The Complementary Approach to Environmental Health

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THE PATTERN of growth and the subdivision of man's activities tend to follow his urgent interests rather than conform to a strictly logical scheme. The term "environmental health" is used to cover those public health problems that arise from the impact of environmental conditions as distinct from those that arise by association with others and are subsumed under the term "community health."

Within the activities described as environmental health, subdivision is again pragmatic rather than logical. Air pollution, water pollution, and food protection are short if somewhat inexact names given to three programs in environmental health that deal with major and easily visualized segments of man's environment. Radiological health by contrast pursues the special environmental factor of ionizing radiation in whatever part of the environment (air, water, food) that is relevant and so cuts across them all. Environmental engineering starts with a technology and applies it to problems of environmental control, again in any appropriate segment of the environment. Occupational health makes yet another approach by directing its attention to a particular group of people, the gainfully employed, and the environmental conditions associated with their employment.

Illogical though this structure may be, it provides something that a linear subdivision would lack—the opportunity to look at the impact of environment from two points of view. First is that of specific environmental factors acting on a wide variety of people and, second, that of individuals exposed to a wide variety of environmental factors. The cross check, an essential part of any accounting system, is provided by those activities which cut across the three categorical programs (air, water, food).

Of these cross checks, the most extensive and potentially the most valuable is that provided by occupational health. The gainfully employed, or any stipulated group of them, provide a defined cohort of persons whose health and productive activity can be followed through time. In many instances the hazards to which these individuals are exposed at work are simply special cases of those which may affect people in ordinary life, but the intensities are often greater. In the case of new products, such hazards may affect workers earlier than the population at large.

These differences in intensity and time help considerably in projecting the probable effects of the lesser contamination of the general atmosphere. The circumscribed and repetitious nature of the work environment permits it to be studied more intensively and more accurately than the wider world, so that a firm base can be laid from which the problems of the general environment can be approached more confidently.

The Changing Face of Industry

Occupational health was born in the early years of this century as public conscience took note of the heavy mortality associated with cer-

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tain occupations. The causes of these dramatic episodes were discovered and appropriate preventive measures devised. Human imperfections still permit similar outbreaks and vigilance is still necessary, but these dramatic occurrences no longer dominate our concern. However, man's discontent drives him on to new chemical adventures and new potential hazards as fast as his past errors are corrected.

A conservative estimate puts at 500 the number of new substances introduced into industrial use each year, of which an important fraction is likely to have toxic properties. Fortunately, our increasing chemical and toxicological knowledge enables us to forecast the probable action of many of these, and screening procedures built up over the years pick out many more that might in the less sophisticated past have escaped to affect the worker or population. But some get through, and unexpected intoxications occur. New products call for new processes, and while the end product may be innocuous, some of the intermediaries may be far from harmless.

As a rule, a number of individuals must be affected before an occupational origin is suspected, especially if the affection is slow in developing. We are now beginning to realize that certain people are hypersusceptible to specific agents and to develop tests for recognizing these persons before they get a critical exposure. Those who are recognized can avoid exposure; those who escape detection at least serve as an early warning system for the rest.

Physical hazards are equally important with chemical hazards. To the well-known noise of jet engines must be added the continued hiss of compressed air valves, the clatter of falling metal scrap, and the multitudinous noises of any machine shop. Intense radiant heat is a marked feature of aluminum plants, steel mills, and the like, although methods of personnel protection are being increasingly used. Introduction of the laser and the plasma torch have brought with them a range of hazards as yet only partially appreciated. In addition to the risk of direct contact, the power of reflected radiation and, in the case of the torch, X-ray and ultraviolet emanations may be formidable.

But perhaps the greatest change is in the psychological environment of the work place, a change which is far from simple. In the first place, we are in midcourse of the movement started early in the century for the general psychological and social improvement of the work place. Cleanliness, illumination, neatness, attractive toilet facilities, eating places, social clubs, and recreation facilities are common although by no means universal.

The years that have witnessed these improvements have also beheld another phenomenon—a progressive increase in the demand level, or a decrease in the tolerance level for poor conditions. Lest this be used as an argument against misplaced charity, it should be realized that this increase in demand level seems to be true for the population as a whole, perhaps as a byproduct of the affluent society. People will not put up with conditions today that were taken for granted 20 years ago, as witness the current insistence on air conditioning.

Many of these improvements have ceased to be a stimulus to productivity; rather, their absence is now a marked detriment to productivity. This shift in attitude toward the amenities as an entitlement instead of an extra may call for a realistic reevaluation of some industrial welfare programs.

