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MEDICAL SURVEILLANCE

Medical surveillance implies not only the prevention of disease; it is also the active promotion of a healthy work environment.

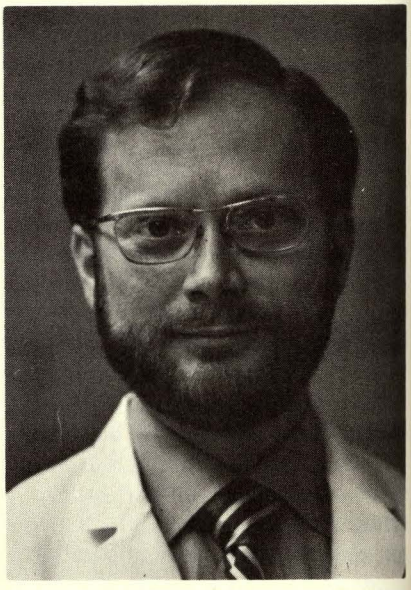
THESE DAYS, air and water pollution are on everyone's lips—and, if it comes to that, in most persons' nostrils and gastro-intestinal tracts. There has been a sudden realization that the environment matters, yet relatively little public thought is given to the health hazards many persons encounter while at work. Although general pollution is a source of concern to all, limited pollution at a factory or mine tends to be ignored, because it only affects the health of a small minority.

Traditionally, medical surveillance has meant that a few concerned industrial physicians have given limited and often desultory attention to the prevention of the grosser and more obvious hazards encountered at work. In its broad sense, medical surveillance implies not only the prevention of disease, but also the active promotion of a healthy environment at work and at play (see Figure 1). To illustrate this thesis, consider a specific but important industry and one with a respiratory problem—coal mining. Medical surveillance should make a positive contribution to the health of the coal miner.

Industrial Environment

Surveillance should start at the time the man applies for his job. Each employer has an obligation to see that he avoids employing persons who are physically or mentally unsuitable for the job for which they have applied. Although coal mining has become less arduous over the past 20 years owing to increased mechanization, there are still many jobs in the coal mine that are harder and more exacting than those encountered elsewhere. Thus, it is neither wise on the part of the company nor fair to the job applicant to accept as a miner a man who has had previous surgery for a ruptured disc. The man would be prone to develop a recurrence of his problem and, furthermore, might well sue the company later. In the same light, persons with obvious respiratory disease such as asthma would be well advised to seek a less dusty occupation—one less likely to produce lung disease (see Figure 2).

The nature of a pre-employment medical examination depends on the circumstances, and the possibilities range from a simple examination to a complete physical examination with sophisticated physical and psychological tests, such as those used in the selection of astronauts. The medical examinations performed on prospective coal miners should include a chest X-ray and some objective assessment of pulmonary function (see Figure 3). Moreover, due to the continuing exposure to



By **Edwin J. Morgan,** M.D., Chief, Clinical Section, Medical Research Branch, Public Health Service Appalachian Laboratory for Occupational Respiratory Diseases, Morgantown, WV.

Establishing an Effective Respiratory Protection Program

1. Introduction—(April 1971)
2. Program Administration—(May 1971)
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Medicine, like jurisprudence, should make a contribution to the well-being of workers and see to it that, so far as possible, they should exercise their callings without harm.

De Morbis Artificium Diatriba

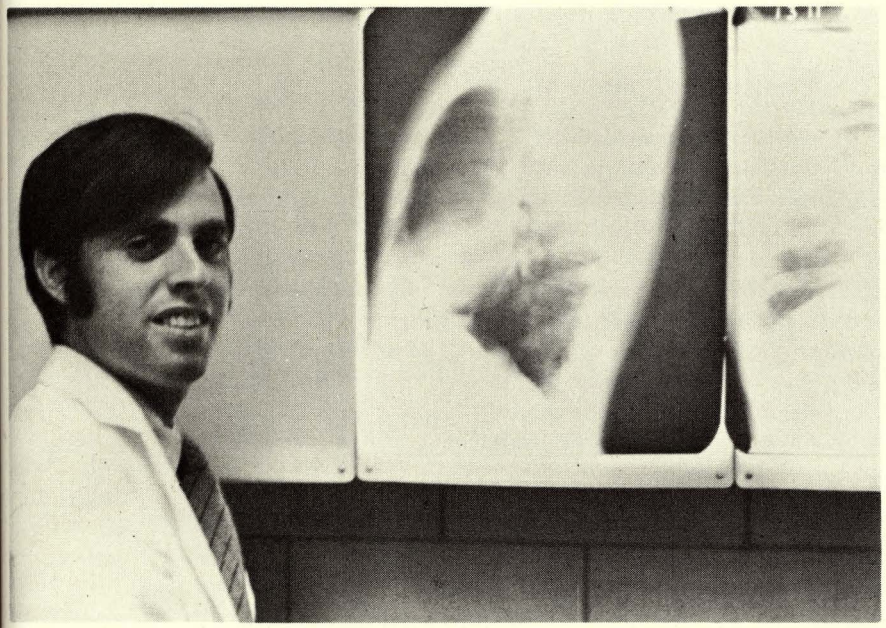
Ramazzini—the father of occupational medicine (1633-1714)

