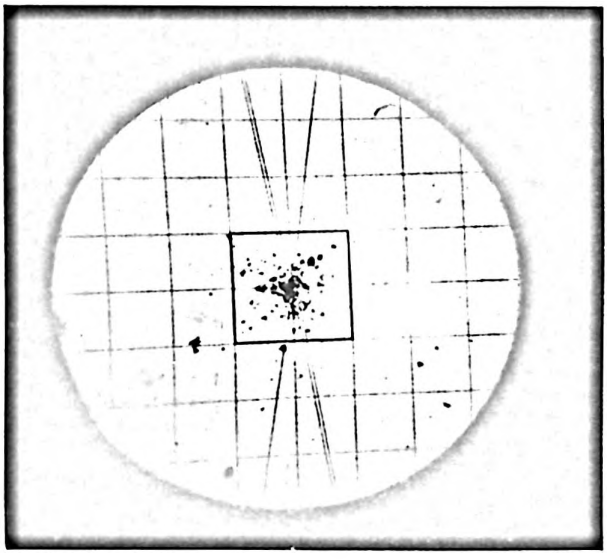
Air samples in both departments confirm the X-ray findings. Counts in the molding areas are fairly high but the particles are mostly of large size, and since molding sand contains other ingredients, such as bonding clay, carbon in the form of "sea coal," and moisture, the action of the free silica is probably modified. In other words, we are dealing with a "mixed dust" which is relatively inert. In the cleaning room, however, grinding castings which have appreciable amounts of sand adhering to them may liberate large numbers

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A.

Foundry dust near shake-out. Note large-sized particles.



B.

Dust from grinding operation in cleaning room. Note large number of very fine or dangerous-sized particles.

Fig. 1 Foundry dust. (Konimeter samples. Space between the two small lines represents 5 microns.)

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of silica particles which have been fractured to a size suitable for inhalation. Estimations in this section reveal high concentrations of very fine or dangerous sized dusts. It is not uncommon for industrial hygiene workers to miss this situation entirely. They have been so impressed with the "visible" dust that they have overlooked the real danger spots.

It is true that the higher the concentration of particles and percentage of free silica in the air, the more rapidly will the disease manifest itself, but even under the worst conditions the development of silicosis requires time. In South Africa, experience indicates that it takes eight years to progress from a pre-silicotic stage to a definite degree of nodulation, and a somewhat lesser time for a man to go from first to second degree nodulation. Also, not all workers develop fibrosis even though they have had similar exposures. Examination of the chest may reveal well-developed silicotic nodules in one man while his partner, who has worked under the same conditions, shows little or no involvement. Most investigators have observed this fact and some have tried to explain it on the grounds of individual susceptibility, influence of modifying factors, or a deficient natural defense mechanism of the body.

NATURE PROTECTS

Nature furnishes protection against dust and foreign substances at the point of entry into the body by means of the fine hairs of the nostrils and the mechanical arrangement of the upper respiratory tract. They form a barrier which offers resistance to all but the very fine particles, while the upward current created by the ciliated epithelium of the trachea and bronchi tends to eliminate the greater part of the larger inhaled pieces which do get through. The efficiency of this protective mechanism in different individuals may partly account for the variations observed in acquiring silicosis. Once dust reaches the alveoli or air sacs of the lungs, the phagocytic cells, which probably originate from the walls of the air sacs or the lining of the capillary vessels, pick up the fine particles and pass to the lymph

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spaces to be transported by the lymphatics toward the hilum of the lung. Along the way the dust cells become deposited in the interlobular tissue and nodes about the blood vessels, and here a slow chemical reaction occurs which results in death of the cells and necrosis of the surrounding tissue. This process stimulates the production of scar tissue cells and interferes with the normal flow of lymph, causing a spread of the dust cells toward the pleurae and throughout the lungs. The result of the reaction is the so-called nodular fibrosis which is typical of silicosis. As time goes on, the nodules increase in size and may coalesce, destroying the air sacs and producing impairment of the lungs.

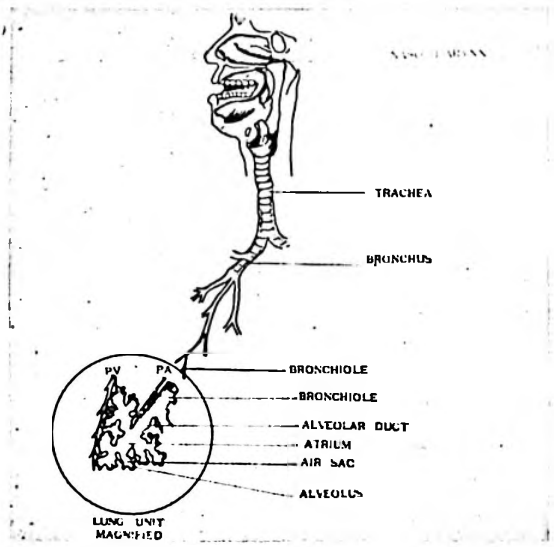


Fig. 2
Path of dust particle.

On microscopic section the nodules are seen to consist of concentric whorls of dense hyaline collagen fibers. The borders are sharply defined and no exudate appears in the adjacent air spaces. Areas of compensatory emphysema or dilatation of the air sacs may be visible.

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SYMPTOMS AND PHYSICAL SIGNS

Significant symptoms and physical signs in silicosis are few. Shortness of breath is commonly reported but actual dyspnoea, as observed after exercise, is unusual. Employees will frequently complain of this sensation but in many instances it can be traced to conditions such as overweight, heart disease and advanced age. On the other hand, some of the worst cases of silicosis will deny shortness of breath. Others will say that they notice it only after exertion, but while doing ordinary work or "walking on the level" they suffer no more discomfort than might be expected of any individual of the same age who does not have disease in his lungs.

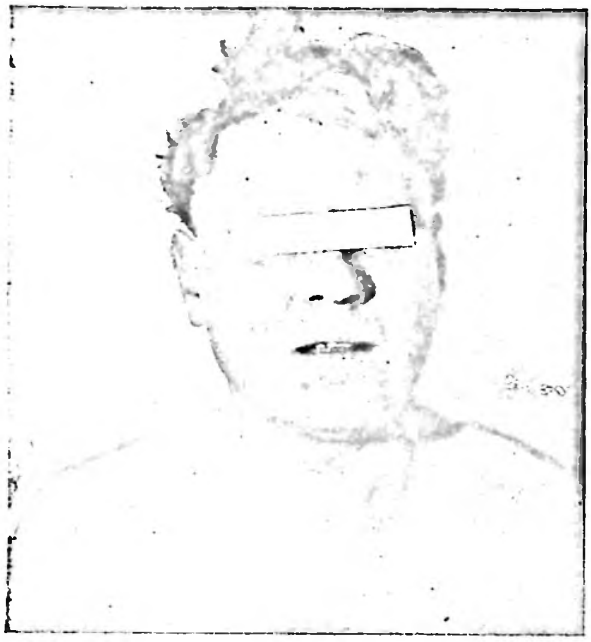
This experience is confirmed by numerous clinical observers in the field of silicosis. Many silicotics are robust, healthy-looking men who would have no difficulty passing the usual life insurance examination if X-rays of their chests were excluded.

A majority are unaware that they have developed the disease because symptoms are lacking. It is only when they have been X-rayed that their condition has been revealed, and in many cases, where the exposure to dust has extended over long periods of time, the X-ray findings demonstrate much less reaction than might have been anticipated. Most of the men are capable of doing a regular day's work, as many of their forbears, ignorant of the findings of physical examinations and X-rays, have done for years before. They still continue to produce effectively without discomfort, even after having been informed that their roentgenograms show accumulations of dust.

FRANK DISCUSSION

With few exceptions, men who have worked in dusty trades such as mining, quarrying, foundry work, etc., show no undue concern on being told of the results of their X-rays. Following a company policy, I have discussed findings with a number of employees whose chest films gave evidence of occupational fibrosis. The men were shown their X-rays and the interpretations were explained in a frank and honest manner. In every instance the employee expressed appreciation

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Note healthy appearance.

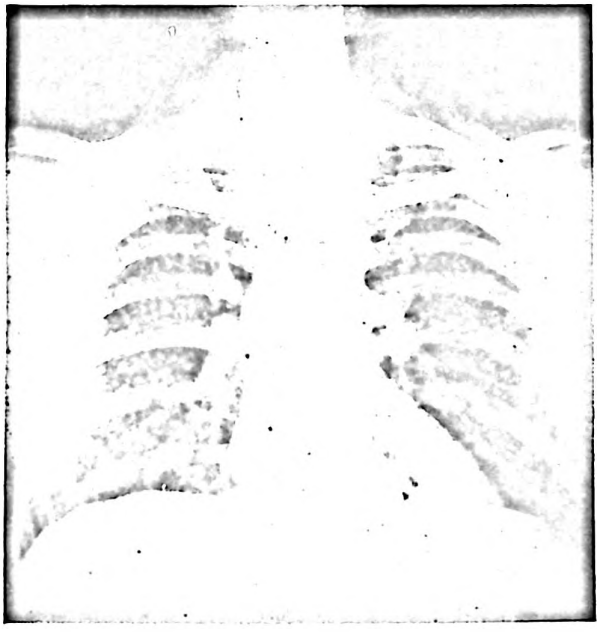


Fig. 3 Uncomplicated second degree silicosis in an iron ore miner.

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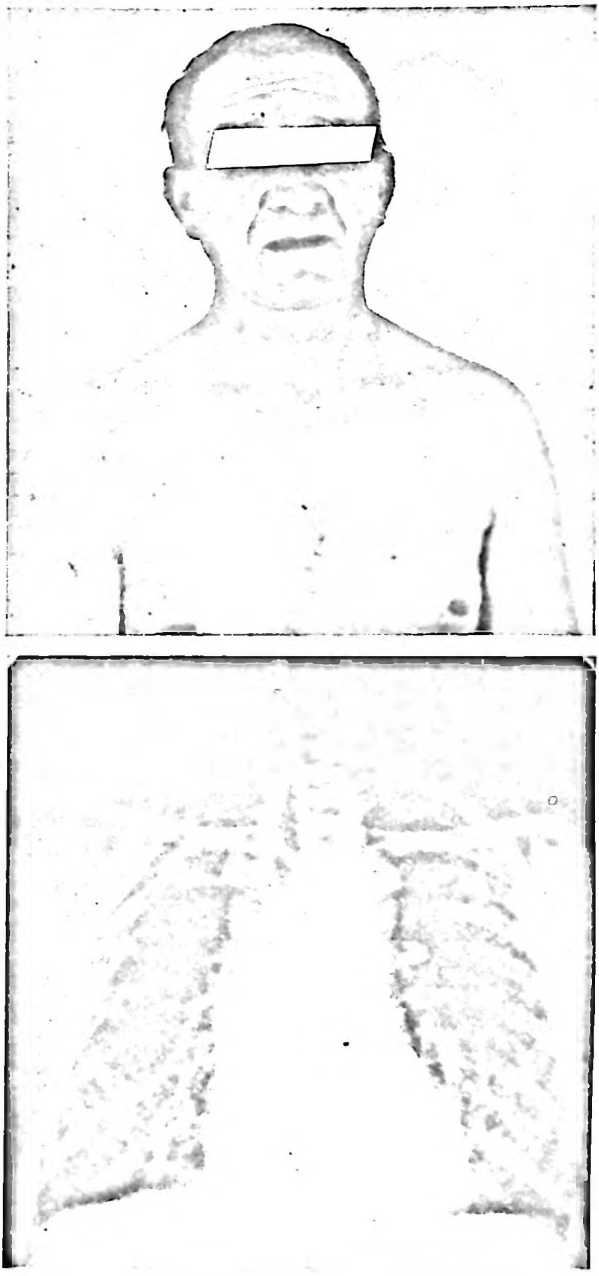


Fig. 4 Complicated silicosis. Old infection (healed tuberculosis) in an iron ore miner.

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and frequently ventured the information that he had worked in dust so long, he expected his X-ray to show evidence of it. He became much more cooperative about wearing a respirator and his confidence in physical examinations and health surveys was greatly increased. A number who had refused to wear respirators admitted having been under the impression that they had so much dust in their lungs, there was no use in wearing them now. However, on being informed that things were not as bad as they imagined, evidence of a new interest in protecting their health appeared.

In this connection, it is my opinion that the psychological aspect of control of the silica hazard has not received sufficient emphasis. Men employed in these industries are no longer disinterested in their working conditions. The majority, unlike many of their parents who came from foreign countries, have had a fair education and are very much alive to the risks of such occupations. They have a good idea of what silicosis is and are able to discuss the subject in an intelligent manner. From close association with dust, they naturally are interested in anything which offers improved working conditions and frequently come forward with practical ideas and suggestions for controlling the hazard. One has only to go into a foundry or working place and set up the impinger or electro-static precipitator to find out how quickly the workers in the neighborhood respond. They are immediately curious, then interested, and once having been told what the tests are for, do not hesitate to voice approval. Workmen notice and appreciate the effort management is putting forth to eliminate dust, and their confidence in the good intentions of the company increases in proportion to the number of promises of improved plant hygiene they see fulfilled.

