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EDITORIAL BOARD

CHANGING CONCEPTS OF OCCUPATIONAL HEALTH *

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I am proud of the honour and privilege that you have bestowed on me in asking me to deliver the 'Sir Ardeshir Dalal Memorial Lecture'. Like every privilege, it is inseparable from an equivalent responsibility. I am keenly aware of the obligation to contribute some worthwhile ideas, in keeping with Mr. Dalal's high ideals, progressive thinking and insatiable desire for service. I know you join me in expressing our gratitude and respect to the great Sir Ardeshir Dalal, whose name you have considered in this Conference, whose vigour, whose character and devotion to the cause of the country we love so well, have won the respect of our countrymen and enriched our Society. He saw beyond the immediate present and was deeply concerned with progress.

We cannot afford to be oblivious of the fact that every year there is a net addition of 1.8 million to 2 million persons to the working force in the country on account of the continuous increase in population. In a speech our Prime Minister said:—

"........We do not want distribution of poverty in India. Poverty is never socialism......You have to produce much more. Therefore you must have a productive apparatus. All the laws passed by Parliament......do not produce a productive apparatus." (Reported by Economic Review).

When I talk of occupational health, I do not just mean expanding a wing of social security programme. There is far more in my concept of occupational health than health insurance and I do not mean what has been called "Socialised medicine" either. My concept goes beyond simple health. It tackles the problem of productivity also.

I start with a fundamental axiom that science and industry, by combining their efforts, can accomplish great and good things for the benefit of mankind.

Industry can justly be proud of its medical service and the health insurance service for which it pays large sums of money, but it cannot sit back and rest on its laurels. Much remains to be attained. It has been estimated that the employer pays four

*Sir Ardeshir Dalal Memorial Lecture, delivered at the 9th All-India Conference of Industrial Medicine held under the auspices of the Society for the study of Industrial Medicine, India, on 14th Feb. 1958 at Madras.

times as much in hidden costs for an industrial accident as the employees' health insurance authorities pay in settling the claim. Interruption of production, machinery damage and training of replacement workers are costly items. These hidden costs are also present when an employee is absent because of illness. Three-fourths of the absences, dependable sources say, are due to common and often preventable illnesses. The question before us, it seems to me, is how to carry out occupational health maintenance programmes one step further to reduce these losses. The answer lies in considering some of the "Changing Concepts of Industrial Health." These concepts visualise care for the total physical, mental and social well-being of the worker both on the job and in the community.

It is not idealistic, therefore, for industrial health to expand its activities into the ever expanding realm of industrial relations in a Neo-technic Machine Age. Already, technological advancements are far ahead of industrial health procedure. The new age, with a definite physical and social complex, has not yet secured an adequate foundation for its humane technology. We, in India, do not have either the necessary social institutions or the explicit social purposes necessary for accepting the gains in such technics. Our minds and the habits we have carried over from the 200 years of slavery are obstacles in the way of our developing the new thought. These technologies need newer qualities of the worker—qualities of alertness, responsiveness and an intelligent grasp of the operative part.

The new technics call to their aid the biological and psychological sciences, the studies of working efficiency and fatigue, the prevention of disease, and the substitution of hygiene for belated repair. The living organism needs a balanced and life enhancing environment by establishing life-sustaining conditions. We have till now been using negative measures for health protection in industry. These started with care of the health and moral of children in cotton mills in England. Use of safety devices in dangerous industrial operations such as masks, shields, helmets, respirators, abolition of lead glazes in pottery, substitution of red oxide of phosphorus for match making and elaborate precautions against radium poisoning in the preparation of watch-dials etc., gradually came into it.

The only positive health measure that one can think of is: fostering of life-conserving occupation with discouragement of those forms of industry which decrease the expectation of life. These ideas can come only when we are more concerned with the calculus of life than with that of production. The changing concept of

occupational health is thus an emphasis on prevention rather than on cure, on health rather than on disease, making the psychological side of mind–body–machine–environment process an object of increasing scientific investigation. This "changing concept of occupational health" believes in what Lewis Mumford has said, 'Efficiency must begin with the utilization of the whole man; and efforts to increase mechanical performance and production must cease when the balance of the whole man is threatened".

Emergence of the Science of Occupational Health

An attempt to harness the achievements of science in a process of directed social and economic change is being done today by the so-called "under-developed" countries to raise the standard of living. We in this country have set our ideals very high. We are attempting within a matter of decades to transfer and absorb knowledge that has been acquired over a period of centuries in the technologically advanced countries. We are trying to force the pace of history and hence the staggering size of our problems. While some of these problems are financial and physical in outlook, the majority of the problems are social, cultural and psychological. The process of economic and social change is fraught with obstacles of great magnitude and must be overcome to achieve our objectives. Government channels are labyrinthine and much time and energy are wasted in procrastination over files and administrative delays.

Within science itself a process of unification is going on that might have seemed difficult a few decades ago between pure and applied science, between physics and chemistry on the one hand and biology on the other. Consequences of far-reaching importance have resulted from the cross fertilization of the different branches of science.