dust in the mines, serial X-rays taken at five-year intervals are indicated. To understand why this precaution is needed, let's take a brief look at coal workers' pneumoconiosis (CWP).

This disease exists in two forms, simple and complicated. Simple CWP is related solely to the inhalation and retention in the lungs of small particles of coal dust. The development of the disease is "staged" into diagnostic categories 1, 2, and 3, according to the extent and profusion of small opacities seen in the chest X-ray—the more the opacities, the greater the amount of dust present in the lungs (see Figure 4). While the simple form of the disease produces little in the way of disability, its higher categories (or later stages), categories 2 and 3, are associated with an increased risk of developing complicated CWP. The complicated form is characterized by the formation of large conglomerate masses of fibrous tissue in the lungs. In many instances, these masses slowly and relentlessly increase in size so that they may eventually destroy the whole lung. Often both lungs are affected. Complicated pneumoconiosis is a cause of respiratory disability and of premature death (see figures 5, 6, and 7).

A certain amount of dust has to be present in the lungs before complicated CWP develops; however, some other factor, as yet unknown, is also necessary and acts as a catalyst. The complicated form of the disease virtually never develops unless the miner already has marked evidence of coal dust present in his lungs. Therefore, if men can be prevented from developing categories 2 and 3 simple pneumoconiosis, the number of men at risk would be substantially reduced. Thus, monitoring men working in the industry is of paramount importance.

Industrial lung disease is an important source of ill health, disability, and death. In addition to moni-



Chest X-rays are vital to the medical supervision of a respiratory protection program. Here Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) M.D. (Michael Lippmann) compares chest X-rays of an individual that were taken at a three-year interval.

Respiratory Protection

Permissible practice—In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as is feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be pursuant to . . . written standard operating procedures governing the selection and use of respirators . . . and persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

Figure 1 is taken from Rules and Regulations as set forth in the "Occupational Safety and Health Standards," as published in the *Federal Register* (Part II) Vol. 36, No. 105, May 29, 1971.

Dust Standard and Respiratory Equipment

Each operator of a coal mine shall take accurate samples of the amount of respirable dust in the mine atmosphere to which each miner in the active workings of such mine is exposed. Such samples shall be taken by any device approved by the Secretaries of Labor and of Health, Education, and Welfare —and in accordance with such methods, at such locations, at such intervals, and in such a manner as prescribed in the *Federal Register*. . . . Such samples shall be transmitted to the secretary in a manner established by him, analyzed, and recorded by him in a manner that will assure application of the provisions of this act—when the applicable limit of the concentration of respirable dust required to be maintained under the act is exceeded. The results of such samples shall also be made available to the operator. Each operator shall report and certify to the secretary at such intervals as the secretary may require as to the conditions in the active workings of the coal mine, including, but not limited to, the average number of working hours worked during each shift, the quantity and velocity of air regularly reaching the working faces, the method of mining, the amount and pressure of the water, if any, reaching the working faces, and the number, location, and type of sprays, if any, used—except:

Effective on the operative date, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of such mine is exposed at or below 3.0 milligrams of respirable dust per cubic meter of air;

Effective three years after the date of enactment, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of such mine is exposed at or below 2.0 milligrams of respirable dust per cubic meter of air.