A Loosely Applied Term

From the preceding remarks it would be wrong to assume that silicosis is not a dangerous disease. It very definitely *is,* but what should be emphasized is that certain aspects of it may have been exaggerated. The term "silicosis" has been loosely applied without

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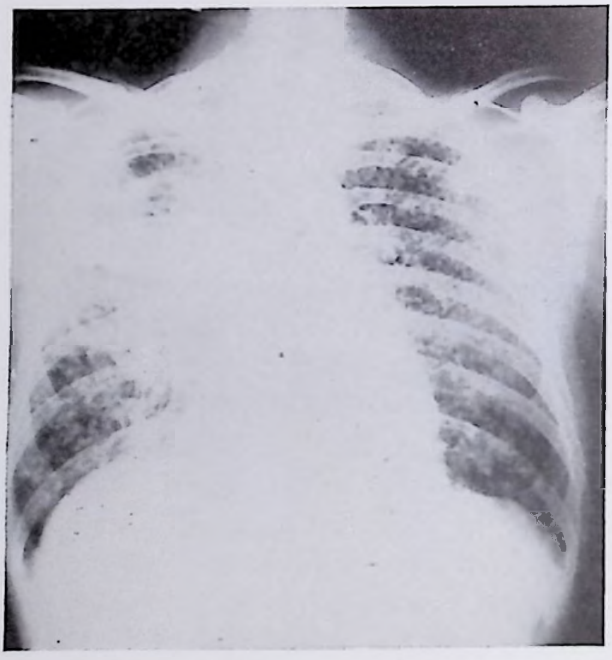
sufficient distinction being made concerning its various degrees and whether or not these have been associated with tuberculous infection. In past years the condition has received wide publicity and the implications which resulted in so much litigation a few years ago still remain uppermost in the minds of many who have not kept informed on progress and knowledge gained through intensive study of the disease. Attorneys still attempt to win awards for their clients and themselves by establishing the presence of silicosis in cases whose occupational history shows no actual exposure and whose chest X-rays fail to reveal nodulation. Sometimes, too, physicians, sincere and otherwise, will substantiate such findings whether they are competent to evaluate the X-ray or not. Here is a situation where the industrial hygienist can demonstrate his value in seeing that justice is done. The decision or granting of an award in a case of litigation may hinge on the accuracy of his recorded findings in a given working place. Evaluation of the degree of exposure may form the main basis upon which a case is judged.

SILICOSIS AND TUBERCULOSIS

When infection (nearly always tuberculous) enters the picture, silicosis becomes a matter of real concern to the employee, his family, his fellow workers, the management, the doctor, the industrial hygienist, and the safety director. The disease is now "complicated" and the outlook much more serious. Unfortunately its presence is not readily detected, for tuberculosis, once established in the silicotic, does not differ materially in its clinical aspects from tuberculosis in the non-silicotic, except that in certain cases progression in the former may be more rapid. In this stage signs and symptoms may be expected, so that the appearance of tiredness, cough, expectoration, shortness of breath, fever, loss of weight, night sweats, and declining appetite in an individual exposed to silica should immediately arouse suspicion of infection. Anyone exhibiting such findings should be X-rayed at the earliest moment and if necessary, removed from his job for his own good and the safety of others around him. One active case of

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Fresh infection (active tuberculosis) in an iron ore miner. Note upper right cavity.

Fig. 5 Complicated silicosis.

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Note emphysema in lower portions of chest and tenting of diaphragm.

Fig. 6 Massive conglomerate silico-tuberculosis in an iron ore miner.

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tuberculosis in a group of silicotic workmen can create a situation of potential dynamite.

Silicosis complicated by tuberculosis is not always fatal, though infection is responsible for the great majority of deaths. Advanced silico-tuberculosis is usually very chronic and slowly progressive, but sometimes, particularly in younger men, the disease becomes accelerated to a surprising degree. On the other hand, I have seen miners with a marked degree of fibrosis and X-ray evidence of tuberculosis develop a positive sputum which later became negative after a period of hospitalization. Sometimes on viewing the chest X-ray, the amount of lung involvement in silico-tuberculosis is amazing when compared with the physical signs and symptoms present. The surprising feature is that such an individual can exist, let alone live, in the fair degree of comfort which he frequently exhibits.

Although, as previously stated, only two substances, free silica and asbestos, are known to produce definite fibrosis at this time, there are certain other conditions which may produce shadows in the roentgenogram similating silicosis. Such diseases as miliary tuberculosis, miliary calcinosis, and fungus infections may cause X-ray shadows inhalation of silicon dioxide dust. However, a careful examination of which are often difficult to differentiate from those resulting from the the chest film and review of the occupational history will usually be sufficient to make the diagnosis clear.

In this connection, the recent paper by Sander[5] on the false nodulation in arc welders and his demonstration of X-rays showing the changes produced by deposition of iron particles in the lungs was most timely. The pattern in the X-rays in these two conditions is almost identical. During the past two years we have been concerned about findings among certain welders and burners which indicate nodulation developing too rapidly in the face of relatively low exposure to be consistent with silicosis. On earlier examination, these films were read as first degree nodulation, but have since been reclassified as probable cases of iron pigmentation. Unlike Dr. Sander's cases, however, a number of these men have had exposure to silica also, which complicates the picture.

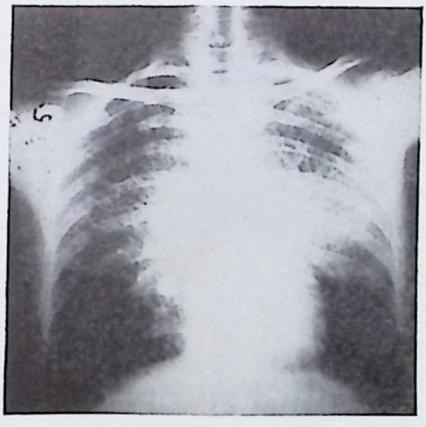
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A. MILIARY TUBERCULOSIS



B. ASPERGILLOSIS



C. MONILIA

Fig. 7 Conditions simulating silicosis.

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Summary

The foregoing discussion has been presented to review some aspects of silicosis which may be of interest to the industrial hygienist and general practitioner, and to emphasize the fact that while the disease is the result of a very definite occupational hazard, certain features of it require special consideration in determining physical disability and rational methods of control.

Clinical signs and symptoms are few, and the uncomplicated type of fibrosis is not necessarily disabling.

Control of the hazard should be based on the correlated findings and recommendations of competent medical and industrial hygiene divisions acting in cooperation with plant engineering departments.

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6

The Respiratory Hazards of Electric Arc Welding

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THE EFFECTS of electric welding fumes on the respiratory tract and lungs have become recognized only relatively recently because of the tremendous increase in production welding in the past five years. Up to the time the vast war production program began, the literature on welding as a respiratory hazard contained only a few reports of several not too well defined fatal cases of pulmonary edema.[1,2] All of these reports had one thing in common, i.e., exposure to unusually heavy concentrations of welding fumes resulting from welding in confined unventilated areas. Welding in large rooms and ventilated spaces apparently caused no untoward symptoms and was not considered hazardous as far as the lungs and respiratory tract were concerned.

Acute Reactions

With the great increase in welding in the heavy industries and shipyards on war production, more clearly defined respiratory effects of excessive welding fumes have become recognized. Upper respiratory irritations, for example, have been particularly troublesome in

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shipyards, where adequate ventilation of some confined areas in the ship's inner and double bottoms sometimes is difficult to accomplish. These irritations are characterized by cough, blood-streaked sputum, nosebleeds, compressed feeling in the chest, hoarseness, and sometimes aphonia. These symptoms have resulted in such terms as "welder's throat," "welder's bronchitis," etc., the latter often applied rather loosely to any case with a chronic cough.

The findings, as a matter of fact, have been confined largely to the nose, pharynx, larynx, and trachea, and only rarely are the bronchi involved. In no cases reported so far from navy or maritime commission shipyards has there been an authenticated case of pulmonary edema. The irritations, therefore, have been almost entirely upper respiratory. The changes are a superficial redness and swelling of the involved mucosa, which gradually disappears over a period of weeks when fume concentrations are decreased. When this cannot be accomplished by ventilation, it has been found adequate to move the affected welder to a job which is not confined. These mucosal irritations appear to be little more severe in most cases than those found with heavy smokers and all of the symptoms always are more exaggerated in heavy smokers than in non-smokers. It, therefore, is advisable to recommend less smoking or complete discontinuance of smoking during the acute stages.

Toxic Metals in Alloys

Some have felt that certain toxic metals in some alloys are the cause of these symptoms and have even theorized that chronic poisoning could be developing in some of these welders. Cadmium is a well known toxic metal which has caused some trouble and several deaths from pulmonary edema have been reported in the past few years from welding alloys containing cadmium.[4] The manganese in some metal alloys also has been thought to be a potential source of manganese poisoning when welded but no such cases have been reported in this country. The reason probably is that most of the manganese goes into the slag and practically none is given off in the fume. Other toxic

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metals, such as arsenic, which are common impurities in steel, also do not appear to cause poisoning for the same reason. Shipyard welding, however, is done almost entirely on mild steel which contains nothing of significance except carbon and iron. It, therefore, is most unlikely that the upper respiratory irritations found among shipyard welders are the result of metal oxide fumes.

The exact component of the welding fumes which causes these mucosal irritations has not been definitely established. It formerly was believed to be the nitrous gases, particularly NO_2, and they were thought to have caused the few reported deaths from pulmonary edema in the earlier literature. However, since then studies by Drinker[3] and others have shown that the nitrous gases are not present in welding fumes in sufficient concentrations to cause irritation of the respiratory mucous membranes. The more likely chief offender in the fumes is the smoke from the cellulose material in the flux coatings of the electrodes. The purpose of the flux coatings, as a matter of fact, is to create a dense smoke to prevent too early oxidation of the weld. It is the writer's belief that it is the cellulose smoke which is almost entirely responsible for the upper respiratory irritation. These reactions have all been transitory and have not left any residual inflammation after the intense exposures have been decreased.

WELDER'S PNEUMONIA

There have been statements from time to time that the incidence of pneumonia is increased by exposure to welding fumes. However, none have been supported by statistical data. The only statistical evaluation of pneumonia among welders, made at the Kaiser shipyard in Oakland, California,[5] rather conclusively showed that the pneumonia rate was not higher among welders than among other workers in the yard. Nor is it reasonable to theorize that the pneumonia incidence could be higher in the absence of pulmonary edema, which always precedes a chemical pneumonia. While animal experimentation with welding fumes has shown an increase in both pulmonary edema and pneumonia in exposed animals, the concen-

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trations of fumes per body weight have been many times higher than could ever be developed with human exposures. It, therefore, seems reasonable to assume that even with confined welding on mild steel, the fume concentrations are never sufficiently intense to cause any reactions beyond the upper respiratory inflammations described above.

CHRONIC CHANGES

Chronic lung changes due to prolonged exposures to concentrated welding fumes have been recognized even more recently than the acute reactions. They have been of special interest to the writer because of his privilege of observing a group of welders with such changes for about ten years. In 1935, in the course of a routine X-ray survey for tuberculosis in a plant, a number of welders were found whose chest X-ray films showed changes deviating from the normal.[6] This plant was engaged in making 1,000- to 3,000-gallon tanks for trucks. In the larger tanks partitions were welded into the tank, dividing it into three compartments. The opening into each compartment was 11″ x 18″, just large enough to admit a small-sized man. The X-ray survey demonstrated that a few of the smaller men in this department showed pulmonary roentgenological changes characterized by generalized discrete small round shadows somewhat resembling silicosis. Inquiry revealed that they were doing most of the work within the confined spaces. Others with similar X-ray findings, but less in degree, had done less work within the tanks. Still others, whose girths were such that they were unable to do any of the confined work, showed no changes at all. Welding was done with a low carbon steel containing no special alloys or special metal ingredients. Upwards of 90 per cent of the fume consisted of iron oxide (Fe_2O_3) of extremely fine sizes (less than ½ micron). Fumes were so dense inside of these tanks before ventilation was installed in 1935 that the welder could scarcely see beyond a foot from his eyes.

The illustration here shown is of a man, 43 years of age, who now is a foreman in the tank welding department. For a period of 11 years before 1933, he spent about 25 per cent of his time inside the tanks

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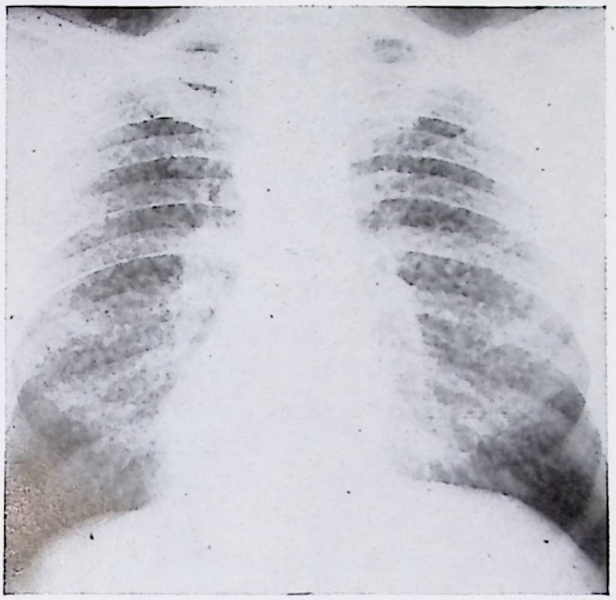


Fig. 1

Film of March 13, 1935 shows rather sharply defined rounded shadows throughout both lungs, more or less resembling silicosis but hilum shadows smaller than would be expected with silicosis of this degree.

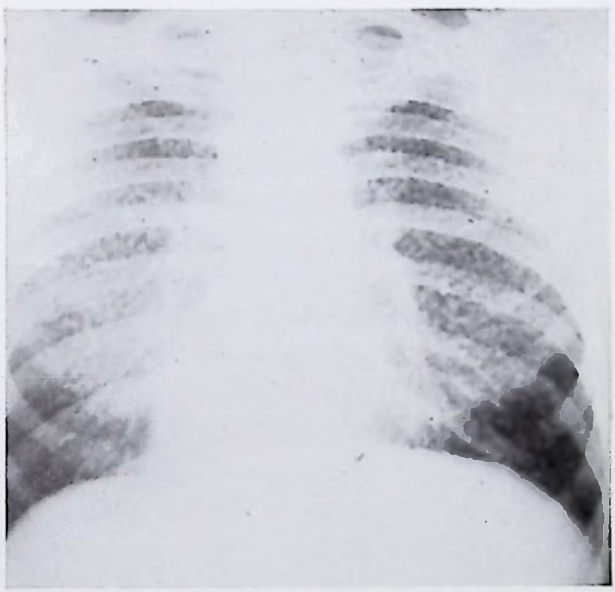


Fig. 2

Film of April 6, 1944 shows no visible changes in the 9-year interval when differences in technique are considered

H.R. Age 43. Electric welder with bare metal electrodes for 11 years before 1933, much confined work. Has been foreman in welding department since 1933 and works daily without symptoms. Has never had silica dust exposure. Shadows most likely due to iron pigmentation (siderosis).