During the last 3 decades, due to efforts of specialists in many fields, like medicine, biochemistry, biophysics, climatology, toxicology, environmental engineering, psychology, psychiatry, medico-social work, anthropology, human engineering and human relations, health insurance, business and governmental administration, a new field of science has come to be defined as occupational health. Although differences in the parent fields are extensive, the realisation is growing that all are concerned with the same general problems, physical, mental and social health of all types of workers and that workers in each field must know and be prepared to use these methods and results.

The speed with which this new science of occupational health can develop will depend almost entirely upon the length of time that will take for traditional barriers between these subjects to be broken down. This will depend in turn upon the ability of the workers concerned to accept and to practise the basic rule of scientific procedure—that specific methods and principles must be devised and followed in the solution of each concrete problem. All principles in various sciences have been discovered through the pursuit of the practical requirements of living. Engineering, medicine and the theoretical sciences of physics, chemistry and biology arose through practice. The science of human relations made its advance in the course of application particularly in administration, psychiatry and social work as is seen in the experiments by the Western Electric Company. In each case, however, the specialist was hampered by the fact that he was dealing with a limited range of the total phenomena. Only where industrial health and industrial hygiene developed as an applied science a synthesis became possible, for occupational health alone provides a common meeting ground for all the different subjects which have in the past dealt with industrial health. Occupational health as a learned discipline is as old as Ramazzini (1633-1714 A.D.). During the greater part of the last 300 years it has served as a place in which to put odds and ends of information which could not be pigeonholed elsewhere. It has also served as a source of interesting information about "occupational diseases." Even though this attitude was generally held, occupational health had the advantage over other disciplines on a point of view which is comparative both in time and in space. The range of complexity in health problems provided by such beings as a cave man and the space dog Laika in Sputnik No. II at one extreme and the miners in the deepest gold mines of the world (Kolar Gold Fields) and the members of the Himalayan expedition team on the other, make an objective evaluation of the phenomena of health necessary.

Occupational health is a general science of human happiness; all peoples are included in its view as part of its subject matter. It is a science in which the variables are the properties of human beings. The various elements of their industrial environment are the measures to be applied to the relations between these variables as "units of happiness".

Occupational health is a subject which is capable of being studied by the methods of the natural sciences, like physics, chemistry and biology; social sciences like psychology, anthropology and sociology; and applied sciences like medicine and engineering etc.

I could have made a choice between concentrating on certain of the areas of traditional study (like industrial hygiene, occupational diseases, workers morale, health versus productivity etc.),

looking at man as a whole or on those aspects of man which are defined as occupational health aspects. One purpose of any science is to obtain generalisations which will provide a basis for modifying the old or building the new. The extension of the interests of the traditional occupational health specialist into the field of modern industrial society does not, however, help to define the field of occupational health. In science, a field of study is one which possesses a specific characteristic known as functional dependence. Unless functional dependence is exhibited by the subject matter, scientific methods cannot be applied. When the value of one variable changes uniformly with changes in another (x varies as a function of y), functional dependence is said to exist in such a relationship. The science of occupational health aims to discover such relationship and work out the precise nature of the functional dependence and describe the functional relations between variables. Now where can we find such a field which possesses this property? This field is in industry and is better defined as industrial relations or human relations in industry. A change takes place in one relation of a person and changes follow in his other relations. A man gets his hand cut off in a sawing machine and unemployment, starvation, frustration and misery come to the family.

Now, before we investigate the functional dependence, we must devise objective methods of measuring the phenomena. These methods are known as *operations*. We must furthermore measure only those variables which vary significantly *i.e.* exhibit functional dependence. Occupational health field exhibits the characteristics of functional dependence and can be studied by the operational method. These methods in the main belong to the physiological laboratories since occupational health problems are the result of the interaction of the physiological properties of the human organism with his industrial environment.

New fields of Occupational Health Activities

It is not idealistic to expand occupational health activities into the realm of human relations. Also in our eagerness for more and better production we must not permit technological advancements to out-distance industrial health procedures.

Take for example the subject of relationship of man to machines, a subject we have totally neglected in this country. In 1947 Taylor and Boeltor introduced the idea of bio-technology implying a meeting of minds of biologist and engineer. They pointed out 3 facts: (1) man and machine are becoming increasingly interdependent; (2) man's environment is becoming increasingly artificial, as opposed to natural; (3) the engineer himself must become increasingly aware of human (bio-social) value. Most of you have heard of the word "human engineering". Herein we find a synthesis between the "measurers of men" (the physiologist, the psychologist and the physical anthropologist) and "measurers of machine" (the engineer). For man and machine to become a working unit, it is essential that the measurements that the two carry out must be pooled and integrated. Then alone the two important factors of the working unit can be brought under control, the health, comfort and safety of the operator; the efficiency of the total mechanical operation. This man-machine duality ultimately centres on one theme: efficiency, which is the same thing as comfort, versus strain.

The biological aspect of this problem needs a physical anthropologist or human biologist, a physiologist and psychologist to measure body size, proportion, build, strength, agility, neuromuscular co-ordination, adaptive response, torque at various measured increments of a total angle or linear distance through which an arm, leg or other parts of the body can travel (range of movements, its position, type, direction and degree, eyelevel, visual range) etc.