Medical Examination

The operator of a coal mine shall cooperate with the Secretary of Health, Education, and Welfare in making available to each miner working in a coal mine the opportunity to have a chest X-ray within 18 months after the date of enactment of this act; a second chest X-ray within three years thereafter, and subsequent chest X-rays at such intervals thereafter of not to exceed five years as the Secretary of HEW prescribes. Each worker, who begins work in a coal mine for the first time shall be given, as soon as possible after commencement of his employment, and again three years later if he is still engaged in coal mining, a chest X-ray; and in the event the second such chest X-ray shows evidence of the development of pneumoconiosis the worker shall be given, two years later if he is still engaged in coal mining, an additional chest X-ray.

Figure 2 details the "Interim Mandatory Health Standards" for respiratory equipment and medical examinations as prescribed in the *Federal Coal Mine Health and Safety Act* of 1969.

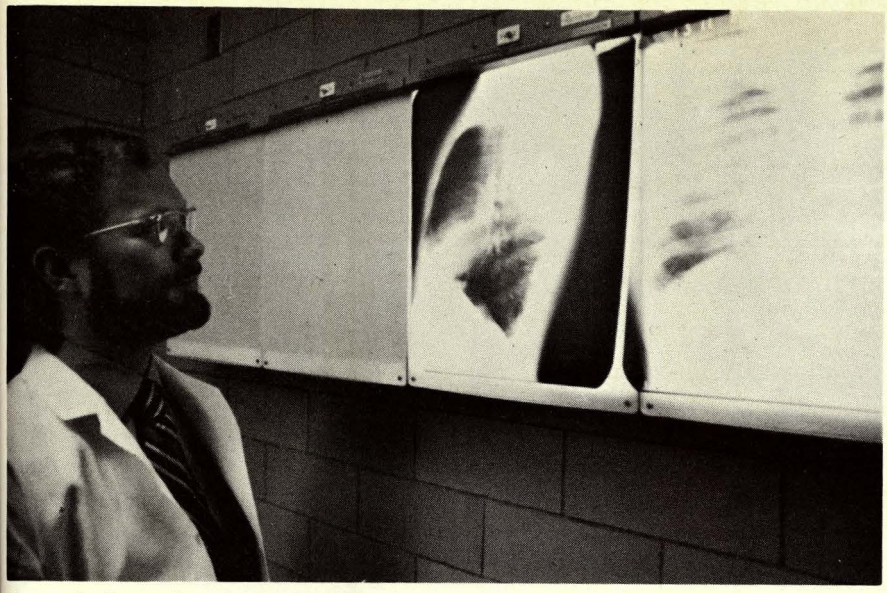


Figure 3 shows the author, Dr. Morgan, examining a chest X-ray as part of an employee's preplacement examination—part of an over-all medical program to help prevent cases of occupational disease.

toring the health of the industrial worker, preventive dust control programs will need to be implemented and enforced to obtain a major improvement in this situation. The present standards for the U.S. coal mining industry, if adhered to, should do much to alleviate the problems of dust-produced respiratory disease (see Figure 2).

When the Medical Research Council of Great Britain carried out its classic study of pneumoconiosis in South Wales some 30 years ago, the air-borne dust was measured in terms of the number of particles per milliliter, and particle mass was calculated. A reasonable correlation was found between these two measurements. The shortcomings of the particle counting technique did not become fully apparent for more than a decade. When sufficient data became available, however, it was evident that the prevalence, or frequency, of pneumoconiosis in British collieries did not relate well to dust exposure as determined by this technique. Furthermore, when X-ray units began periodic visits to all collieries in 1959, no obvious relationship was apparent between dust exposure and the progression of pneumoconiosis. The correlation found in South Wales 30 years earlier seemed only to apply to that restricted sample and may well have been fortuitous. It was not until early 1969 that a good correlation was obtained between X-ray changes and environmental dust exposure, and this came with the substitution of gravimetric measurements for particle counting.

It has now been established that the mass of respirable dust in most U.S. coal mines has already been reduced to less than 3 mgs. of respirable dust per cubic meter of air, the level presently required by the *Federal Coal Mine Health and Safety Act* of 1969 (see Figure 2). New dust control measures are being explored to decrease further the amount of respirable dust; these include methods of preconditioning the coal seam, the use of foams and high-velocity water jets to keep dust out of the air, new cutting machines that will raise less dust and even the use of remote control mining devices to keep the miner out of the dustiest regions of the mine.