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and welded entirely with uncoated electrodes. Since then he has done no welding. He was a rather small man and apparently did not mind doing the inside work. Past history reveals no episodes of acute respiratory symptoms, cough, blood-streaked sputum, or other symptoms. He is a long-distance swimmer and is able to swim as far at this time as he did in the previous ten years. Occupational history reveals no other exposure to dust or fume except that of iron oxide. Periodic chest films have shown no changes in these lung shadows in the past 9 years and he has not developed any symptoms referable to the lungs. (For additional illustrations of other welders' chest films showing these changes, see the March 1944 issue of the *Journal of Industrial Hygiene and Toxicology*.[7])

POST-MORTEM STUDY

The opportunity for post-mortem study of the lungs of one of these welders, who died following a back injury, presented itself in 1937. Grossly the lungs gave the appearance of intense anthracotic pigmentation, but microscopically the pigment was seen to be iron when the potassium ferrocyanide stain for iron was used. These iron collections were largely in the perivascular lymphatics and actually framed the end-on view of blood vessels, this most likely accounting for the nodular appearance of many of the shadows on X-ray films. Connective tissue stains showed a complete absence of fibrosis and fibrous nodules. It was our conclusion from these studies that the stippled to nodular shadows seen in this group of welders were due to these inert deposits of iron oxide particles in the perivascular lymphatics.

A careful work analysis of all of the welders in this plant showed that only those who had done the confined work inside of the tanks had sufficient iron accumulations in the lungs to be visualized by X-ray. One man who had welded in this plant for 32 years but never inside of the tanks showed no evidence of iron deposits. In other words, only with such highly concentrated fume exposures, which are never reached when welding is done in an open room, will there be sufficient iron accumulated to be visualized. We do not expect any

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more such lung changes in this plant because of the excellent exhaust ventilation now being used in all of the tanks. The fume concentrations in the small compartments now are no greater than outside in the open room.

PIGMENTATION AND TUBERCULOSIS

The possible relationship of welding or iron pigmentation with an increased tuberculosis incidence also was considered by us in the study of this group of welders. One of the men who had done some confined work and who showed slight evidence of iron pigmentation developed an upper lobe infiltrate in 1939, which undoubtedly was tuberculous. Because no bacilli were found and because he was well clinically, he was kept at work but removed from the confined jobs. Frequent observations thereafter showed a slight spread of the lesion by 1941 and then a slow retraction for the next three years. He now has a definite fibrous scar which appears arrested. Although bacilli never were found, it was our conclusion that this was a spontaneous arrest of a reinfection tuberculous infiltrate in a welder who had some iron accumulated in his lymphatics and who continued welding during the whole period of development and retraction of the infection. This case tends to confirm the animal experimentation done by Gardner[8] at Saranac Lake, in which tuberculous guinea pigs were exposed to high concentrations of welding fumes, without any resulting progression of the tuberculous lesions. It seems safe to conclude that welding or iron pigmentation does not predispose the lungs to tuberculosis or tend to reactivate tuberculous foci.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of stippled and nodular shadows on chest roentgenograms requires careful analysis of all exposure factors in each case before the diagnosis is made. All too often physicians make a diagnosis of silicosis whenever they see abnormal roentgen shadows presenting a nodular pattern, without considering other conditions which can cause such a pattern. The welder's iron pigmentation has been most frequently misdiagnosed as silicosis, but several

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cases also were called miliary tuberculosis and fungous infection. The X-ray appearance of the iron deposits differs from silicosis in that the hilum shadows are not enlarged, the pigment shadows are more discrete and sharply defined than silicotic nodulations, and there is no tendency to confluence of the shadows. Where a welder has had considerable silica exposure as well, it frequently is quite impossible to state from a roentgenogram how much of the nodular changes are due to silicotic nodules and how much to iron pigment. In such cases, an exact evaluation of the silica exposure is the more important because of the functional impairment associated with advanced silicosis.

Our experience with pure iron pigmentation suggests no functional impairment of the lungs in the absence of an associated silicosis. The welder foreman whose chest roentgenogram is illustrated in this article has the largest accumulation of iron we have found in anyone observed so far. Yet he has not noted any shortness of breath even on excessive exertion, especially with distance swimming of which he still does a considerable amount. Detailed physiological studies have been made by Enzer[10] on fifteen welders with iron pigmentation in whom he found no deviation from the normal. When one considers the inertness of the deposits and the complete absence of fibrous tissue reaction, this absence of impaired lung function is entirely understandable.

More and more cases showing these X-ray changes in welders will be found in the next few years, not only because of the tremendous increase in production welding in the past five years, but also because of the increasing numbers of X-ray surveys among industrial workers. A large group was reported by Groh[9] of Cleveland last year in jeep frame welders, whose work was not especially confined but where the fumes at the breathing level were highly concentrated. A number of cases have been found at various army induction centers in the past few years and several otherwise 1A prospects have been denied admission to the armed forces because of misdiagnoses. Such misdiagnoses always cause unnecessary alarm in those affected. Interpreters of chest

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films are advised to be on the alert for these cases to prevent the unfortunate consequences of such misdiagnoses.

TERMINOLOGY

Finally, the matter of terminology has caused some controversy and misunderstanding. It will be noted that the author has not used the term "siderosis" in this article, but there is no logical reason why it should not be used provided there is no implication of associated fibrosis in that term. Unfortunately, to pathologists "siderosis" always has meant "lung fibrosis in iron miners" because the fibrosis due to associated silica inhalation was not differentiated. Most iron miner's pathology actually is a "sidero-silicosis". Since there is no more functional impairment associated with iron oxide deposits in the lung than with tattoo deposits in the skin, it has been thought unwise to attach an "—osis" diagnosis to these changes. "Iron pigmentation" seems to be a safer and more descriptive term.

Summary

1. Acute upper respiratory irritation frequently results from exposure to excessive concentrations of welding fumes, even where the fumes do not contain any of the toxic metal oxides.

2. These are entirely transitory irritations, leaving no residuals after decrease of exposure and not causing any increased susceptibility to pneumonia or tuberculosis.

3. Prolonged exposure to excessive fume concentrations, upwards of eight years, causes deposition of iron oxide in the perivascular lymphatics, which can be visualized by X-ray.

4. Because of complete absence of fibrosis with iron deposits, there is no functional impairment resulting from iron pigmentation and no tendency to reactivation of latent tuberculous foci by the iron accumulations.

5. Electric welding in open rooms where the fume concentrations remain low causes no respiratory symptoms, either acute or chronic, and may be considered a safe occupation as far as the lungs are concerned.

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Elements of Diagnosis and Prognosis in Pneumoconiosis

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THE PNEUMOCONIOSES have been discussed in such detail in so many places that no useful purpose will be served by repetition. Here we shall consider only the essentials in diagnosis, prognosis and disposition of cases. The interested reader will find fuller treatment of the subject in the papers cited in the appended bibliography.

The term, pneumoconiosis, means any state of the lungs resulting from prolonged inhalation of dust particles. Pulmonary infections due to living organisms are customarily excluded; organic dusts are occasionally under suspicion but rock and mineral dusts are the most common excitants. Since the effects upon the lungs vary with the nature of the inhaled material, pneumoconiosis may mean anything from simple accumulations of inert matter to serious diseases resulting from highly irritating particles. Colored dusts, like the oxides of iron or coal in reasonably pure form, are deposited in the framework of the lungs and produce the *pigmentations* known as siderosis and anthracosis but have no measureable effect upon respiratory function.

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Combinations like anthraco-silicosis and sidero-silicosis are common, but the dangerous element is the silica and not the coal or the iron. Irritants like quartz or other forms of free crystalline silica and asbestos provoke the formation of scar tissue which replaces functional lung and gives rise to the *diseases*, silicosis and asbestosis. In every pneumoconiosis there is some distortion of the normal roentgenographic pattern of the lungs but such distortion does not signify an associated impairment of function. Pulmonary infections occur in the lungs of persons exposed to dust in occupation just as they do in the general population but the discovery of roentgenographic evidence of the two conditions in the same lung constitutes no proof of causal relationship. The latter must be established statistically from experience in large groups exposed to particular kinds of dusts with perhaps the aid of experimental observation. It is well established that free silica dust specifically predisposes to infection with the tubercle bacillus but not to infection with other bacteria. The same cannot be said for other forms of pneumoconiosis.

Diagnosis

DIAGNOSIS depends upon three essential factors, no one of which can be disregarded although at times they may be difficult to elicit.

1. A history of exposure to excessive concentrations of dust over a period of years.
2. Demonstration of characteristic changes in a chest roentgenogram.
3. A physical examination often marked by findings that are trivial in comparison with the extent of abnormal X-ray shadows.

History of Exposure

THE HISTORY OF EXPOSURE must reveal a period of years spent more or less continuously in atmospheres containing unusual amounts of very fine dust. Since industrial employment is the only one that furnishes these conditions, significant pneumoconiosis is without exception an industrial condition. The dusts of nature are usually too

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coarse, the concentrations are not high enough for any extended period of time and the lungs of most human beings are sufficiently well guarded by protective mechanisms to permit effective accumulations of foreign particles. Industrial dust exposures become hygienically significant in occupations associated with grinding, crushing, milling, drilling or blasting rock, or with the use of very finely divided rock powders. Even then most persons are sufficiently well protected so that exposures of at least four or five and more often ten or more years are necessary to produce significant effects. Only under very unusual circumstances when workers have been practically overwhelmed by irritating dusts like quartz, in closely confined spaces, has silicosis developed in periods as short as eighteen to twenty-four months. Time is essential not only for a sufficient quantity of dust to accumulate within the lungs but for irritation to result in tissue reaction. Let it be emphasized that pneumoconiosis does not result from being caught in a dust storm or from driving on dusty roads; it is not produced by a few weeks' employment in the dustiest mine or mill that can be found. The diagnosis of the most significant form, silicosis, should rarely be made unless the history reveals employment for at least four years in an industry mechanically treating quartz or some other form of free silica. Rare exceptions occur in individuals whose upper respiratory protection is subnormal, but here the roentgenographic pattern should be indisputable. Other exceptions in the past have been the unprotected sandblaster or drillers of pure quartz in unventilated tunnels.

CHEST ROENTGENOGRAMS

CHEST ROENTGENOGRAMS reveal patterns that vary with the character of the pathological changes in the lung and these in turn vary with the kind of dust that has been inhaled. Dust reaction in a normal lung will have different characteristics from that in lungs with associated infections in either healed or active state. While these patterns are by no means definitive for particular dusts, they are sufficiently diverse to permit classification into certain main types. It is the writer's con-

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viction that the response to dusts of different types is so widely diverse that it serves no useful purpose to include every manifestation of all the pneumoconioses in a common classification. To do so may unintentionally imply progression from one phase to another that is quite beyond the potentialities of the condition under consideration. Silicosis, the reaction to free crystalline silica, is recognized pathologically by multiple, small nodules of fibrous tissue distributed uniformly throughout both lungs. Asbestosis, the reaction to silicates in *fibrous form,* is similarly identified by a fine, tenuous, diffuse fibrosis which replaces large amounts of functional lung tissue. Most other dusts that have been well studied, including a majority of the non-fibrous silicates, cause major reactions in the walls of blood vessels and perhaps the septa between lobules of lung tissue. A few may have secondary effects on the walls of the functional air spaces but these forms are still under investigation. These different kinds of pathological changes cast shadows on an X-ray film that group themselves into four main pattern groups. To facilitate description the common categories will be cataloged and described with comments upon their significance.

CATEGORIES OF X-RAY SHADOWS

1. SIMPLE EXAGGERATION OF THE NORMAL LINEAR MARKINGS. Most of the shadows cast by X-rays traversing a normal lung are due to vessels containing blood. The air-filled bronchial tree throws no shadow except in the case of the stem bronchi and trachea whose thick walls are barely visualized in a good roentgenogram. The shadow pattern of the normal lung is therefore comparable to that of a leafless tree with the finer twigs at the periphery not clearly seen. Any change which thickens the pulmonary vessels will result in heavier vascular shadows involving both large and finer branches. It so happens that most inhaled materials tend to accumulate first in the walls of the pulmonary vessels. The mere aggregation of particles themselves or the slight amounts of reaction that they provoke increases the density of the delicate connective tissues about the

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vessels. When such changes are at all marked the shadow of the vessel is heavier than normal. As a great many kinds of dust produce such changes, exaggerated linear markings are common findings in persons employed in industry. There is nothing specific about such a pattern to indicate its cause and it is rarely associated with clinical symptoms. It may be the precursor of subsequent silicotic changes but this cannot be inferred because in many persons, regardless of exposure, no further development follows.

2. RETICULATION is a term recently popularized in England as descriptive of the shadow pattern in the films of coal miners. In this country certain mixtures of silicate dusts, including some of the talcs for example, have produced similar effects. Between the exaggerated linear shadows of thickened blood vessels is a background of small, ill-defined ringlets which in the aggregate suggests the appearance of a rough orange peel. Apparently these shadows are cast by thickened septa between lobules of lung tissue. Like the outer coats of blood vessels the coarser septa of the lung contain large lymphatic trunks and some kinds of dust particles tend to accumulate about them. The exact reason for such localization with only certain kinds of dust is not clear. Symptoms are said to be more frequent in persons with reticulation than with simple linear exaggeration but further study of these subjects is necessary to be certain whether this is invariably true. Disability from this cause is hard to understand unless the thickenings of the septa reduces the elasticity of the lungs.

3. NODULATION is the term used widely in this country to describe the small, round, discrete shadows cast by the nodules of fibrous tissue that constitute the characteristic tissue reaction of silicosis. In typical cases of moderate severity occurring in lungs not altered by associated infection, the nodular shadows, not over three or four millimeters in diameter, are uniformly distributed throughout all parts of both lungs. In long standing silicosis the costo-phrenic portions of the lung fields are usually clear due to the development of compensatory emphysema incident to retraction of the upper lungs.