The technical aspect of the problem would need an engineer to measure the spatial range within which the machine set up is a functional unit; measurements of the total machine and its parts, or the design of levers, control gauges with reference to the movement dynamics of the operator.

Since 1949 I have been privileged to travel widely in India and elsewhere studying machines, processes and conditions of work, and I can with frankness say that a large number of machines are unsuited and even incorrect for the body measurements of a large number of our workers with substandard health conditions.

Another type of study, important to the aircraft and automotive industry, is the study of human skeleton, when subject to the vicissitudes of mechanisation, when either man or machine fails. Studies of the skull, the pelvis and the thighbones to determine the amount of stress (force, tensile, compressive or shearing) that bones may stand up to reach the breaking point, or study of the biomechanics of the bones. For this we need an anatomist and a physical anthropologist. The object of the above two kinds of studies is to produce a machine-man continuum and understand the principles of safety as basic human engineering. The Harvard School of Public Health has done a large volume of work on this subject.

Likewise, in the cycle of human dynamics industry stands much to gain by drawing on the talents of the preventive psychiatrist, because man primarily is an emotional rather than a reasonable creature and he emotionally accepts ideas to act on them. A very large number of situations are created everyday in industry and in the behaviour of a worker a multiplicity of patterns are generated which a trained psychiatrist alone can deal.

Proceeding further—the work of a toxicological research laboratory is extremely important in the occupational health field. The information from such laboratories is directed to three main uses: preventive, engineering, product development and the doctor's clinic to help him understand the signs and symptoms when workers are exposed to various atmospheric concentrations of toxic chemicals.

Speeding up of Industrialisation

The national industrial policy as defined in 1956 in the second Five-Year Plan stresses speeding up of industrialisation. This is having far-reaching influences on physical planning. Take only one aspect of this subject the effect of location of industry on problems of health. We see that any expansion of consumer (small-scale) industries in an existing town induces a sprawl into adjacent residential areas with disastrous consequences. Such a condition was reported by the "Statesman" of Calcutta with illustrations of these industries in Howrah which were said to be housed in improvised garages and stables with precarious extensions.

The growth of population workers in Calcutta industrial area as reported in the census report is an eye-opener. This population increased from 15,01,374 to 46,27,920 (over 3 times) from 1901 to 1951. This has made Calcutta Industrial District a slum, because of problems of inadequate space, light, ventilation, public health problems, and problems of general well-being of the workers. Here again we see the same functional dependence of health on planning for growth of industries. As regards the problem of workers' housing we have not yet set any biological and social criteria for housing like standards for sanitation and disease prevention.

If living standards and productivity continue to rise and if leisure continues to make consumptive activities, and population goes on increasing as fast as during the last decade, our one single problem of housing and food will overshadow all other national problems.

The Science of Health Physics

The science of health physics is not a basic discipline, such as biology, mathematics, physics or chemistry. In health physics we find extracts of those aspects of the basic disciplines that may be necessary to synthesise to fit into the area of industrial hygiene engineering. Thus the operational philosophy of radiation safety is the same as that of industrial hygiene.

Atomic energy is exerting considerable influence on existing branches of chemical industries. Moreover, a new branch of chemistry is emerging, namely radio-chemistry. Radio-chemical processes are being used on an industrial scale. Nuclear reactors and fission products are being used by chemical industries. High tension electrical equipment is producing radiation for the treatment of matter.

The use of atom in the field of industrial chemistry is tending to become very extensive.

In the words of Mr. David A. Morse, Director General of the International Labour Office, "Experience so far suggests that the time lag between discovery and application has been compressed far beyond expectation and that a potent accelerating force is the rapidly rising demands for additional sources of energy all over the world—demands which aside from everything else are being steadily increased by the progress of automation." As atomic energy is increasingly widely used and many more 'APSARAS' are born, the problems of protection of the health and safety of the workers and their descendants against the harmful effects of radiation are becoming an increasingly important task. The Atomic Energy Commission will have to start proper courses for health physicists for training of physicians.

The importance of the Physiology Laboratory

Pulmonary physiology in comparison to any other medical specialty is unique in having a theoretical and a clinical field with a sharp division. The literature on pulmonary physiology is now very formidable. To the clinician these papers on detailed techniques are apt to look complicated. But as a subject of great clinical importance pulmonary physiology finds the greatest use in the field of occupational health and in thoracic surgery. All patients undergoing such surgery have invariably a series of tests of pulmonary function carried out. This has led to development of simple methods of clinical assessment.

It is amazing that during the past 5 years there has been a great expansion of the clinical application of pulmonary function tests, in treatment of chronic lung abnormalities such as emphysema, industrial pulmonary fibrosis, in the diagnosis of functional disabilities from a given pulmonary lesion. A competent clinician is expected to know enough about the more complex functional tests to

make use of the information that they provide. The teaching of chest diseases has several facets and all these are of great importance if total patient care is to be our aim. The physiological tests contribute to the broader outlook on disease.

Occupational Health Problems in U. S. A.