Medical surveillance of miners in their working environment should then consist of:

- Preemployment physical examinations, chest X-rays, and pulmonary function tests (see Figures 8 and 9);

- Periodical chest X-rays with special attention paid to miners with complicated pneumoconiosis (progressive massive fibrosis) and to young miners who develop pneumoconiosis rapidly:

- Gravimetric sampling of respirable dust;

- Research into new methods of dust control and into the physiological factors which predispose some workers to the retention of dust in their lungs.

(These can be adapted to conform with the hazards associated with other industries.)

Home and Community

In our concern about dust levels and chest X-rays, it is easy to overlook the worker as an individual. We must bear in mind that he is subject to physical and psychological stress not only at work but also at home and in the community. Furthermore, his inherited personality traits to which are added his life ex-

Category	Round or Irregular Profusion
0	Small opacities are absent or less profuse than in Category 1
1	Small opacities are definitely present but are relatively few in number
2	Small opacities are numerous, but normal lung markings are still visible
3	Small opacities are very numerous, and lung markings are partly or totally obscurred.

Figure 4 summarizes the diagnostic categories of lung X-rays. (Adapted from "UICC [International Union Against Cancer] Cincinnati Classification of the Radiographic Appearances of Pneumoconioses." *Chest*, American College of Chest Physicians, 112 E. Chestnut St., Chicago 60611.

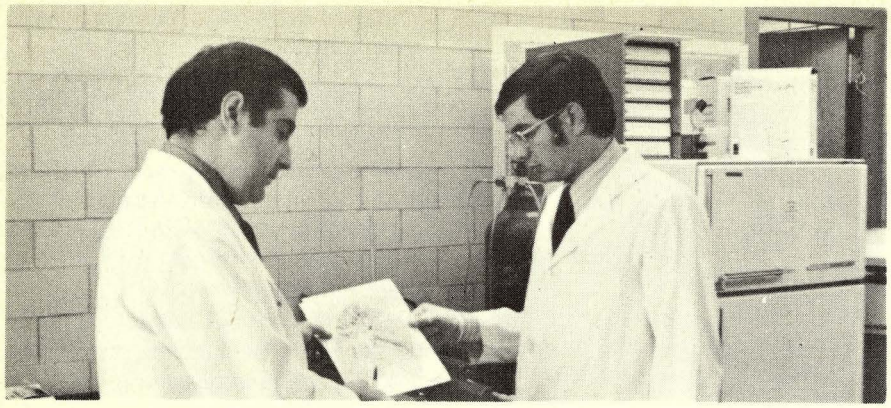


Figure 5 shows Dr. Eugene Cassidy, chief of ALFORD pathology, and Dr. Robert Walat, pathologist, inspecting a Gough section of a diseased lung.

periences determine his ability to adapt in the highly complex world in which he finds himself. Medical disease entities, such as occupational diseases, make their appearance only when the physiological and psychological equilibria are sufficiently disturbed.

The family and community help to form the worker's adaptive potential, but when he leaves the security of this environment for a factory or a mine, he enters a psychological and physical environment that is quite different and threatening. It is a man-made, highly artificial environment with a wide variety of potentially hostile and biologically unfamiliar exposures. These may include chemical irritants, air contaminants, thermal stress, noise, radiation, mechanical vibration, and unusual infective agents. He may also be assigned to the night shift or to rotating shifts, which make it even more difficult for him to adapt to his work environment. These factors in turn affect his ability to interact with his family and community and his ability to make the physiological, psychological, and social adaptations that are necessary to maintain the emotional stability to be a productive member of society.

The worker's emotional state is a very important determinant of his susceptibility to accidents in his working environment. Automation and the modern industrial milieu tend to favor the flexible worker who can be readily shifted from one job to another. This places an additional strain on the individual who is more of a craftsman or who enjoys the security of working at the same job for many years.

It is difficult for most of us to realize that there are many people in the world whose jobs provide very little satisfaction. Dr. R. F. Tredgold has recently summarized the reactions of workers whose jobs entail "soul-destroying frustration or everlasting boredom" with no challenge, no purpose, and no sense of achievement.