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There may also be a limited tendency to conglomeration of nodules in *small* areas but on stereoscopic examination the outlines of the individual units are still discernible. Such small conglomerations are more apparent than real and are often due to fortuitous superimposition of shadows viewed on a flat film. The larger, massive conglomerations in which the outlines of component nodules are no longer seen are probably due to associated infection and will be discussed later.

When silicotic nodulation begins to make its appearance in roentgenograms the branching shadows of the blood vessels are blurred and later as the nodules become larger, they are completely obscured. These developments have been compared first to the shadow cast by a tree in bud and then by one in full leaf.

While there are other conditions which may simulate the roentgenographic picture of silicosis, the shadow pattern described when taken in conjunction with the clinical story and a history of adequate exposure to free silica dust constitutes strong evidence for a positive diagnosis. A few other dusts like the exceedingly fine metallic iron in welding fumes and other rarer substances may produce similar effects but then the occupational history becomes decisive. Reactions to infection lack the uniformity of distribution of silicosis and the patients are obviously ill; tumor metastases rarely exhibit the uniformity of size and distribution of the nodular reaction to free silica.

To indicate the severity of the silicosis, it is customary to classify the X-ray films by numerical stages — 1, 2 or 3 depending upon the number and size of the nodules. While certain individuals examined in serial films show evidence of progression through these successive stages this is not invariably the case. Furthermore, a stage 1 lesion in a granite cutter is apt to be quite different in appearance from a stage 1 in a hematite or a gold miner from some other location. The components of the dust other than quartz account in large part for local variations in the picture. A subdivision of silicotic shadow patterns into stages is useful in indicating progression of disease within

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a particular group but it is doubtful whether it has much value in comparing the severity of the silicosis in different locations.

4. MASSIVE CONGLOMERATE NODULATION. The writer strongly subscribes to the South African view that the presence of large localized areas of conglomeration in a film showing evidence of nodulation constitutes evidence of associated infection in the lungs. The infection, in an active, dormant or healed state, has injured a localized portion of lung tissue so that more silica is retained in the area. Unusual numbers of nodules form locally and furthermore there is stimulation of any connective tissue formed in response to the infection itself. The result is a mass of nodules embedded in a solid matrix of silicotic scar. The X-ray casts a solid shadow which the stereoscope does not resolve into its individual components. Such massive conglomerate lesions generally occur in the upper portions of the lung. They may be bilaterally symmetrical; they may radiate outward from the hila. Sometimes they involve the lower lungs.

In early or moderately advanced conglomerate disease the rest of the lung fields exhibit the picture of nodulation. In old cases, however, contraction of the massive scars, which are usually covered by fibrous pleural adhesions, results in marked distortion of the lungs. Most of the more normal tissue with its contained nodules is pulled into the orbit of the massive scar and then bullous emphysema over-distends the remaining part of the lung. In such cases the usual pattern of generalized nodulation is disturbed and perhaps only a few or even no discrete nodules can be visualized. Here diagnosis must lean heavily on the history of occupational exposure.

The nature and character of the underlying infection is hard to establish. Tuberculosis is much the most common cause and this etiolgy can be proved in about 60 per cent of the lesions studied postmortem. Other organisms capable of producing an organizing pneumonia could have the same effect. As will be noted later, the problem of determining activity of a tuberculous component of one

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of these massive conglomerate lesions is most difficult for a sterile scar can cause almost as much damage as scar tissue encapsulating a nidus of living tubercle bacilli. Years later these bacilli buried deep in silicotic fibrosis may finally reach its surface and when they do death from rapidly progressive tuberculosis is imminent. Repeated films taken at intervals of a year may show no apparent change, but as soon as the size or shape of the area is altered then suspect activity of the underlying infection.

5. DIFFUSE HAZE TO GROUND GLASS APPEARANCE. The former appearance was once described as a precursor to the development of silicotic nodulation but in recent years it is less frequently mentioned. It is conceivable that such haziness might result from exposures to exceptionally severe industrial exposures, as a result of which the air spaces of the lungs would contain enough dust phagocytes to intercept X-rays and thus cast a shadow. Today this type of abnormal shadow is most commonly associated with early asbestosis and a few of the less known pneumoconioses. In early cases such shadows spread over the lower lung fields to more or less obscure the outlines of the normal vascular markings. As the disease advances the haze becomes more dense and extends upwards toward the apices. In fully mature asbestosis all vascular markings throughout the lower two-thirds of the lungs are obliterated by the so-called ground glass appearances, a widespread, uniform density composed of confluent, minute stippled shadows.

In the diagnosis of asbestosis such patterns must be associated with a history of exposure to *fibrous* asbestos dust usually for periods of six to eight years or more. Asbestos is often mixed with other minerals for industrial use and unless there is a sufficient proportion of long fiber in the dust generated from the mixture the X-ray pattern just mentioned will not be produced. Inhalation of particulate matter may result in linear exaggeration but this cannot be diagnosed as asbestosis.

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GENERAL CONSIDERATIONS

The films of a person with a history of exposure to dust in industry should be viewed with the same objectivity as those of any other patient and one should studiously avoid the conclusion that every abnormality detected is due to the occupational exposure. Localized shadows involving one lung are practically never due to inhaled dust; infection is much more probable. Miliary calcification, a condition of unknown etiology, is not uncommon in industrial workers. The lung fields are studded with small, hard, round shadows but unlike the nodulation of silicosis, these lesions vary in size and distribution and only by occasional coincidence is there a history of exposure to siliceous dust. Tumors and miliary tuberculosis can be eliminated by the condition of the patient and lack of uniformity in distribution of nodules. Linear exaggeration is a non-specific effect of anything which thickens the blood vessels or their connective tissue sheaths. When the change is well marked and there is an associated history of dust exposure the diagnosis of pneumoconiosis is tenable. Heart failure leaves its marks in the lower lung field; advancing age causes some accentuation of the vascular pattern. Finally it should be remembered that a poor film or one taken short of full inspiration produces artefacts that are often mistaken as evidence of pneumoconiosis. Full size 14x17 inch films are none too good for the purposes in hand and stereoscopic films are still better as they throw shadows into perspective and thereby tend to minimize the severity of abnormal conditions. Where possible comparative study of films from other employees in the same industry is immensely helpful in establishing the characteristics of a particular pneumoconiosis. It cannot be done from an isolated case. And finally it must be appreciated that serial films taken at yearly intervals on a group of individuals will teach an observer more than all that has ever been written on the subject.

Physical Examination

PHYSICAL EXAMINATION constitutes the third essential in the diag-

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nosis of pneumoconiosis. The condition cannot exist without demonstrable evidence of its presence in a suitable roentgenogram; its significance cannot be established without a careful examination of the subject. Many persons subjected to routine X-ray examinations are found to have surprising amounts of pneumoconiosis of which they are entirely unaware. When they are subsequently examined they still show no impairment of respiratory function or disability. This can only mean that a large proportion of the pneumoconioses are not clinically significant. It is the duty of the examiner to differentiate between such cases and those that are important either at the time or will become so in later life.

THE METHODS OF EXAMINATION include all the usual procedures and in addition some form of exercise test that can be duplicated with a reasonable degree of accuracy. Common office procedures consist of tests in which the subject is required either to step up and down from a box, to bend from the waist and touch the floor or to assume a sitting position as he lies prone on the examining table for a given number of times at a standard rate. The pulse and respiration rate and the blood pressure are taken before the test and again three to six minutes afterwards. In subjects with no impairment these functions should return to the resting level in about three minutes. The sitting-up test has the advantage that the blood pressure can be recorded before and after exercise without removing the cuff from the arm.

SUBJECTS WITH SIMPLE EXAGGERATION OF LINEAR LUNG MARKINGS have as a general rule no symptoms and no measurable disability. In some locations particular combinations of minerals in the dust are said to cause cough and exertion dyspnoea while the X-ray still reveals only changes of this character. These instances, however, seem to be rare exceptions to the general rule. One should always remember that disability may be due to some entirely unrelated condition.

IN PERSONS EXPOSED TO FREE SILICA DUST, linear exaggeration often precedes the appearance of nodulation but this is not invariably true and many men remain in the linear stage throughout a life-time of

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exposure; presumably they have such good upper respiratory protection against dust that they never inhale enough to cause nodular fibrosis. On the other hand there are occasional young men in whom linear changes develop rapidly with only a few years of employment at dusty jobs. Even though they have no subjective or objective symptoms such persons should be advised to work elsewhere for with continued exposure, the chances of further progression are strong.

SUBJECTS WITH GENERALIZED NODULATION, even in a second stage, likewise rarely have symptoms except on sudden or unusual exertion and the most searching physiological examination usually fails to reveal significant impairment of respiratory or cardiac function. The reserve capacity of the lungs is so great that there is still enough uninvolved lung tissue to meet all but the most extraordinary respiratory demands. Here again there are occasional exceptions to the rule. The young individual who develops nodulation after three or more years of exposure in an environment where others react in eight or ten often complains of shortness of breath. Presumably he is so poorly protected against inhaling dust that all his pulmonary tissues react and while nodules are forming, the alveolar walls generally become so involved that they impede the passage of gases. The same is true occasionally for entire groups of men exposed to "insulting concentrations" of very pure quartz dust, as for example a notorious group of sand blasters who had worked without respirators inside of tank cars. All of these men were reported to be dyspnoeic after eighteen to twenty-four months and at autopsy their lungs showed a generalized silicotic consolidation. However, these considerations do not apply to the ordinary exposures of mining, rock crushing, foundries, etc., where dust concentrations are low enough to permit slow evolution of silicosis.

ACCESSORY FACTORS like age and high altitude affect the response of the silicotic lung to exercise. Men over 55 with and without silicosis accommodate to exercise less readily than younger individuals.

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At high altitudes the decreased respiratory reserve of the silicotic manifests itself more promptly than at sea level. The point to emphasize is that widespread nodulation does not necessarily mean disability. Mature persons who have developed this condition gradually can continue at work although it is reasonable that they should be removed from further exposure to high concentrations of silicious dust. In some mines where a distinction is possible, they are kept out of rock work but allowed to mine ore.

In the case of SIMPLE DISCRETE NODULATION, the physical signs are trivial in proportion to the amount of X-ray change. The expiratory note is often prolonged and somewhat harsh. There may be signs of associated chronic bronchitis and in advanced cases evidence of dyspnoea may be elicited.

THE MASSIVE CONGLOMERATE FORM of silicosis is an entirely different matter. The great majority of persons with this type of disease are short of breath, some even at rest. The symptoms and signs are those of emphysema and chronic bronchitis. It needs no refined methods of examination to demonstrate such disability. Occasionally, however, individuals are found who suffer relatively little inconvenience from such disease and many prefer to continue at the work to which they are accustomed. Their disease has developed so gradually that they have accommodated themselves.

It is the physician's problem to determine whether they should be allowed to work. It has already been pointed out that many and perhaps most massive conglomerate silicotic lesions develop on a tuberculous basis. On first thought one is tempted to conclude that the subject should therefore be given the benefit of sanatorium treatment or at least hospitalized to determine whether his infection is active. Experience in this country and elsewhere has demonstrated the fallacy of this procedure. These men have no symptoms attributable to infection; they resent such treatment and will not cooperate. Deprived of exercise their dyspnoea becomes much worse — perhaps because of increasing emphysema. No amount of rest will result in decrease

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in size of the massive fibrotic areas. The expedient course is to allow them to work at jobs compatible with their abilities — at made work if necessary — so that they may retain their self-respect and keep in reasonable physical condition. Their disease should be watched in roentgenograms repeated at least once a year. At the first sign of rapid change in the lesion they should be made to quit work. Sputum examination for tubercle bacilli is discouraging but should be done from time to time especially if the X-ray indicates any change. After two or three years of negative monthly examinations, a time will come when some will develop a positive sputum. Then, of course, the health of their associates demands removal. Anywhere from 20 to 40 per cent of persons with such disease ultimately die of heart failure which comes on suddenly and terminates within a few months. Most of the rest succumb to tuberculosis.

Tuberculo-Silicosis

TUBERCULO-SILICOSIS is the term used to describe this very chronic combination of tuberculosis and silicosis. It should not be employed for other less common manifestations of this infection in silicotics. There are some cases in which tuberculosis develops typically with cavity formation in a localized apical focus and bronchogenic spreads or with miliary dissemination. Such cases should be designated as bronchogenic or miliary tuberculosis *with* silicosis.

Asbestosis

In uncomplicated silicosis the X-ray shadows seem much worse than the symptoms; in the subject with asbestosis the reverse is reported. Subjects with a relatively slight diffuse haze are said to be definitely short of breath on exertion and to be bothered by cough and pain in the chest. The nature of the pathological change in asbestosis makes this seem more reasonable for a fine fibrosis not nearly as dense as the nodules in silicosis obliterates wide areas of the capillary bed in the lungs which should theoretically reduce the area available for respiration. However, many individuals with extensive

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ground glass changes in their films seem capable of continuing their work. Further study is needed to determine whether as in silicosis, asbestosis that develops slowly, permits a reasonable degree of accommodation.

Pulmonary infection and particularly tuberculosis is not as common in the American asbestos worker as in his silicotic fellow although a considerable but undetermined proportion of the cases die of this cause. When the tuberculosis supervenes its course is apparently the usual one and there is nothing comparable to the exceedingly chronic tuberculo-silicosis which results from free silica and the tubercle bacillus. Experimental work fails to demonstrate any specific predisposition to the tubercle bacillus which it has proved in the case of silicosis.

Treatment

TREATMENT of any pneumoconiosis is prophylactic. As engineering control reduces industrial dust concentrations this group of diseases should become rarer. There will probably always be a few persons with inherently deficient upper respiratory protection who will develop a certain amount of pulmonary reaction. Others whose lungs are damaged by previous infection will also react precociously. Medical control in industry will see that such persons are not permitted to expose themselves to dust.

Against free silica, aluminum dust inhalation offers good prospects of prophylaxis. It is apparently safe — at least in the absence of pulmonary infection. If enough aluminum is inhaled it will absolutely neutralize the effect of quartz. It will not cause preformed, mature silicotic nodules to disappear but early tissue reactions resolve and further progression ceases. Aluminum therapy in fully developed cases of silicosis is said to afford symptomatic relief although actual physiologic improvement is limited to a small proportion of the cases that have been studied. Aluminum inhalation must never be permitted to replace good hygienic control of the work places; its greatest use is to prevent progression of silicosis in men who already have early disease but wish to continue at work in their present jobs.