I have had an occasion to study very carefully the problems of industrial hygiene at more than two dozen different kinds of institutions in 8 different States in U.S.A. and gain valuable information on the application of advanced techniques and methods for research and investigations in the field of industrial hygiene and occupational medicine. These may be summarised as follows:—

1. The health and care of the industrial population are axiomatic. The interest is created in the training of the general practitioner.

2. It is the medical school to which falls the responsibility to prepare this physician, who as a part of his general medical background is made to understand and integrate the environmental factors with occupational pursuits.

3. Industrial medicine has been designated a specialty within the science of medicine, with one big outstanding object that in this specialty the industrial physician will deal with man as a whole, his environment, his social relationships, his recreation, and the inter-relation of all factors influencing his health and productivity.

4. At many of the universities special departments have been started for research in industrial diseases and their help is available in a consultant capacity to the factories.

5. A large body of medical laboratory technicians auxiliary to the medical profession are being trained. These jobs appeal to entrants who have been interested in scientific subjects at school or college. The training of medical laboratory technicians is very much neglected in India and steps should be taken to build up an Institute of Medical Technology for training of such personnel.

6. All medical colleges and teaching hospitals have research departments. This is considered necessary for good medical education.

7. A great stress is laid on the development of hundreds of research fellowship programmes in the field of occupational diseases.

8. Most of the scientific instruments are developed in these research institutes and so also methods and practices of work.

9. Great use is made of modern developments in the field of electronics, sound, radio-isotopes, and newer chemicals for advancement of research in industrial medicine.

10. Stress is laid on building up of comprehensive medical libraries for use of research workers, where large amount of documented data are available that would help further knowledge in the field of research.

11. A large body of experts exists to provide expert advice to intending research workers on planning their projects, on the most appropriate methods of collection and sorting of data and analysis of results.

Occupational Health Education and Research

Scientific men in medicine, *i.e.* men in medical research, medical education and medical practice, are feeling the need of a radical change in methods of providing, distributing, and paying for medical care.

To a public naturally enough preoccupied with the highly personal problems of getting and paying for medical care, leaders in medical science have tried to convey the truth that the only real "insurance" consists in ensuring that physicians, dentists, nurses, industrial health engineers, public health and other health personnel are adequately *trained* and are competent to provide modern up-to-date health services to individual patients and the community. Mere financing of medical service will not guarantee this. The real point that is involved must be adequate *support of education and research* in medicine as a life science involving the whole field of biology and the contributions, in theory as well as in instrumentation, of chemistry, physics and mathematics. This should be the main principle of our national policy or of public sentiment. It is true that somewhat under the impact of independence there has been a marked rise in the kind of abstract appreciation on the need of basic research on the part of the government, and very little on the part of the public and the universities, but not the extent of convincing the national spirit to realise its stated aims.

Professor Einstein has said, "All history of science shows that it is not through organisation and planning that the great advances were achieved; the mind of some individual must get the spark and finally, the freedom of work of the individual scholar is the main condition of scientific progress. Organisation is a poor instrument to find out new ways and means."

Traditionally the occupational health specialist is a man of diagnosis and treatment. Heretofore, the average industrial physician has had little concern with research within his field, all this being left to a few centres of occupational health investigations. There are very few places where occupational health research is being carried out and very few attempts are being made to exploit the scientific talent in the country. Also, there is no machinery to process and forward the findings of the little research on occupational health that is being carried out, to the labour, administrative and legislative bodies in the State and the Centre.

The question of occupational health research in India takes an added importance from 3 major points of view:—

(1) To assess both the similarities and differences which may prevail in the same type of industrial situation in India and other countries.

(2) To advance and supplement the available scientific knowledge on the subject taken for a country undergoing rapid changes in its industrial history and policy.

(3) Large funds are available now for research institutions, scientific instruments libraries, training of workers etc., research in the field of labour problems under various Government plans.

(a) *Fundamental Pre-requisites*

Some fundamental pre-requisites for occupational health research in their order appear to be:—

1. Doctors should be Directors of Research Institutes. They should be suitable, experienced and possessed with knowledge of a wide variety of the occupational health problems who could be made responsible largely for the planning of the research projects, their execution under their control, and presentation of research studies.

2. Provision should be made of a "suitable task force" to attack research problems presented on an ad hoc basis in connection with occupational health planning in the country. This function will, for the present, fall on the bodies concerned directly with the subject like the Labour Ministry, the Health Ministry and the Industrial Health Advisory Committee of the Indian Council of Medical Research.

3. Staff for carrying out research projects should be of two types, research workers and research assistants.

4. Facilities should be available to research personnel to carry on their work and to integrate their research findings with the knowledge available in international literature.

5. Provision of expert guidance should be made to workers interested in the same topics. Those who wish to undertake research

should be given expert advice on planning their projects, the most appropriate methods of collection and sorting of data and analysis of results.

6. A large body of medical laboratory technicians should be trained as auxiliary personnel to the medical research worker. These technicians should be trained in the four basic branches of medical science, namely, histology, chemical pathology, (bio-chemistry), bacteriology and haematology.

(b) *The Field of Research*

The field of occupational health research is so broad that no individual is competent to survey it.