Certain reaction patterns are common:

- Increasing anger against the "establishment;"
- Chronic disgruntlement and grumbling, which may flare up into active antagonism or violent speech;
- Preoccupation with pay, especially as compared with that of others;
- A gradual withdrawal into boredom and irresponsibility with apathy and depression;
- Redirection of energies into some other field where impulses can be creative or even destructive.

Any of these reaction patterns may provide some measure of satisfaction and then gradually be adopted as habitual pattern of behavior. It is not hard to imagine how disruptive and hazardous these behavior patterns can become in an industrial setting—particularly, if we do not recognize them as symptoms of job dissatisfaction.

In a factory, each worker is, in a sense, a member of a team engaged in a cooperative production.

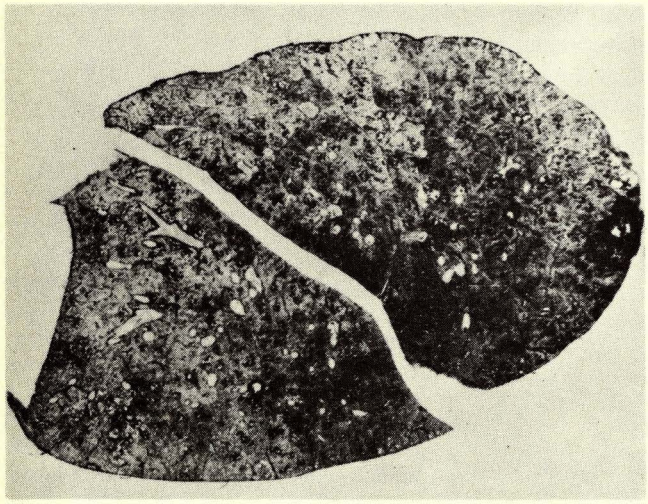


Figure 6 shows a Gough section of a human lung containing coal dust.

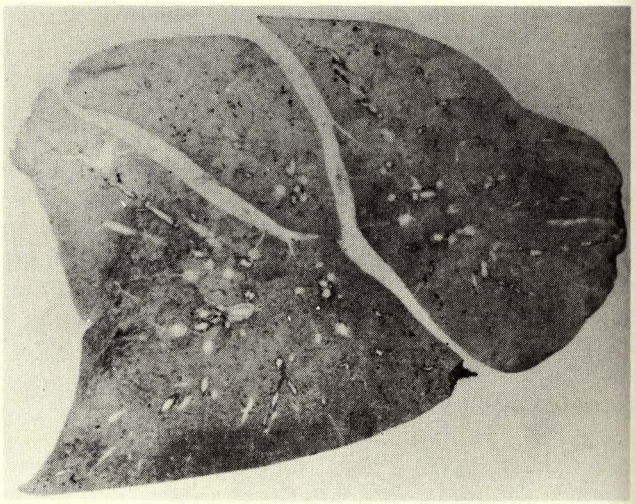


Figure 7 shows a Gough section of a normal human lung. The difference is obvious.