The tremendous strides that have been made in the acquisition, transmission, and presentation of data over the last quarter century have brought about a serious psychological crisis, nonetheless important for directly affecting only a few at present. The amount of detailed information that can be and often is delivered to any one individual is quite beyond his absorptive capacity. If he attempts the impossible, he is subject to severe stress, both from the primary confusion and from a sense of failure. If he confines himself to the possible and selects certain data from the morass, he may well be haunted by the fear of omitting important or even crucial information. If really critical decisions hang on his evaluation of the data, such as diverting planes from a collision course or preventing the mixture of incompatible chemicals, he may well lie awake at night with his doubts.

Allied with this situation is the problem of maintained vigilance. How can the dial watcher gaze at instruments presenting nonsignificant information for indefinite periods of

time and still maintain the alertness (*a*) to recognize a significant situation when it occurs and (*b*) to take appropriate and immediate precise action? And what is the effect on his vigilance of temperature, noise, and lighting conditions?

To all of this must be added the changing type of employment required in modern industry. The much discussed automation is simply the latest step in a change that began with the industrial revolution. The demand for unskilled labor is steadily diminishing, and even the semiskilled worker is under some threat. It is not so much that machines displace people as that they call for different people. The distinction, however, is academic for those who are in danger of losing their jobs. A deep-seated uneasiness must prevail in their ranks, only partly relieved by the possibilities of retraining.

The presence of a persistent uneasiness in even a small segment of a work force must have repercussions on the rest, affecting both efficiency and general welfare. Aging, with its inevitable decline in efficiency, must intensify the specter for some of these, although it provides an ultimate grim statistical relief.

Research and Investigation

Like many industries, occupational health has developed a duality which creates some problems of internal organization but which is essential to its role. On the one hand there are the research and investigatory functions which seek to capture and systematize existing knowledge, develop new knowledge of their own, solve type problems, and provide special nonrepetitive services to public agencies. On the other hand there are the programmatic functions which seek to develop models and examples of monitoring, preventive, and remedial activities by State, local, and industrial organizations and to provide the statistical background necessary to the discharge of those functions.

Training and grants activities have affiliations with both main divisions, but perhaps more with the former. Here we will consider only those research and investigatory activities that have grown up in response to recognized occupational health problems before passing on to problems extending to wider segments of the communal environment.

Toxicology is one of the three classic bases of investigation in this field. Starting from a natural desire to know the toxicity of various substances to which man may be exposed, toxicologists discovered the great complexity of the apparently simple question and now consider not only the effect of a large number of circumstantial variables in both environment and man upon toxicity but also the detailed mechanisms of tissue response, defense, and repair that follow exposure. Extensive animal experiments, the epidemiology of human exposure, pharmacodynamic inquiry, genetic studies of hypersusceptibility, and vital microscopy are part of the toxicologist's armamentarium. Tentative standards have emerged, but much more needs to be known before they can be made really satisfactory.

Occupational medicine has from the beginning supplied the essential clinical interest and approach, although it tends to be fragmented. The interest in trauma passes to one group, that in pneumoconioses to another, that in dermatology to a third, and so on, with only relatively sporadic concern for the systemic intoxications, skeletomuscular dysfunctions, and neuroendocrine disturbances.

The physicians who see occupational cases as part of a more general practice, the specialists in occupational medicine, and those who are primarily concerned with preventive medicine in an occupational setting need to get closer together. This closer intercourse is necessary not only for the interchange and integration of medical information but also for contact with the related medical sciences. These sciences have information and ideas to impart but they also need guidance and constructive criticism from the clinicians.

Engineering is the third leg on which occupational health traditionally stands. Measurement of the physical factors in environment (particulates, air movement, heat, noise, illumination), engineering controls (ventilation, sound absorption, filtration), and the whole range of industrial hygiene services are traditionally grouped together for mutual interaction and support.

Technical breakthroughs, such as the plasma torch, the laser, use of ionizing radiation, and ultrasonics, have greatly extended the range of responsibilities for this group and at the same

time have markedly increased the scope of instrumentation. Old problems, such as measurement of atmospheric particulates, are getting an entirely new examination in the light of modern knowledge and technology.

With the increased complexity of both problems and knowledge, new specialties have grown out of or been added to the classic trio. Analytical methods have become so complex and expensive that separate specialist provision has become necessary. The mass spectrograph and gas chromatograph now yield in glamor to nuclear magnetic resonance and neutron activation analysis; the electron microscope reaches for a resolution of a few Angstroms; and the analyst finds himself with the vital microscopist in problems of molecular biology.

Physiology brings specialist studies different from those familiar to most clinicians, and under the umbrella of psychology come at least two other types of highly specialized inquiry—responses of the special senses to specific environmental stimuli (sound, light) and behavioral responses to the whole gamut of environmental situations. Inevitably, other specialties appear in intermediate positions between the older recognized disciplines, of which neuroendocrinology is perhaps the best example, partaking as it does of physiology, medicine, and biochemistry.