A characteristic feature of occupational health research is one of *intention* and not one of method. The intention in occupational health research laboratory is to apply the results of research to advancement of human welfare and happiness. The emphasis should be on short term investigations aimed at the solution of urgent practical problems. When the fundamental knowledge available is already substantial, investigations of this type generally lead to satisfactory solutions of immediate value. This seems to be a lesson of great significance in planning for the future.

To be able to explore this field, a triple process is indicated:

Reorientation,
Reconstruction,
Expansion of Research Programmes.

(c) *Methods of Research*

Most of the studies in industrial health problems have been devoted to observation of field conditions or industrial conditions in factories, mills and workshops. While the *observational* aspect of the studies has gone on meticulously, the research bodies have not as yet taken on the *experimental* aspect of the studies by observing the compatibility of observational fact by deliberately testing their validity in artificial but appropriate circumstances, devised for the purpose. Until recently all industrial health research work has been almost entirely *observational*. It is, however, an admitted fact that when a branch of research is debarred from using the *experimental* method, it is heavily handicapped in its general advance. It is this reason which accounts for the stunted development of the subject of industrial health research in India.

There are practical limitations to the use of investigational or observational method, in part due to its dependence on adequate techniques for the investigation of health problems of workers. If chemical and instrumental methods are not available, the Research Unit lacks badly both on tools and skill. Progress in clinical knowledge of occupational diseases has been very insignificant. Facilities for clinical investigation in hospitals for occupational diseases do not exist. No attention has been paid to plan for promoting work in the clinical field. There has also been no attempt to make liaison with existing clinical research for exploiting the many opportunities which clinical research workers already have.

Clinical research is dependant upon access to patients. With the development of health insurance work in various States with which the State Directors of Health Services are intimately connected, there is presented a special opportunity for clinical research in industrial health.

(d) *Connected Problems*

The above considerations often lead to a number of other connected problems, such as:—

Accommodation,
Apparatus,
Material, and
Shortage of men experienced in research.

It may be very appropriate here to read what observations Prof. J. B. S. Haldane made in his recent visit in India.

"He urged the necessity of carrying on actual field observations with few or no instruments for the development of biological sciences. He deprecated the tendency of scientific cloister for carrying on routine research."

Madame Irene Curie also did not favour the "building first and a research thereafter policy."

It is said that a laboratory develops with a research programme and not *vice versa*.

It is felt that the shortage of men experienced in research is due to:—

(1) No recruitment of fresh personnel.

(2) Scarcity of suitable investigators, trained in the use of experimental method with a sufficiently wide knowledge of the working of the human organism.

(3) Competition of other expanding medical and scientific services from limited man-power available.

(4) Those who control and direct research have no time to engage personally in research.

(e) *Ways of promotion of Occupational Health Research*

(1) Institution of special fellowships for research in industrial health.

—Senior fellowships to men fitted to undertake research.

—Junior fellowships to provide opportunities of training.

(2) An all-India Medical Research Service.

(3) Occupational Health Research Liaison Committee for exchange of scientific information with other countries and bodies. This Liaison Committee can also arrange for the training of Indian graduates in industrial medicine and hygiene.

It will be a link of potential value to strengthen bonds in different countries.

(f) *Industrial Health Research Establishments*

The number of establishments engaged in this kind of work is very few. The I.H.R.A.C. should find out more suitable places for increase in work. It should find more workers. Alternatively, it should invite more foreign scientists to stay to work here as has been done in many other fields of health work.

Another method is to encourage attendance at international industrial health conferences of workers engaged in occupational health research, visit to laboratories and research establishments—the Council providing the necessary expenses.

Yardstick of Social Progress

The problems arising out of rapid urbanisation, which is taking place without accompanying industrialisation to provide employment, are closely tied with the problem of relative economic and social development.

The other side of this problem is that a growing economy requires rewards and incentives in the form of higher living standards, so that workers may feel that they have a stake in producing more. A worker is an economic force—a vital economic resource. His capacity to produce more is influenced by his level of health and education. These two aspects go to enrich human lives.

The machines, the mines and the factories and rising productivity have no other purpose than to provide opportunity for the healthy development and enrichment of human beings. A public policy, when it provides for economic development at a high cost in terms of health and material well-being, is unsound and unjust. Any positive measures for social progress must include,

(*a*) Improvement of health and physical vigour.

(*b*) Improvement of conditions of work and standard of employment.

(*c*) Improvement of level of educational accomplishments.

In a truly humanitarian and democratic society voluntary action is the most vital force for the pursuit and attainment of such measures. Government action financed by State is never a primary factor in social progress. If people make efforts, no State aid is needed for any form of social progress.

Ergonomics or the study of the relation between man and his working environment brings anatomy, physiology and psychology to the service of industry. The use of ergonomic principles can shorten the time needed to carry out tasks, improve the health of workmen, and lessen fatigue, thus reducing the likelihood of accidents. It also increases productivity and shortens training time. Why not such a subject be taught to all medical men?