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Management of the Silicotic Patient

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SILICOSIS, by the very nature of the disease, does not lend itself to effective treatment and our efforts, once the disease has been acquired, must necessarily be directed toward halting the process short of disablement. The problem therefore resolves itself into one of proper management of the patient rather than of treatment in the usual sense of the word.

That the problem of adequate supervision and treatment of workmen in the dusty trades is the problem not only of the industrial physician but of the general practitioner as well is indicated by the results of a recent survey of the industrial hygiene problem in fifteen states, including Colorado, Idaho and Utah.[1] From these results it was estimated that over 1,000,000 workers in the United States are exposed to silicious dust. Of special interest to the mining West is the fact that of 55,676 workers in 548 plants devoted to the extraction of minerals, not more than 40 per cent had the services of a plant physician either part-time or full-time. With these conditions aggra-

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vated by the war, the family physician must inevitably assume a greater share of the responsibility for the proper management of silicotic patients.

THE PHYSICIAN'S RESPONSIBILITY

Good practice in the management of the silicotic as well as in the solution of the whole problem of silicosis demands that physicians assume a greater responsibility for the conditions under which their patients work. It should be required that the air these patients breathe be made to conform to established minimum standards of freedom from dangerous dusts. The physician who fails to do this is not justified in permitting the patient to continue in his hazardous employment. Unfortunately, the removal of the silicotic worker will only result in a healthy worker being exposed to the same hazard and the physician thereby contributes to the perpetuation of the disease.

The primary responsibility of the physician who undertakes the management of the patient with silicosis is to advise him intelligently and truthfully as to the necessity for a change of employment. Sayers[2], in explaining the view held by the Division of Industrial Hygiene, U. S. Public Health Service, points out that a man should not be removed from work to which he is accustomed and at which he is able to earn his living merely because a diagnosis of simple silicosis has been made. He emphasizes the need of removing the dust rather than the man, and feels that if the atmospheric concentration of dust is brought within safe limits, there is little reason to believe that the silicosis will progress more rapidly than if the man were placed in another occupation.

DISPOSITION OF PATIENT

The decision as to the disposition to be made of the patient with silicosis is dependent on certain well established principles. First in the order of importance is the assurance of safety to the patient, and this in turn depends on a number of tangible factors and at least one very important intangible factor.

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The amenability of the patient's occupation to effective dust control is of major importance, and though it depends to a large degree on the cooperation of management, it is sometimes necessarily modified by technical difficulties. The atmospheric concentration of dust in which the normal individual may work for a lifetime without disabling injury is not definitely established, but in the case of pure silica, is probably around 5,000,000 particles between 0.5 and 5.0 microns in diameter per cubic foot of air. Where the free silica content of the dust is less than 100 per cent, proportionately higher total dust counts are permissible. In most of the states where there is a significant silica hazard, state boards of health have adopted regulations incorporating these or similar figures.

So long as the disease remains uncomplicated its extent is of less importance than the rate of its evolution as determined from the duration of exposure to dust. It may be, and often is, directly proportional to the duration and intensity of exposure, though occasionally it may be modified by components of the dust which exert an inhibiting effect on the action of silica. In such cases it is justifiable to permit the patient to continue at work provided steps are taken to bring atmospheric dust concentrations within safe limits. Since the original publication of this paper clinical studies on the use of aluminum powders in the treatment of silicosis (see references 3, 4 and 5) have suggested that these powders may have an important place in the future management of the silicotic patient. Their precise role, however, depends on further study of their actions.

Each case of silicosis presents its own particular problems, but the majority of cases fall into rather definite patterns of which the following examples are typical.

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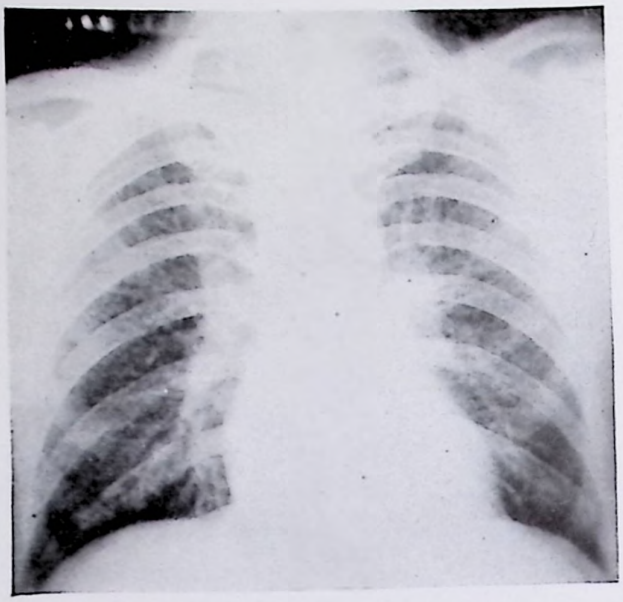


Fig. 1
Initial examination.

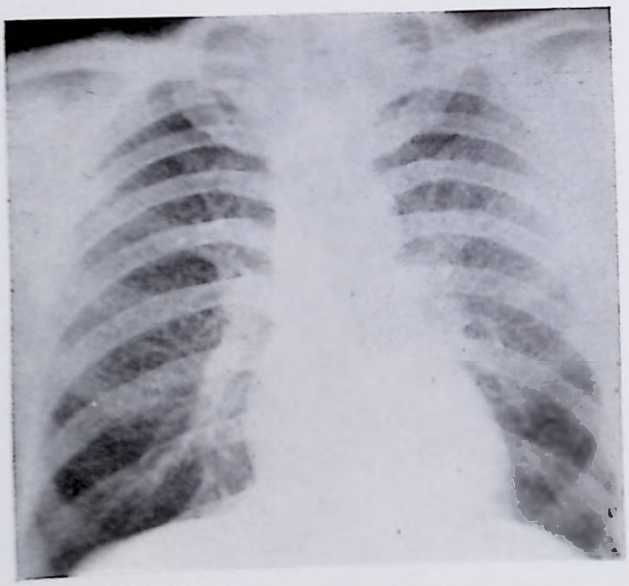


Fig. 2
2 years later.

CASE No. 361

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CASE NO. 361

Case No. 361 (Fig. 1), is representative of the type of problem most frequently encountered. The patient, aged 35, had been exposed to very high concentrations of dust for three years. At the initial examination he appeared in excellent physical condition and had no complaints. Since his disease was mild in spite of the intensity of exposure, and because the operation in which he was engaged was now well controlled from the standpoint of dust, it was decided to allow him to continue in the same work with the understanding that the decision would be reconsidered should his subsequent course warrant.

Two years later (Fig. 2), his condition was unchanged and his silicosis had shown no appreciable progression. Although the interval is rather short it is probably long enough to establish a trend and there is no reason to believe that this man would have benefited more by a change of occupation.

Complications as a rule may be expected to have an adverse influence on the future course of the silicotic process, and of all the complications, tuberculosis is by far the most important. Regardless of the clinical status of the disease, when tuberculosis is suspected in the silicotic patient he should be removed immediately from further exposure to silicious dust. A diagnosis of healed re-infection type of tuberculosis in the pre-employment X-ray is an absolute contraindication to employment in the dusty trades, and when tuberculosis appears in the silicotic patient the outlook is always serious.

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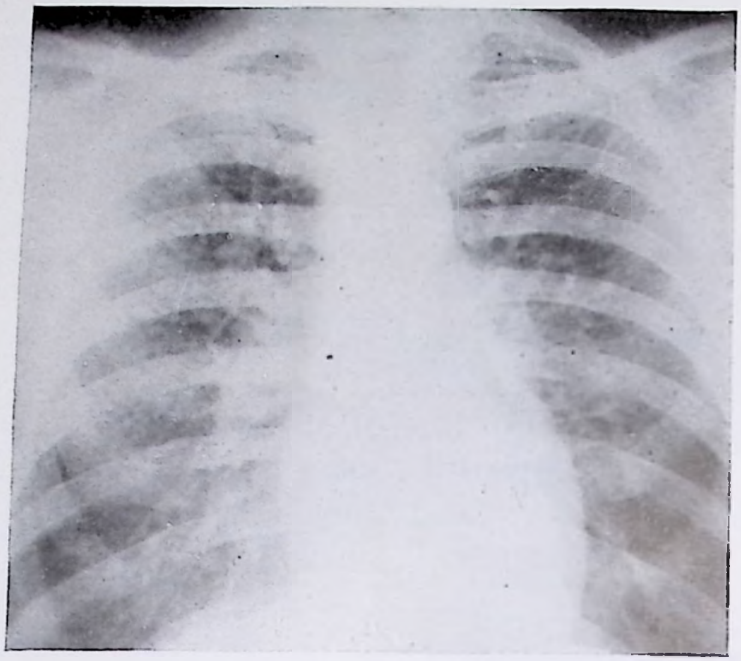


Fig. 3
Initial examination.

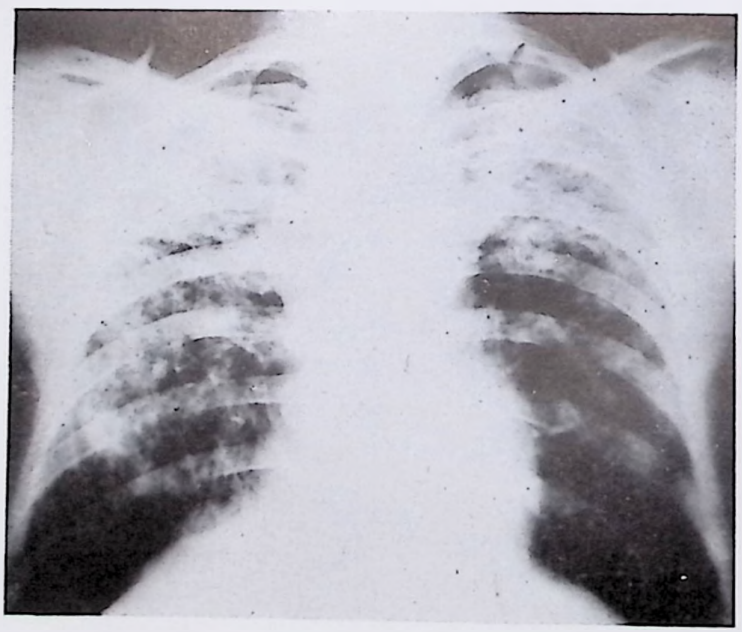


Fig. 4
3 years later.

CASE No. 369

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CASE NO. 369

Case No. 369 (Fig. 3) illustrates such a problem. The patient, aged 40, had been exposed to high concentrations of dust for four years when first seen in 1940. Although the degree of occupational fibrosis noted was no greater than that of the preceding case, the nature of the markings in the upper lobe of the right lung and in the apex of the left suggested the possibility of a complicating infection in these areas. He refused to give up his job, however, and six months later the suggestion of infection became almost a certainty. Although he then agreed to take outdoor employment, his condition deteriorated rapidly until at the last examination in 1943 (Fig. 4), he was totally disabled. In spite of the striking involvement noted in the X-ray, the sputum was scanty and tubercle bacilli were not found in repeated specimens.

Occasionally an uncomplicated case of silicosis is seen in which the disease progresses at a rate all out of proportion to the severity of the dust exposure. Again, the development of the disease is apparent early in one individual while another, under practically identical conditions, fails to develop the disease. Such anomalous cases are by no means rare, and the theories devised to explain them are uniformly unsatisfactory. Until a more adequate explanation is brought forth it must be assumed that the degree of susceptibility of an individual to injury by dust is peculiar to that individual, and is comparable to susceptibility to infection, though it is not known whether the characteristic is inherent or acquired. Although examples of this "individual susceptibility" are frequently encountered consideration of the problem should not be permitted to divert attention from the all-important factor in the causation of silicosis — excessive concentration of silica dust in the air which the workman breathes.

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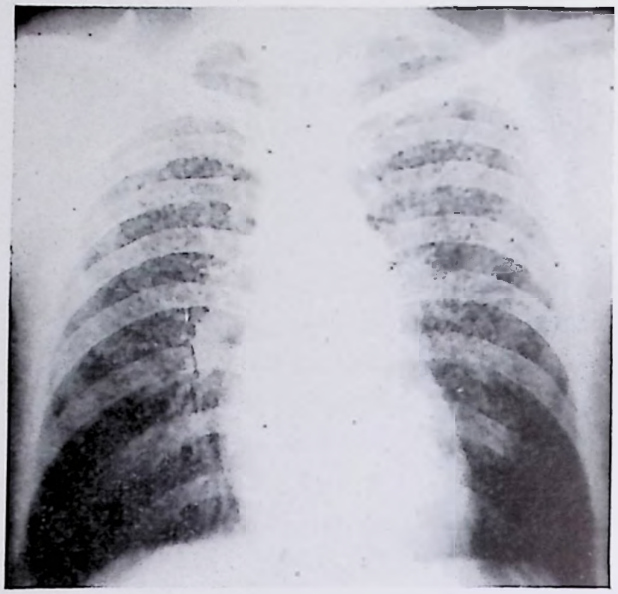


Fig. 5

CASE No. 26

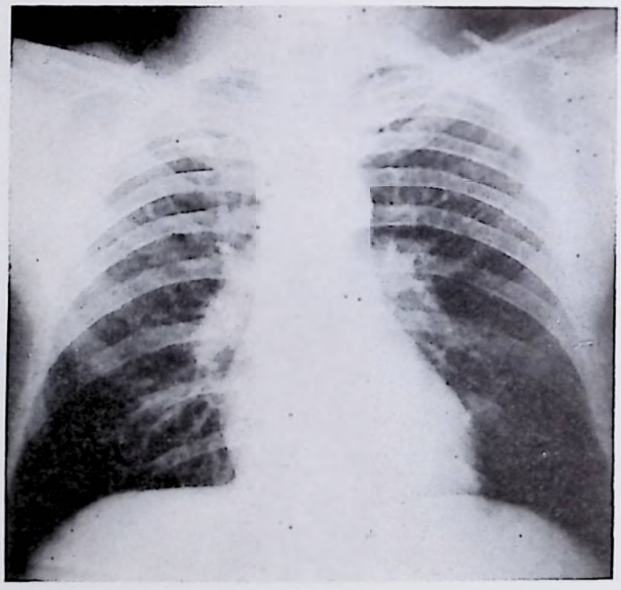


Fig. 6

CASE No. 278

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CASES NO. 26 AND 278

Cases No. 26 and 278 (Figs. 5 and 6) are offered to illustrate the influence of the factor of "individual susceptibility" in the production and subsequent course of silicosis. These men, ages 40 and 31 respectively, were engaged in the same kind of mining operation for the same number of years. Both worked in the same mine during the same period and their dust exposures should have been about as similar as is possible under ordinary mining conditions. Yet one has only a mild linear exaggeration while the other has a far advanced simple silicosis. Case No. 26 (Fig. 5) represents the reaction which might be expected from the degree of the dust hazard known to exist, whereas the other patient exhibits an unusual susceptibility to dust .When such susceptibility becomes manifest, immediate removal from dust exposure is imperative.