The result of this multiplication would be chaos but for two things: First, the developments are still attached to a central concept, occupational health; second, the common goal has necessitated still another development but this time one with cohesive and centripetal properties. This last development, sometimes referred to as ecology, is simply a conscious continuing process of comparing the information from various lines of investigation, seeking the interconnections, searching again for the missing pieces, and generally trying to see the worker not as a man exposed to a particular chemical but as a total man in a total environment.

The Wider Aspect

The phrase "total environment" is relative. In a narrow concept of occupational health it would begin each day when the man arrived at work and end when he left. But a little consideration shows the futility of such a limitation. The man at work is not an isolate. He is still angry with the neighbor who let his dog tear up the new bushes or worried about that big bill that is 4 months overdue. He has the cold the kids brought home from school and then there was that late party last night! The deafness he is inclined to attribute to his job may really be brought on by helping his neighbors with a power saw or his dizziness by an unidentified medicine supplied by a well-meaning aunt. We must concern ourselves with the other three-fifths of the employee's life even when our interest is strictly one of occupational health.

From this point it is easy to move into the nonworking environment as far as necessary to provide a cross section of the more general environmental effect, and thus make the cross linkage that separate considerations of air, water, and food would lack. Some examples of current studies in occupational health illustrate the opportunity.

Coal miners' chest diseases. The focus of this major study is naturally the miner, but the miner lives in the Appalachian hills, exposed for the major part of his life to their atmosphere with its own pollutants. He is liable to whatever respiratory infections strike the area and subject to economic fluctuations which may, at times, affect his nutrition. He is intimately affected by any economic and social stresses of the region and at least partially circumscribed by the customs, hygiene, and mores of the community.

For the disentanglement of these interactive factors one must make parallel studies of nonminers, miners' wives, men who have left mining for other employment in the area after various periods, and miners in regions with quite different surroundings from those typical of the Appalachian area. The investigations themselves cannot begin and end with the physical state of the examinee. A detailed occupational and clinical history is essential, but one must go further and take note of the social situations under which the individual lives and seek possible correlations between these and the incidence or progress of the disease. In short, what started as a study of miners becomes essentially a community study involving general

atmospheric quality and perhaps even that of food. And yet the objective is still the elucidation of coal miners' chest diseases!

Industrial chemicals. Let us take some actual incidents but attach them to a single hypothetical compound, *X*. Small amounts of *X*, prepared in the laboratory, were found under controlled field conditions to be much more effective than its simpler predecessor *Y*. The manufacturing processes were modified. Several complex side products developed, but the yield of *X* was good, so further refinements were not sought.

A couple of years later it was found that a large proportion of the employees in that particular part of the plant were developing severe skin lesions. Further investigation showed that some of the men with skin lesions also had signs of more marked biochemical disturbance, some of it potentially fatal. The end product seemed safe enough but apparently some of the intermediates or byproducts were not. A full-scale toxicological investigation was obviously necessary. The possibility of synergism with other exposures outside as well as inside the plant had to be considered; the possibility of escape of the responsible agent to the outside community came up; and operations research had to decide whether to discontinue operations, change the process, enclose or automate the operation, or rely on protective devices for the worker.

Questions far beyond the laboratory were involved. Had the material been a pesticide the further question might have arisen as to whether some of the toxic side products might not be liberated by weathering in the field. In that case we would have to confess that little study has been made of the effects of crop microclimates on the persistence and effective transmission to man of even the better known pesticides. Once more we are verging on general atmospheric problems where we will undoubtedly cut across studies of air pollution as such.

Noise. The relationship of industrial noise to loss of hearing has long been under investigation. The broad features have been established but there is much that is uncertain, such as the significance of high-intensity peaks in a white (broad band) noise exposure of lower intensity and the relationship of temporary hearing loss to the permanent loss that would ensue with continued exposure. But without waiting for the resolution of these unknowns, industry is already concerned with less dramatic but more widespread phenomena, such as loss of attention or work efficiency in noise not sufficient to produce deafness. From here it is a small step to the distractive or "nuisance" effects of noise and their possible relationship to productivity.

It is similarly a gentle series of steps from the airport maintenance crew exposed to jet noise to the terminal employees, to the traveling public, and to the community around a large airport. The problems differ only in degree. The methods of measurement and interpretation largely overlap and skilled investigators are few. If only for the sake of conserving resources, any separation of investigations seems unwarranted.

Conclusion

Occupational health is a much needed field of activity in its own right. In order to discharge its responsibility for determining and controlling undesirable features in the work environment it needs a wide spectrum of capabilities and resources to pursue many different types of investigation. For the proper evaluation of its findings it needs to probe the environments of employees beyond their actual work places. In many respects it will cut across the inquiries pursued by the categorical approaches of air, water, and food pollution. Cross linkage and cross examination are necessary. They need to be exploited to the advantage of environmental science in general.