Occupational Health—Industry's Opportunity and Challenge

The world of occupational health as I have described is not small, and it has a difficult but fascinating sphere. Occupational health measures have not yet been placed on par with other safety measures and are not equally appreciated as aids to production or as a social obligation. Management, too, is often vague as to what it expects of the medical department and by and large, has not yet learned to use the physician optimally. The medical colleges in the country do not meet the future health needs of our nation. There are not enough well trained physicians for industries or departments of occupational health.

It is not too much to ask that health should rank in importance with other major features of the national economy, such as food supply, housing, employment, education and industrial and agricultural production.

We all are to some extent aware of the trends in our population, its composition and related matters; increasing urbanisation with local, regional and ethnic problems; increasing industrialisation and the need for sources of power and river valley projects; all these are challenges to the occupational health administrators to plan to meet their responsibilities.

Knowledge is Strength

"Among any people, disease and disabilities will diminish as knowledge spreads." This is not an ambitious statement; it seems logical enough. Knowledge of the simple rules of physical and mental hygiene certainly offers the strongest protection against disease and the usefulness of education can no longer be seriously questioned today.

The techniques of health education have now-a-days acquired an effectiveness amply confirmed by experience and have become indispensable tools in public health work.

Harnessing Social Sciences to the needs of Industrial Society

A distinctive feature of the industrial scene today is the recognition of the growing importance of the human factor and the increasing interest in the application of social sciences to the needs of industrial society. Though there is some scepticism about their applicability, it is worth realizing the possibilities of this kind of investigation in the selection and training of personnel in industry, in the adjustment of physical working conditions and in analysing the relations between individuals and groups of people. The contribution of social sciences to the understanding of human relations is at present largely potential.

The industrial physician of tomorrow will have to learn to recognise the total social situation in which work people find themselves. Factory is not the only main focus of work. Industry is a complex of interacting groups and individuals. The satisfactions of daily life are largely bounded by the rewards of work. And, so too, the dissatisfactions.

It is said by industrial sociologists that the degree of job satisfaction and worker productivity results from three influences which exist both in and outside the work plant. These are: (1) biological factors, such as, the nature of diet and health; (2) psychological modes of adjustment, such as, withdrawal, compensation and rationalisation; (3) social relations, such as leadership, rivalry, co-operation and isolation. The worker can be fully understood by recognising him as a bio-psycho-social organism. Thus, the basic sciences which are concerned with the understanding of the worker, are industrial physiology and industrial sociology.

Industrial physiology, as a scientific aid to industry, tends to regard the worker's health as a strategic commodity. The worker is looked upon as a machine which must be maintained at peak efficiency. His health is considered vital to his personal happiness, industrial efficiency and economic value.

Industrial psychology is the study of the individual worker and his adjustment to the work.

Industrial sociology is the youngest of the three basic sciences to turn its focus from the worker as an individual to the worker as a group member.

The time has now come when the development of the subjects of industrial medicine, industrial psychology, industrial health in India, should cast off its old skin and emerge out into a newer, mature subject through a metamorphosis of its thought and line of action.

Whiting Williams had, as early as 1925, pointed out "unity of life and labour in that the worker is a social organism and must be viewed as a member of many groups, both inside and outside the work plant."

The meaning of Work and Occupational Health

It is not possible to discuss "Occupational Health" in any satisfactory way without considering the question of "work". This is because in order to understand the problems created by lack of "health" (mental, physical and social well-being), it is essential to explore the needs which work satisfies.

There are four fundamental needs. The pattern of these needs may be very uneven, with the importance of each need varying with experience of the individual. But it is important to remember that these needs are continuous and they play a continuing and important role in the life of the individual. First, there is the need for interpersonal relationship. We all know that even a child's dependence on his parents is for more than the satisfaction of his physical needs. Likewise the need for food and shelter of a worker is met by his pay packet. But the future capacity of both the child and worker for inter-personal relationship is dependent upon the degree to which their need for a feeling of belonging is satisfied. This need of the child is satisfied through two institutions in the society, the family and the school. For the worker, the job situation is one of the major sources of his satisfaction.

The second psychological need is the need for learning, challenge or progress. In childhood, the child is constantly presented a challenging or a learning situation and it is easy to satisfy this need for progress. Likewise, the worker to live a full life should continue to be challenged, as it is through the meeting of challenges that we all get our sense of progress. In the young, the satisfaction of the need for learning is easily met. Men see a need for continued learning in order to progress in the job situation and work or employment can satisfy this need in many different ways to different people. For a worker that work may be the only situation in which he has a sense of competence, therefore failure in meeting a new challenge may be very damaging to the individual's sense of worth. Thus, the same job situation may provide him the satisfaction of a need for self-esteem or may present threats and fears.

The third psychological need is for a sense of self-esteem which is partly met with in the second need for progress. This means every one of us has to have something to build on, for a lack of personal worth leads people to commit suicide.

The fourth need is a need for some social purpose. Nobody can live a completely selfish life. This need finds its major satisfaction in the employment field.

Obviously, the satisfaction of one need may have to be at the expense of another. But the fact remains that the denial of these needs may well bring about tensions and the health problems and inter-personal difficulties which creates tension in living. Now this presents a challenge, particularly to those doctors in the mental health field, as industrial health departments work with these people.