Having considered the safety of the patient in determining the need of a change of employment, due regard must also be given to his age, degree of disability and economic status. One should be certain that the patient is able to obtain and hold a new job, and that his earning power will not suffer to a degree out of proportion to the benefits he is expected to derive from a change of occupation. It should be remembered that these men are usually skilled workmen with years of experience in their work which enhances their value to the industry they serve but is of no value to them when they leave it.

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Summary

The general practitioner has a large share in the responsibility for the proper management of the silicotic patient. In addition to treating him for the relief of his symptoms, the physician must also advise him if and when a change of employment is advisable. The indications for such a change are fairly clear-cut, and there is no justification for taking a man from his job merely because he has simple silicosis. The factors which influence the decision to take a man from his job are the safety of the patient, his age, degree of disability, economic status, and his value to industry. Of these factors the first is the most important, and depends on the amenability of the patient's occupation to effective dust control, the extent and rate of development of the disease, the possible presence of inhibiting substances in the dust, and finally, to the possible influence of the "individual susceptibility" of the patient to injury by dust.

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9

Aluminum Therapy in the Prevention and Treatment of Silocosis

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IN 1936, Denny, Robson and Irwin of the Banting Institute in Toronto, demonstrated that finely divided aluminum would inhibit the action of silica in the lungs of experimental animals. This important discovery was checked and confirmed by other investigators. The seriousness of the silica hazard in other industries as well as mining stimulated widespread interest in the application of this new method of prophylaxis.

It was proposed to disperse aluminum dust in underground mine workings but after various trials this procedure was abandoned as not being practical. Silicotic patients were treated individually by the inhalation of aluminum, and in some instances, aluminum dust was dispersed into the atmosphere of change houses for the purpose of establishing its prophylactic action. Gardner, at the Saranac Laboratory, also used amorphous hydrated alumina.

With a disease of such marked chronicity and of such slow development, it is evident that any method of prophylaxis or therapy can be proven only over a considerable period of time — years rather than months. Also there was a reluctance on the part of industrial

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hygienists to indorse the aluminum inhalation method because of the fear that it would tend to undermine engineering and medical control of silicosis, usually a fairly complex and expensive procedure. Moreover, if the advantages of inhaling aluminum dust were to be definitely demonstrated, its administration to groups of silicotic workers must be carefully supervised by competent medical observers.

Early in 1945, it was evident that there was need for an authoritative statement with respect to this subject inasmuch as the urgency of the silica hazard in many industries led to a demand for the adoption of the aluminum dust method. After several conferences at which were represented the Canadian group, the Industrial Hygiene Foundation, the Council on Industrial Health, and the Council on Pharmacy and Chemistry of the American Medical Association as well as other interested parties, a memorandum was agreed upon embodying the following points:

1. It is recognized that aluminum inhibits the action of silica upon the lungs of experimental animals. As silicosis develops very slowly, only carefully controlled administration of aluminum dust treatment will show whether man reacts similarly. It must be borne in mind that industrial dusts are usually mixed with other minerals and that environmental variables are involved which are not present in animal experimentation.

2. The therapeutic use of aluminum appears to relieve symptoms in some patients with silicosis but not in all. A word of caution was expressed with respect to the possible action of amorphous hydrated alumina in increasing susceptibility to tuberculosis, as reported by some investigators. Similar action has not been reported for metallic alumina. It was strongly emphasized also that there must be no let-up in dust-control measures by engineering methods.

3. Finally, it was recommended that the general application of aluminum therapy in industrial plants be delayed until carefully controlled experiments show that it is effective in preventing or alleviating silicosis in man.

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Medical Aspects of Compensation for Partial Disability from Silicosis

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LAWS whereby compensation may be awarded for partial disability due to silicosis are now in force in several states. During the past year other states, notably New York, have expressed an interest in such legislation. In view of the experience that it is sometimes difficult to establish the existence of total disability, it seems reasonable to anticipate that the problem of partial disability may be equally or perhaps even more troublesome. Moreover, partial disability legislation now in effect has conceivably assumed the existence of discriminatory powers as yet outside the experience of the medical profession. The purpose of this presentation is, therefore, to explore the medical problems which might be met in determining the existence of partial disability, in assigning it a value and in establishing its causal relationship to silicosis.

This subject is a fertile ground for misunderstanding because of the lack of adequate definition of the meaning of disability. Most legal definitions characterize disability on the basis of loss of earning

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power. While this may be a practical measuring stick it leaves something to be desired from a medical point of view. "Earning power" or "work output" can be maintained in the face of progressive medical (physiological) disability by the simple expedient of working more steadily throughout a given work period. Moreover, as will be discussed later, factors other than physical capacity or health enter into "earning power" and the level at which it stays.

The author, though cognizant of the legal definitions of disability, believes that progress will be made if disability is also considered from the standpoint of the physiological integrity, the health and well being of the individual. From this point of view, peak physical performance of the organism or "work capacity" becomes the ideal measuring unit. The author's definition of disability, upon which the remainder of this discussion is based, is therefore somewhat different than the accepted legal one.

Because of the fact that age alone will gradually produce total disability in those crafts requiring physical exertion, partial disability must be thought of as a loss of work capacity which, though not completely incapacitating, is more marked than that due to the normal aging process alone. Total disability may be said to exist when one is no longer physically able to carry on in such a manner as to be employable in the job for which he is trained.

TYPES OF PARTIAL DISABILITY

Three types of disability observed in the silicotic may be thought of as being partial in nature. One is a physical disability characterized by a complaint concerning breathing. The patient describes it as a "loss of wind" and will state that "shortness of breath" forces him to cease exertion at levels of physical work that used to be tolerated with comfort. Or he will sometimes note that physical exertion which formerly was done with comfort now makes him "aware of breathing." Cough, chest pain and increased susceptibility to upper respiratory infections are also common complaints of the silicotic but these rarely make him want to give up work. In fact these latter symptoms are

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usually ignored or borne stoically. A change in the ease and comfort of breathing is nearly always the disabling complaint.

A second type is in reality a "potential disability" and may or may not be classed as a partial disability. Statistically the diagnosis of silicosis predicts that the sufferer has more than the average chance of becoming tuberculous and in such an event he is granted less than the usual odds to recover from the infection. Moreover, this diagnosis signifies a shorter life expectancy and a reduced period of employability. To be sure, many, perhaps most silicotics live a normal length of life and experience no curtailment of income. Nevertheless from any group of silicotics a certain number, varying with the occupation and environment, can be expected to earn less while living and to die younger. Unfortunately, it is well nigh impossible at the present time to predict which of the afflicted individuals is fated to do poorly.

A third type of partial disability exists in every case of silicosis in that the diagnosis virtually precludes the employment of such a man by a new employer in any job having a silicosis hazard. This means the silicotic is no longer a free agent and is denied the opportunity for advancement under a new employer. This type of disability occurs at the time of the diagnosis and might well be termed "economic." These last two types of disability present a problem only in respect to the diagnosis of silicosis. The remainder of this presentation will therefore be confined to the problems anticipated in assessing and determining the cause of partial disability characterized by abnormalities of breathing

The data upon which the comments in this discussion are based have been gleaned from the literature and from a detailed clinical and physiological study now being made in this laboratory of a group of silicotics from the mining industry, who evidence the pathological process in all of its stages, and of a group of normal men chosen with particular attention to age and environment. The author is also indebted to Dr. A. R. Riddell of the Division of Industrial Hygiene, Department of Health of the Province of Ontario, Canada, who has

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kindly commented upon the problems faced by their referee board in administering a partial disability law for silicosis now in force in Ontario.

ADMINISTRATION

The feasibility of adequately administering partial disability legislation in the silicotic will depend in a large measure upon the methods available to the physician by which he may assess the degree and cause of the disability. Hence a clarification of the limitations of these methods is essential. Since partial disability represents a deviation from normal ability, any evaluating method will be limited in utility by its capacity to correctly estimate normality. The meaning of the term "normal" is familiar. It should be recognized, however, that although a method of measurement may be adequate, the deviations from the mean of a series of observations may be so large and so distributed that normality ceases to have a very significant meaning. There are four methods that readily suggest themselves as means of estimating disability.

X-RAY EVIDENCE

Some place great emphasis upon the roentgenogram in determining the presence or absence of disability. Whereas the X-ray is the cornerstone of diagnosing silicosis, experience seems to show that disability can be determined only in the most gross manner by this method. Our studies have convinced us that the roentgenogram is virtually useless in determining total disability, and is actually a pitfall of which one must be wary in determining lesser grades of disability. This view supports the general consensus.

OUTPUT INADEQUATE MEASURE OF DISABILITY

It has been suggested that daily "work output" or "earning power" be used as the measuring device of disability. The daily production of an individual depends upon personal incentive, natural physical and mental endowments, and the nature of the job in relation to the output of the entire producing unit. Variations in these factors are

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responsible for the fluctuations of work output to be observed in a group of normal men and even in the same man from period to period. Moreover, these same factors control the ease with which one accomplishes his daily stint — some finishing ahead of time and others working hard to finish within the allotted period. It is apparent that one originally possessing a larger than needed capacity for work could suffer some degree of disability and still maintain the usual ouput by simply working more steadily throughout a given period. In fact, this is the mechanism of compensating for the disability due to aging. The precise limits of the range of this type of compensation are unknown, but they appear too large to make "work output" a useful method of assessing disability. Moreover, since incentive plays so large a role in the daily output and the ease with which it is done, it would be very difficult to ascribe all variations in output to silicosis even though the latter be present. Although the output method will reveal disability, particularly when the work habits of the man are known, it would be difficult to consider this method trustworthy in all cases and it is probably of limited value in any.

The third method consists of a careful physical examination and history together with such routine physiological tests as the electrocardiogram, the response of heart rate and breathing during mild exercise, sedimentation rate, sputum and urine examinations. Vital capacity, breath-holding time and the pressure developed by blowing against resistance are sometimes included.

The scope of this presentation will not permit an exhaustive analysis of the significance of the findings obtained by this approach. Those familiar with the art of medicine recognize the possibilities for error inherent in these procedures, even though extreme care to avoid them is observed. The problems of interpreting sign and symptom by both the examiner and the patient make this method a difficult one. Again, the large variation in the so-called normal man militates against the significance of any observation until the difference is marked. Moreover, examining physicians are usually required to give a decision concerning disability without the important advantage

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of observing the patient over a period of months. During one examination it is almost impossible to thoroughly grasp the complete situation in any given case. This works hardship enough in a decision confined to the establishment of total disability and would make the determination of partial disability particularly difficult. The Ontario Board of Referees have often found it necessary to repeatedly examine the claimant over a period of months in order to reach a clear decision. This method, when used by a physician whose knowledge of the patient extends through the years, thus affording him a basis for comparison and a thorough understanding of the complainant's psychological attitude and background, would be less liable to lead to error than any method now commonly used, although, even in the hands of very able clinicians, it leaves much to be desired.

MEASURING BODY FUNCTIONS

It seems highly desirable to attempt to measure body function in an objective manner in order to avoid the personal factor always present in clinical impressions. With this in view, a fourth approach (in reality merely an extension of the third) is to subject the claimant to rather complicated measurements designed to objectively test as fully as possible the capacity of the man as a unit to accomplish physical labor and to determine as specifically as possible the effect which the silicotic process has exerted upon pulmonary and cardiovascular function.

The methods now used in such studies are not entirely satisfactory. The data obtained are still of an experimental nature, the interpretation of which is subject to change in view of later developments. However, such measurements now show conclusively that among normal men the individual will vary as much as 15-20 per cent above and below the mean for the group, though the method produces duplicate results within 5 per cent for the individual. In other words, an individual might be disabled in a given function by as much as 30-40 per cent and still be classed as a low normal. It is apparent that these tests would be extremely useful if some means were known whereby one

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could determine what the normal of any observation should be for the individual. Regardless of the imperfections now present in this approach, the data obtainable by these methods afford extremely valuable assistance to the evaluation of disability and merit further study.

SOME CASES REVEAL NO DISABILITY

When disability has been shown to exist, it remains to be proven that silicosis is the causal agent. Our studies have amply confirmed the conclusions of others that simple discrete nodulation due to silicosis can exist without any evidence of disability. In fact some cases of conglomerate silicosis fail to reveal demonstrable evidence of disability. One must recognize, therefore, that the presence of silicosis in a subject evidencing disability may be entirely coincidental. Disease of the cardiovascular system, of the kidneys, of the lungs, viz.: essential emphysema and asthma, may be coexistent and the actual causal agent of the disability. The evaluation of renal or cardiac function is most difficult, the more especially when complete failure has still not occurred. For this reason, it is often impossible to ascribe even total disability to coexistent silicosis; in regard to partial disability this problem is greatly magnified.