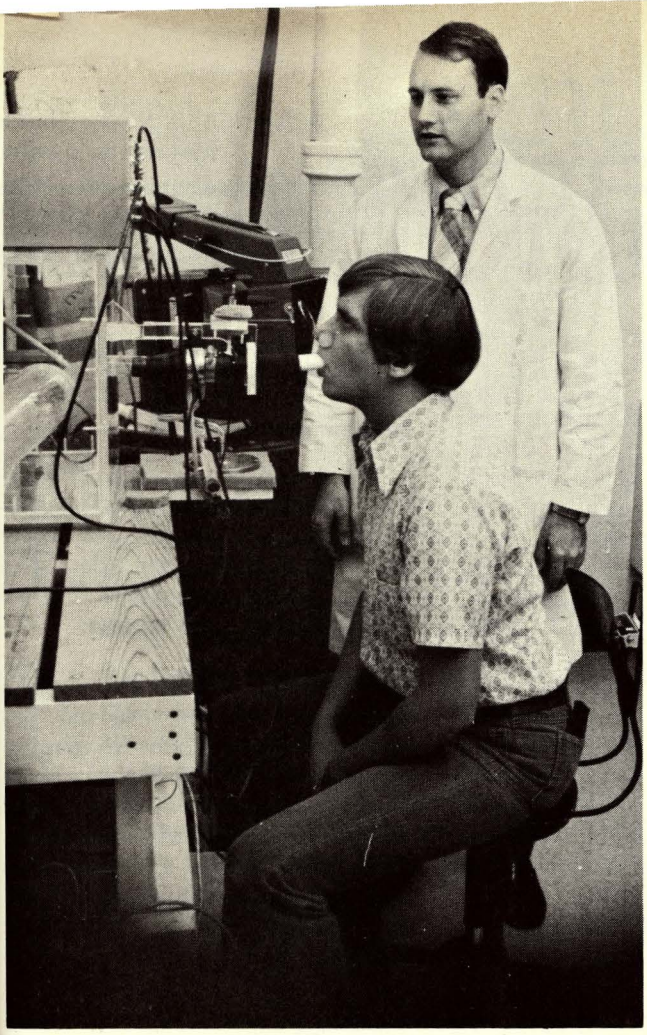


Figure 8 shows an oscillator being used to measure a subject's air-way resistance.

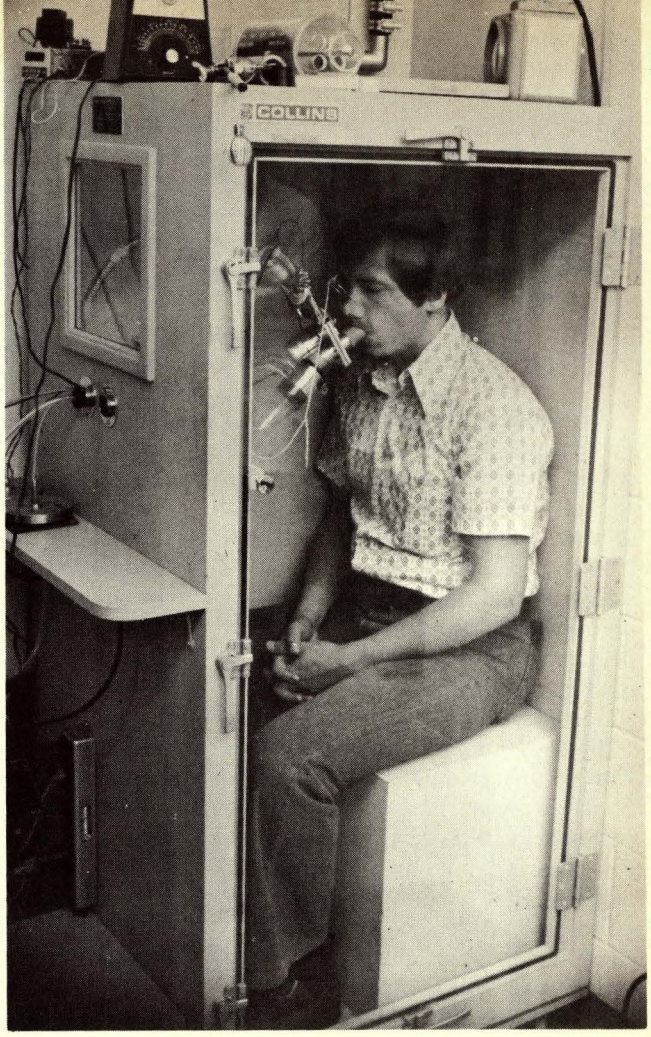


Figure 9 shows a *Body Box,* where a plethysmograph measures total lung volume and air-way resistance.

His relations with his coworkers and his supervisors acquire a peculiar importance. The mere act of living and working in an industrial society carries with it a way of life, which constitutes a challenge to man's biological capacities for meaningful adaptation. Considering the psychological and physical stresses on the industrial worker, it is not surprising that some of them become depressed, emotionally unstable, and maladjusted and, therefore, present serious morale and safety problems in the plant. When a worker develops a poor attendance record, begins to do substandard work, becomes absent-minded and therefore accident prone, or uses alcohol to control his anxiety (and to impair his judgment), this means that medical surveillance is inadequate and probably focused only on his working environment. Teamwork among medical, administrative, and safety personnel, as well as community social workers and psychologists, and the worker's family is necessary to extend the scope of the medical surveillance of a respiratory protection program beyond the worker's immediate medical problems and his industrial environment.

The current emphasis on prevention in industrial medicine is encouraging, but it must extend beyond the factory environment and into the family and community if we are going to help the industrial worker maintain his well-being in his very complex and sometimes hostile environment.—**End.**

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