Let me repeat: the occupational health specialists are needed. Millions of them will need to be working hard in the years between now and 2000 A.D., when the world's population will be doubled and we must ponder on what that means to industry as a part of men's destiny. The social implications of two biggest post World War II controversies are growing population and health, technology and food. They are already staring us in the face.

Today, more than at any time since the industrial revolution, the human element is regarded as being of paramount importance in industry. This is due in part to a growth of social consciousness, particularly during the last half-century. It is also due to the presence of economic events.

Newer Concept of Management Training

The problems with which management has to cope now-a-days are becoming more and more complex and ever changing at least from year to year. Ever-widening specialities, disciplines and technologies claim that management should know the basic principles of their special field, because their result bear so much importance on scientific management. As such management is confronted with a multi-faceted set of demands from fields, such as, business and political economy, psychology, physiology, social medicine, sociology, scientific engineering, statistics etc. Sure enough, no manager can, however, afford to ignore the principles of industrial physiology, psychology, medicine, sociology, and ruin the success of his business. The principles contained in these sciences may be useful generalisations only, and not the exact laws of pure sciences, and also may be

subject to change to suit the varying circumstances, but the fact remains that they are useful principles and must be adopted for the benefit of business, the partners in the business are those unknown millions, the consumers of the nation, for whose ultimate benefit business exists.

The smallest definition of management is "the process of planning, organising and directing the actions of a group of people in a given working environment to achieve the desired objective of production of goods". In this broad aspect it is alike the function of head of a family, a chief of a tribe, a captain of a ship, a general of an army, a ruler of a kingdom. And just as everyone of them has to learn certain basic principles the ruler of a kingdom learns from Kautilya's *Arthashastra*, Chanakya's principles of *Polity* and Machiavelli's *Prince*, so also management has to seek knowledge in such worthy professions as law, medicine, engineering, economics and sociology. The growing syllabus of any course for scientific management stands witness to it. This has been necessitated by the complexities of the neo-technic phase of the 20th century. The greatly widening field of technology is creating newer intricate problems of new concepts of personnel and industrial relations, social problems and problems of a Welfare State.

In the modern training and development of management, narrower fields of skills and technical competence have given place to training in ability to handle human relations, and human problems of a technical age. He works with specialists in medicine, law, sociology, engineering, technology, pure sciences, applied sciences and research workers. He works as a part of a team to occupy his place as a manager to shoulder his responsibilities. Managements' welfare work is not solely a question of "canteens and concerts" but a deeper understanding of human values at work. Industry not only deals with economic man, but with family man, spiritual man and man as a citizen.

With the continuous unfolding of sociology, psychology and anthropology as aids to our knowledge in an industrial age, there is real scope and purpose in health work as was never before.

Industry of the future, with its emphasis on automation, electronic and chemical operations and nuclear energy, will continue to offer challenging work for the industrial physician.

During the last decade since independence we have made considerable progress in social thinking and this has changed the role of medicine in industry. It has moved from one of industrial surgery—to industrial hygiene—to industrial medicine—to occupational health, which includes curative, preventive and administrative medicine. This field is becoming wide and is still growing.

Responsibility of Physician to Patient, Community and Industry

This triad of responsibilities of the doctor is evident in workmen's compensation cases when his responsibility is not confined to the patient, but extends to the community to the members of the Workmen's Compensation Commission, and to the industry. He executes these additional responsibilities by providing medical testimony in courts. The training and experience of the average physician in industry or outside does not prepare him for the complexities of modern Workmen's Compensation administration. The hall mark of his professional competence does not end with diagnosis of illness. He must learn to evaluate injury, to relate a purely medical condition to a bewildering variety of non-medical factors; to prognosticate on the patient's ability to work after the injury has been treated; to particularise the condition of a worker in detail to permit compensation boards to make a rupee evaluation of a trauma.

What Industry Expects from the Medical Profession

It is a co-operative effort in the expansion of interest in industrial medicine, a knowledge and appreciation of the problems of the industry in the employees of which doctors take personal professional interest, a professional appraisal of the extent of injuries, and a realisation that health insurance is designed not to relieve the patient of all responsibility but to help only to relieve the financial burden of his illness.

In a carefully planned paper, Dr. Gunn persuades the medical man to realise and accept his responsibility in the occupational health programmes of an industrial community. He behoves them to put the right hand of friendship forward, and be willing to contribute their thinking to the medico-social needs of industry and show that occupational health is their business.

Not all of what I have said can be accomplished even in a decade if business and industry will not learn to realise and shoulder the growing social responsibility and social obligations which their trusteeship and management throw on them, for business is not only for the owners but for the society as a whole. Indian business has to become a part of the community in which it operates. All business has a stake in the community and a responsibility to it.

Pandit Nehru while inaugurating the 4th Asian Regional Conference in Delhi, the other day said that "in India and other newly independent countries political independence had preceded economic independence, while in Europe and United States the reverse had been true".

The wants of the people in economically under-developed countries had become pressing before the means to satisfy them were available. Increase in production had become an urgent consideration.

Government—any government—is not an end in itself. It exists to serve certain human purposes. These purposes should be enlarged—let none of us forget that labour problems are human problems. The ultimate answers do not lie in the legislator's ink-pot or in the lawyer's brief.