BREATHING DISCOMFORT

Another factor concerned in the etiology of the disabling symptom occurring in silicosis deserves more detailed discussion partly because its occurrence is not rare even now and would probably be greatly exaggerated by partial disability legislation. Breathing discomfort is related to three factors, namely, the minute volume of air being respired at the moment, the maximum or reserve capacity for breathing, and the sensitivity of the central nervous system structures which record or make one aware of breathing. It has been shown that the normal person becomes short of breath when the breathing demand exceeds 50-75 per cent of his capacity for breathing. The variation of the level at which this occurs signifies a difference in the person's nervous system sensitivity or awareness. It is possible to accurately

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measure the volume of air breathed in response to exercise and also to measure the reserve or maximum capacity that one possesses for breathing. By this means we have shown that the volume of air breathed in response to exercise is essentially normal in the silicotic even when disability is present. True disability in the silicotic is due chiefly to a reduction of the breathing reserve (maximum breathing capacity) and because of this, 50-75 per cent of breathing capacity is reached at successively lower levels of exertion as the disease process advances. We have observed, however, a number of silicotics who complain of being aware of breathing when they are using definitely less than 50 per cent of their reserve. In other words, these men are short of breath because of an increased sensitivity to the sensation associated with breathing. This condition is not confined to silicosis, but is common in many chronic diseases of the chest, and in the neuroses. A possible explanation of this phenomenon is as follows: These men know that they have X-ray evidence of silicosis and also have intimate acquaintance with the extreme shortness of breath which they have observed in others suffering with far-advanced silicosis. It is probable, therefore, that under such circumstances either consciously or subconsciously they become much more acutely sensitive to all things having to do with their own breathing. This psychological element in breathlessness exists to a varying degree in nearly all silicotics. It is a factor that can be determined fairly accurately by measuring the breathing response to exercise and the breathing reserve; it should be evaluated in all cases claiming disability. This abnormality is very amenable to treatment by suggestion.

PRESENT METHODS NOT ADEQUATE

From the foregoing discussion concerning the limitations of available procedures whereby partial disability might be assessed and shown to be due to silicosis, it is apparent that present methods are not entirely adequate for either purpose. Because of the great variation in functional capacity that has been demonstrated to exist among normal men, it seems highly probable that a partial disability repre-

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senting a drop in function of 30-40 per cent may exist without being definitely discernible. Moreover, standards of respiratory capacity below which one becomes totally disabled are not adequately defined. For this reason, it is very difficult to differentiate between a totally disabled and partially disabled person. The Ontario board recognizes this problem, as is evidenced by the fact that they classify any disability greater than 80 per cent as total disability. This attitude, based upon actual experience, supports the conclusions of the author. It would seem that the zones of partial disability which border on normality and on total disability are those that would be most difficult to assess. There is, however, a range of partial disability between these extremes which appears to be definable using present day methods. To divide this range of partial disability into degrees of severity would be to assume an accuracy of estimate that probably does not exist.

FURTHER STUDY NEEDED

An attempt to establish silicosis as the causal agent of the disability, either wholly or in part, would probably lead to confusion because of the problems associated with determining the actual effects of aging and also because methods are not as yet available to determine with sufficient accuracy the status of other systems such as the cardiovascular and renal. Symptoms indistinguishable from those of the silicotic are also a part of the earliest observable indications of breakdown of these latter vital organs. Unfortunately, objective evidence of failure in these structures usually follows instead of preceding the symptoms, so that it is very difficult to be certain that the heart or kidneys are implicated, and to what degree. Nevertheless, when symptoms are present in a given case, there exists a strong temptation to ascribe them to the pathological process which is demonstrable. Since the objective evidences of silicosis always precede its symptoms, this pathological process almost invariably is assumed to be the cause of the disability. This oftentimes erroneous assumption is a stumbling block in determining the causal agent of total disability and would be a far greater problem in partial disability.

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Further study will be needed before a satisfactory solution of this general problem can be reached. Efforts should be directed toward the development of more accurate and more sensitive methods for detecting changes in the reserve powers of the respiratory and cardiovascular systems. More comprehensive and detailed observations of normal persons in various age groups are needed in order to evaluate the disabling effects of normal aging processes. Insufficient attention has been directed to study of the silicotic prior to the development of disability. More comprehensive data must be obtained concerning the different stages of silicosis and the effects due to the variations in composition of irritating dusts before an adequate background upon which to base partial disability legislation can be said to exist. An invaluable opportunity exists in the cooperative study of this problem by both the clinician and those devoting the major portion of their effort to detailed physiological investigation of respiratory and cardiovascular function.

Summary

Adequate administration of total disability legislation requires the use of consultants having wide experience and rather special knowledge concerning the various phases of the problems to be met. The proper administration of partial disability makes the availability of such consultants paramount in importance. Moreover, adequate time to observe each individual — at repeated intervals if need be — must be allowed. In addition, the utilization of all available methods to assist in evaluating the physiological integrity of the patient should be used. Under such circumstance, compensation for partial disability in silicosis might within limits be adequately administered. Any attempt to accomplish this task with the use of less effort would be likely to lead to confusion and failure.

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Occupational Diseases - The Physician and the Law

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ONLY THE Minnesota Workmen's Compensation Law prescribes sick pay (compensation) for employees of state hospitals who acquire tuberculosis in the course of their duties. Except for this state, no federal or state law declares that tuberculosis shall be considered an occupational disease. Workers afflicted with tuberculosis have made claims that the disease was due to their specific occupations and, in hearings on such claims, physicians have certified that the hazards in certain occupations were competent producing cause of the disease, while in others they have attested that the patient's work did not cause or activate tuberculosis. Compensation boards, in their legal decisions, have merely rephrased the testimony of physicians. The basis of decisions, as to whether a disease is occupational, is not legislative fiat nor the opinion of referees or compensation boards; it is established by members of the medical profession.

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MEDICINE VS. LAW

Too often, when meeting medical problems with compensation aspects, physicians ask: What does the law say? They are surprised to learn that the law answers no medical questions.

We shall more effectively advance occupational health and the administration of workmen's compensation if we distinguish between the medical aspects, which are the physician's concern, and the legal aspects, which are the administrator's concern. The latter are outside the physician's province although he may suggest changes in the law or in the procedure where health matters are involved.

EXTENT OF COMPENSATION LEGISLATION

There are federal compensation laws that cover employees in the District of Columbia, harbor workers, and employees of the United States Government. With the exception of Mississippi, all our states and territories have compensation laws, but no two are identical. Some general principles may become apparent if we group these laws according to similarities and differences. All provide some medical care and sick pay during the period of disability. The employer may pay compensation directly or he may pay a premium to an insurance company that will then pay compensation and medical costs.

In no place are all workers within the scope of a compensation law. Farm labor and domestic help are excluded in most states. Some states include only specified industries. In many states the employer is not required to pay compensation unless he has a certain minimum number of employees; in some states the minimum number clause does not apply to hazardous employments. This minimum varies from two in Oklahoma to 16 in Alabama. In many states the compensation law is compulsory; in other states it is elective by the employer and the employee. Legal information on individual cases must be sought in the specific law of each state or territory.

OCCUPATIONAL INJURY

When we say an injury is occupational we mean it is the result of an accident that arose out of and in the course of employment.

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If, however, the occupation is not covered by the compensation law of the state, even though an injury is occupational, the worker is not entitled to compensation. Whether an injury is occupational is a question of fact. That fact is contained in the answer to the question: Is the employee's injury the result of an accident sustained while at work? Often the answer is self-evident; sometimes it is difficult to find. It is, however, always a medical question and the physician's answer will be the same whether it is asked in Alaska or in Florida.

Let us assume the medical answer is: Yes, this injury is occupational. The next question to be asked is: Is the employee to be paid compensation by his employer for wages lost because of his injury? or more simply: Is this injury compensable? Whether it is compensable or not depends on the law of the state or territory under whose jurisdiction it comes. It is a legal question entirely and the answer varies in different jurisdictions.

OCCUPATIONAL — COMPENSABLE

When physicians differentiate between the terms "occupational" and "compensable" they recognize a boundary that separates their medical field from the legal-administrative field. Physicians, and only physicians, can decide whether a disease is occupational. Lawyers and administrators, but never physicians, must decide if an occupational injury or disease is compensable under the law of a state.

All compensation laws cover injuries and such diseases as are proximately caused by the injury. If a physician testifies that a compensable injury caused tuberculosis (and the authorities are satisfied that his testimony is correct), the patient is then paid compensation for wages lost because of tuberculosis. A latent tuberculosis aggravated by an injury and disabling the employee is compensable as part of the injury. The employee is paid because the disease is a result of the injury just as he is paid for an abscess developing at the site of a severe contusion. Physicians do not classify such a case of tuberculosis as an occupational disease and neither does any law. It is part of the compensable occupational *injury* and is therefore compensable.

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STATES IN WHICH ONLY INJURIES ARE COMPENSABLE

Many states include injuries only among compensable conditions; they specifically exclude occupational diseases from the compensation law. For example, the South Dakota compensation act reads: "Injury shall mean only injury by accident and shall not include a disease in any form except as it shall result from the injury." The Wyoming law reads: "Injury shall not include a disease except as it shall directly result from an injury received in employment."

The compensation laws of 22 states and of Alaska contain a substantially similar clause. In these states tuberculosis is compensable only when it results from a compensable injury.

STATES SCHEDULING OCCUPATIONAL DISEASES

The laws of 14 states contain a limited list (usually called a schedule) of occupational diseases for which compensation must be paid if they disable the employee. The Rhode Island schedule contains the names of 31 diseases; Kentucky lists only the inhalation of noxious fumes and gases. The other states are intermediate. In none of the lists or schedules is tuberculosis mentioned; therefore, tuberculosis acquired by a hospital attendant through contact with a patient is not compensable in any of these states. If tuberculosis is a complication of any of the scheduled (i.e. compensable) occupational diseases and if it is proximately caused by that scheduled disease, it is then compensable. This is analagous to compensation for tuberculosis caused by a compensable injury.

STATES WITH BLANKET COVERAGE

Ten states have blanket coverage for occupational diseases. The federal, Hawaiian and the Philippine compensation laws also have blanket coverage. In addition to occupational injuries, under blanket coverage *all* occupational diseases are compensable. It is of interest to note that the major part of our industrial population is within these jurisdictions.

In blanket coverage jurisdictions the decision as to whether a disease is compensable is based on the answer to the medical question:

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Did this disease originate in the patient's occupation? Occupational tuberculosis in these states is compensable, as well as tuberculosis caused by any occupational disease or injury.

OCCUPATIONAL DISEASES

Physicians have certified that certain diseases are causally related to specific occupations when clinical and field observations or experimental data have indicated the occupational relationship. Here the decisions of compensation boards, based on the medical testimony, have been correct and the duty of the medical profession has been well done. Other cases in which the disease, de facto, was not occupational have also been classified as occupational by compensation boards. The decisions have been erroneous because they were based on erroneous medical testimony. The responsibility for these erroneous decisions rests on the medical profession. Ours is the blame for any harm resulting from these errors and ours is the duty to correct them.

Erroneous decisions on the occupational origin of any disease have serious consequences for medical practice. If today we were ignorant of the relationship of silica dust to silicosis (as we were a few decades ago) many hundreds of miners would be deprived of compensation. Furthermore, thousands of miners and stone-cutters would have silicosis if they had not been protected by the measures based on our knowledge of this etiological relationship.

Dr. L. Teleky calls attention to the situation in France where some physicians allege that silicosis is always a tuberculous infection and that silicosis is the product of the bacillus combined with silica. The consequences of this error are that disabled workers are deprived of the benefits of occupational disease laws and prophylaxis against noxious dusts is neglected.

Let us consider another result of mistakes in etiology. Assume a stone-cutter changes his occupation and works as a porter in a hotel for a year; at the end of the year he is disabled because of silicosis and claims compensation. Assume further a physician testifies that the dusty porter work of the past year either activated or aggravated the

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disease and that the history of the man's occupation as a stone-cutter during the preceding ten years is not the determining factor in the disease. Consequently, the hotel employing the ex-stone-cutter is held liable for compensation and the stone-cutting company is released from liability. The decision is unjust. Its consequences extend beyond the important field of administration of justice into the field of medicine and public health. The probable effects of such a decision are:

1. Preventive measures in silicosis are scuttled when such testimony is given official endorsement.
2. Rehabilitation of men with silicosis is made doubly difficult if the next employer risks being held liable for the disease.
3. A physician who advises a stone-cutter with early silicosis to take a job as a porter would be giving advice contrary to officially accepted medical doctrine that such work is harmful for a silicotic.

The result is physicians not specially trained in occupational diseases soon accept this legal fiction as scientifically established fact. To paraphrase Gresham's monetary law, bad medical doctrine with official imprint drives out good scientific fact. Physicians, therefore, have a direct professional interest in decisions concerning compensation for occupational diseases.

COMMUNICABLE DISEASES

Certain communicable diseases among hospital personnel are clearly of occupational origin. There is seldom doubt of the occupational origin of measles in a nurse who has been in contact with the disease in the hospital. Of course, there is the remote possibility that the nurse may have acquired her infection, as other adults may, from a disease carrier in a public place or from a child in her own home. However, when the probabilities are so great that she did acquire it in the course of her occupational duties, when there is no way of distinguishing the rare case acquired outside the hospital, we can classify nearly all cases of measles, scarlet fever, diphtheria, typhoid

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fever, and chicken-pox as occupational when occurring in any one who, in the course of duty, has had recent contact with the disease. Although the occupational origin is certain, it is not established by law or by rules of any state compensation commission. It is established by medical testimony.

Under some conditions it can be shown that such disease is not occupational. For example, an interne was taken ill with typhoid fever two days after returning from a month's vacation at home. On the basis of our knowledge of the incubation period we can classify the disease, in this case, as not occupational.

A physician's certificate is on file for every case in which it is ruled, by compensation referees or boards, that the disease is occupational. Signing such a certificate is simple. Usually no one doubts the conclusions stated in the certificate and the physician never hears again of the etiological relationship of the disease to the occupation. The very simplicity of the procedure causes many physicians to lose sight of the fact that the decision rests on that certificate. It constitutes the medical testimony establishing the basis for the decision. No compensation board or court could award compensation without such testimony.

OCCUPATION AND TUBERCULOSIS

Many student nurses on enrollment have no roentgenographic evidence of tuberculosis and have negative tuberculin reactions. If any of these students later present signs of tuberculosis, the probability is that the infection was acquired in the course of employment. There is no doubt that a few of these young women acquired the infection in the same way as students in academic schools who have no occupational contact with patients. Nevertheless, the probability that a previously tuberculin-negative nurse acquired the disease in the course of her duties is strong. There is no way of differentiating the few infections acquired otherwise.

In a claim for compensation in such a case, a physician's certificate is submitted stating that the disease is probably due to occupation.

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There being no difference of medical opinion, such a case is classified by compensation boards as occupational, on the basis of the medical testimony represented by the one physician's certificate.

There are other cases in which tuberculosis clearly is not acquired or activated by reason of occupation in the institution in which the patient is employed when the disease is discovered. In few cases is this non-occupational origin clearer than when an employee with a history of tuberculosis prior to employment suffers a recurrence while engaged in work completely non-hazardous from a tuberculosis point of view. If physicians fail to certify that such cases are not occupational they effectively scuttle all efforts at re-employment of ex-patients in suitable occupations.

PRECEDENT AND EXPERT OPINION

If a higher court has made a decision on a question of law (for example, whether charitable institutions come under the compensation law), the lower courts usually accept this as a binding precedent and make similar decisions in all similar cases. The first decision acquires some of the characteristics of law.

There is no such thing as precedent in medical testimony (or in any question of fact). Let us assume that physicians considered a dermatitis arising under certain conditions of work as non-occupational and that a decision was rendered accordingly. Any time a similar claim arises and a physician has new or additional evidence, or is of the opinion that the conclusions drawn in the preceding case were not warranted, hearings are held for reconsideration of all medical questions in the new case. Physicians can change the status of any disease from non-occupational to occupational (or vice versa), provided they have sound evidence and are willing to present it in specific cases before the proper authorities. If a physician reports a disease occupational or non-occupational "because the compensation authorities have previously made such a decision", he is, in effect, evading his own responsibilities. If the physician has no opinion on the etiology or is uncertain, he should so state and de-

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fer to other physicians whom he accepts as authorities. A physician must never defer to legal decisions based on testimony with which he is not directly familiar or with which he is not in complete accord.

WHEN IS TUBERCULOSIS A COMPENSABLE DISEASE

Tuberculosis is a compensable disease whenever it is:

1. Caused by an injury which in itself is compensable. This applies wherever there is a compensation law.
2. Caused by an occupational disease which in itself is compensable. This applies in states that have blanket coverage or an occupational disease schedule.
3. Caused by occupational contact with tuberculosis patients or occupational exposure to the bacilli. This applies in states that have blanket coverage.

Summary

Compensation laws have been a major factor in progress in the discovery, treatment and prevention of occupational disease. When physicians fail to recognize the occupational origin of a disease, its prevention is obviously impossible. When a non-occupational disease is incorrectly classified as due to occupation on the basis of a physician's erroneous testimony, though the effect may be less obvious, disease prevention is similarly made impossible. The erroneous classification establishes a fictitious origin and the industrial physician combats that fiction of occupational hazard while the ignored real cause continues to produce disease.

The whole structure of compensation law and occupational health rests on medical data. Physicians especially are charged with the duty of discovering and formulating medical data and deciding on the relationship of disease and occupation. All compensation laws acknowledge that physicians are the sole authorities in this field. That supreme position will be maintained as long as physicians accept the responsibilities which go with it.

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Occupational Disease Liabilities - Financial and Humanitarian

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NO DISCUSSION of either the financial or economic aspects of the occupational disease problem can be attempted without a full consideration of the humanitarian approach; neither can the humanitarian aspect be explored without considering the economic background.

When laws were first proposed in the various states, substituting present compensation systems for common law procedure in indemnifying employees and dependents for accidental injuries, much opposition developed on the part of industry. It was alleged that such laws would ruin industry because of the increased cost of insurance coverage. Particularly strong was this argument where competitive states did not have or propose similar legislation. True, insurance costs for coverage under the new laws did increase many times over

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the premium charges for employer's liability insurance where the employer retained his common-law defenses. In Wisconsin, insurance companies actually increased insurance rates under the new 1911 compensation law 400 per cent over the rates used for employer's liability protection prior to the enactment of the law. In other words, an employer who, prior to September 1, 1911, paid an annual premium of $1,000 for employer's liability protection, was required to pay a premium of $4,000 if he elected to become subject to the new Wisconsin Compensation Law.

However, compensation premiums alone represent only a small part of the economic loss occasioned by our industrial accidents. The fourth Biennial Bulletin of the Minnesota Compensation Insurance Board is authority for the statement that when the industrial accident picture is viewed in its entirety, indirect losses caused by these accidents, such as increased labor turnover, damaged machinery, damaged materials and products, slow-downs, decreased efficiency, and other consequential items aggregate four times more than compensation insurance costs.

WISCONSIN EXPERIENCE

In 1909 the Wisconsin Legislature appointed an interim committee to study compensation systems and prepare a bill to be introduced in 1911. This committee in submitting its bill in 1911 appended a special report giving four important reasons for recommending the enactment of a compensation law. The most important reason cited was not, as might be assumed, a reference to benefits to employees and dependents following accidents, but "to provide a means of minimizing the number of accidents in industrial pursuits." In amplifying this statement, the committee continued, "In this connection it is reasonable to expect that where compensation must be paid for every injury, employers will endeavor to reduce the number of accidents for the practical reason that fewer accidents must necessarily reduce the amount of compensation paid." This prophecy of the committee was indeed accurate.

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Almost every two years since 1911, the Wisconsin Compensation Law has been liberalized by legislative amendments. Benefits under the present law are computed by actuaries to be a trifle over 100 per cent greater than they were in the law as passed in 1911. During that same period, compensation insurance rates have been increased not in excess of 25 per cent. This rather nominal increase in insurance costs has not been due entirely to the prevention of accidents and diseases in industry.

Wage levels have risen considerably since 1911 and any increase in wage levels above the maximum wage on which compensation is based naturally affects insurance costs favorably. However, no one will question the assertion that in the main, the splendid work done in accident and disease prevention is largely responsible for this favorable development of large increased benefits with a comparatively small increase in cost.

The District of Columbia and all states except Mississippi now have compensation laws covering accidental injuries. To my knowledge, there has not been a single instance where legislation was introduced to provide for a return to the former common law procedure. Frankly, it seems unreasonable to assume that industry would care to return to the former system despite its lower insurance costs.

ACCIDENTAL INJURY — OCCUPATIONAL DISEASE

If there is any justification for compensation (regardless of fault) in the case of accidental injuries, then such justification should apply even more forcibly to a compensation system for occupational diseases. Few accidents occur where the worker is not partly at fault and where avoidance of the accident does not rest in a considerable degree within the control of the employee. However, with occupational diseases, the picture is vastly different. The employee can do little to avoid the onset of an occupational disease because usually he is unaware of the hazard. Many times even the employer dealing with new chemicals or new combinations of chemicals is unaware of potential hazards to the health of his workers.

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Also, from the standpoint of costs, the benefits paid for occupational diseases represent only a small fraction of the total benefits paid under the laws. According to the latest statistical release of the Industrial Commission of Wisconsin, only 5.5 per cent of all cases settled in 1943 and 3.4 per cent of all benefits paid were chargeable to occupational diseases and all other nonaccidental injuries. The percentage has been comparatively uniform since 1940. During that year 3.4 per cent of all cases settled were in the occupational disease group; in 1941, 3.4 per cent; in 1942, 4.1 per cent; in 1943, 5.5 per cent. While the figures for 1944 have not been released officially as yet, a letter from the commission indicates that 5.4 per cent of the cases settled were in this group. Costs, likewise, have been comparatively uniform. In 1940, 3.2 per cent of the benefits paid were chargeable to occupational disease claims; in 1941, 4.5 per cent; in 1942, 3.9 per cent; in 1943, 3.4 per cent. No statistics are available for 1944.

It must be remembered, however, that these figures represent overall state costs. Many industries and occupations have no disease hazards, while others have disease hazards which are considerably more costly than the hazards of accidental injuries. However, that same picture is present in comparative hazards of accidental injuries in certain industries and occupations. These hazards are measured by insurance rates. For example: In Illinois, the manual classification "Clerical Office Employees" carried a rate of 6 cents per $100 of payroll. "Structural Steel Erection," on the other hand, carries a rate of $8.81 per $100 of payroll.

Why then, with such small costs and so few claims involved, do we find opposition in certain states to an adequate occupational diseases law? Why should insurance companies be accused, as they so frequently are, of leading this opposition? The liberality of compensation laws is of no financial concern to carriers. They merely assume the liability of the employer as determined by the legislatures, and the rates are based on state-wide experience which is anticipated when new legislation becomes effective. Thereafter the rates are adjusted annually on the basis of actual experience.

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It is almost certain that when the employer starts paying the bill, measures, similar to those taken to prevent accidental injuries when these only were compensated for, will be taken to prevent occupational diseases and improve industrial health. Experience has already indicated that that is precisely what occurs as these laws become effective. Does anyone doubt for one moment that silica exposures have been reduced to safe tolerances largely because silicosis was becoming a costly item of production in dusty trades having a silica hazard?

LIABILITY PROMOTES SAFETY

Even though silicosis was made compensable in Wisconsin in 1919, it was not until the full impact of depression was felt on employment in 1932 that an avalanche of silicosis claims resulted. Little was known then of the disease or of the best preventive means. Insurance rates jumped from 1.083 per cent of the 1911 figure in 1930 to 1.563 in 1934 and 1935. Then when the hysteria abated somewhat and preventive means produced results, state-wide rates dropped again to 1.276 per cent in 1940. Nevertheless, rates in certain classifications were more than tenfold higher in 1934 and 1935 than they had been in 1930 and before.

In 1943 nonaccidental injury claims, which include occupational disease cases, cost Wisconsin industry only $203,230 or 3.4 per cent of the entire benefits paid under the compensation law. Of this total, silicosis claims cost only $30,199 or ½ of 1 per cent although it represented 14.9 per cent of the cost of all occupational diseases. However, in 1940, this latter figure was 61.9 per cent; in 1941, 39.2 per cent; and in 1943, 54.7 per cent.

In September 1943, occupational diseases were covered by 32 compensation acts, including federal and territorial legislation; of these acts, 12 covered only diseases mentioned in a list or schedule, and in several of these, the list was meager and rudimentary. In other words, on the basis of the Wisconsin experience, which is rather closely substantiated in some other states, a full coverage act would

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not increase the cost to industry nearly as much as it will be increased in the states which now do not cover diseases at all except insofar as they may by interpretation be classified as accidental injuries.

There can be no doubt that the control of occupational diseases, whether compensated or not, has improved the standard of industrial health on a national basis during these last few years.

It has been estimated that lost time in industry from general illness, not attributable to employment, is 15 times as great as the loss caused by industrial accidents and diseases.[1] Dr. Sappington, in addressing the American Conference on Industrial Health in 1940, said that the average employee lost 7 days per year due to sickness, for an aggregate wage loss of $1,120,000,000. When disbursements for medical and nursing care and hospital bills are added, plus the cost of losses due to labor turnover, idle machines, and other items, our total economic loss due to ill health aggregates $10,000,000,000 per year.

It takes very little imagination to see that only a small improvement in industrial health standards due to control of occupational diseases would more than offset the increased cost to industry of compensation premiums due to the addition of full coverage occupational disease provisions to present compensation laws.

THE ADMINISTRATOR'S DUTY

The basis for the present opposition to extending the laws to include compensation for diseases is the fear that through loose administration, these laws will be interpreted to offer complete social insurance against all sickness and old-age infirmities at industry's expense. Able administrators recognize this trend. In discussing this danger, Chief Justice of Ontario, Sir William Meredith, said, "Everything depends on the constitution of the board; if it is a bad board, the whole thing will be a failure." Mr. H. A. Nelson, director of compensation of the Wisconsin Commission, recognizing this same danger, said, "Administrators must, first of all, be capable and then must study

[1] Neal, Paul A.: Industrial Medicine, 9:12, p. 622, Dec. 1940.

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and inform themselves fully upon the subject before them if they are to be competent for their task. They must combine at least a fair knowledge of the elements of law, insurance, medicine, and of specific compensation provisions."

It is a serious indictment of the administration of compensation laws that their extension should be retarded through the ill-considered decisions of the very individuals who should be most interested in broader coverage. Even increased benefits for accidental injuries are being denied by legislatures because of the mounting costs. These costs are due in a great measure, not to such liberality as was contemplated in these laws, but to the trend in administration of granting awards for disabilities not even remotely associated with trauma. Such procedure adversely affects those claimants with legitimate compensable injuries.

THE PHYSICIAN'S RESPONSIBILITY

Too many physicians lend themselves to similar trends by trying to establish a relationship between employment and the common, everyday diseases of life and the degenerative manifestations of old age, never realizing that an unjust award, while favorable to a single claimant, adversely affects the more liberal treatment of the many.

ORGANIZED LABOR'S STAND

Organized labor also handicaps the extension of occupational disease legislation through its opposition to those control measures which are absolutely essential in keeping health standards on a high level. It is an accepted fact today that, with few exceptions, no man should be denied employment because of handicaps or infirmities. However, such individuals must be properly placed after a thorough appraisal of their disabilities. With preplacement and follow-up physical examinations under a plan such as that recently drafted by the Council on Industrial Health of the American Medical Association where the rights of labor are recognized and protected, accidents will be prevented and occupational diseases controlled.

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If these adverse influences are recognized by everyone, direct costs of benefits will be kept to such a minimum that laws can be liberalized for accidents and made all-inclusive for diseases. The resultant economic saving in lowered production costs will more than offset the costs of increased benefits.

The cornerstone of our economy is the worker. His well-being is the well-being of the nation. Joyce Kilmer, in one of his lesser known poems said:

Have pity on our foolishness
And give us eyes that we may see
Beneath the shopman's clumsy dress
The splendor of humanity.

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