We must be faithful and wise stewards of the riches we have inherited. We must imagine greatly, dare greatly, and act greatly. For on what we do now, the future will depend—the future not only of our workers but of the subject of health. If we do stand for both, we will again be asked to lead the cause of occupational health.

I trust that you will take away from this IXth Annual Conference of the Society new inspiration and information to foresee your occupational health problems and to prevent them.

The common denominator of all I have said today is confidence—confidence not only in law or government but in one another, in free men and free women, confidence in industry and workers.

My friends, when we have come so far we know we can go farther.

OCCUPATIONAL HEALTH INSTITUTES

Leo Noro

Director of the Institute of Occupational Health, Helsinki, Finland.

"Occupational Health should aim at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment and to summarise: The adaptation of work to man and of each man to his job."

This definition given by ILO WHO Joint Committee under Sir J. Bhore's chairmanship in the year 1950 shows the broad concept of modern occupational health. Thus occupational health work requires specialised knowledge in many fields, in studying their relationship between work and health. We have to know what kind of health hazards could be caused by working conditions (physical, chemical, biological, mental etc.). If we are thinking of modern industry, we shall find hundreds of chemicals which might cause occupational diseases among workers; we find abnormal hard physical and mental stress, very often also among managers or leaders in industry, commerce, politics, etc. We might find also poor nutrition, poor housing, bad human relations in work and at home etc. We have to know how to prevent these hazards by technical, medical or other means. We have also to know the physical and mental demands of different jobs and the methods to guide a man to the right job. Rehabilitation and resettlement of the disabled is also a duty of a democratic social minded society—a task which requires plenty of special knowledge. Social security institutes and employers need more and more objective assessment of working ability or disability. Here I have mentioned only some problems.

We cannot any longer solve all these problems without special laboratories, instruments, equipment etc. We need hospitals to cure sick people; similarly we need special institutes to solve numerous problems in connection with work and health—institutes which are not hospitals but centres for preventive work among working population as we have child and maternity welfare centres for children and mothers. Only a few of the working places are large, most are small which never can have their own industrial medical centres. For these, centralised institutions are required.

The history of Occupational Health Institutes is rather recent. The oldest of them, "Clinica del lavoro" in Milan, Italy, is only 50 years old. During the last 30 years however many similar institutes have arisen around the world. The size, administration, organization and tasks of these institutes varies greatly. In the following list, most important types of them will be mentioned:

Different types of Occupational Health Institutes—Laboratories and Research Units at present:

(1) Large independent institutes which cover the majority of occupational health activities:

Clinica del Lavoro, Milan.
Zentralinstitut für Sozial—und Gewerbehygiene, Berlin.
Institute of Occupational Health, Helsinki.
Institute of occupational diseases and occupational hygiene—Moscow.
Institute of Industrial Hygiene, Zagreb.

(2) Institutes formed as a department of public health institutes or schools:

Department of Physiological and Industrial Hygiene, All-India Institute of Hygiene and Public Health, Calcutta.
Occupational Hygiene Department of Institute for folkhälsan, Stockholm.
Occupational Health Department of Central Institute of Hygiene, Sarajevo.
Occupational Medical Department of Institute voor Praeventieve Geneeskunde, Leyden.
Department of Occupational Medicine in School of Public Health and Administrative Medicine, Columbia University, New York.
Institutes of Industrial Health, Universities of Cincinnati and Michigan.

(3) Institutes connected with forensic and social medicine or pharmacology:

Institut de Medecine du Travail, Lille, Lyon, Strasbourg, Athens.

(4) Units formed as departments in universities or technical high schools (universities):

Institut für Arbeitsphysiologie, Zurich.
Institut Medicina del Lavoro, Naples.
Department of Industrial Medicine, Manchester, Newcastle.

(5) Laboratories or departments of industrial medicine or hygiene in Ministries (departments) of Health:

United States Public Health Service, Departments of Health in most States of the USA.

Sub-departmento de Higiene Industrial, Servicio Nacional de Salud, Chile.

(6) Units formed as departments of Ministries of Labour:

Industrial Hygiene Department of New York State and Massachusetts.

Institutes in Oslo, Munich, Hanover.

Industrial Hygiene Laboratory of Ministry of Labour, New Delhi, and Colombo.

(7) State institutes in special fields of occupational health:

Bureau of Mines, USA.

Petroleum Institut, USSR.

(8) Private or semi-private institutes or laboratories of foundations, industries, trade unions, associations, insurance organisations:

Industrial Hygiene Foundation, Mellon Institute, Pittsburgh.

I.G.L.W.U., New York.

Silikoseforschungsinstitut, Bochum.

Max-Planck-Institut für Arbeitsphysiologie, Dortmund.

E.N.P.I. institutions, Italy.

Philips' Medical Department, Eindhoven.

Liberty Mutual Insurance Co., Boston, Mass.

(9) Occupational medical departments of hospitals:

Industrial Medical Department of Central Middlesex Hospital, London.

Industrial Medical Department of London Hospital, London.

Yrkesmedicinska Kliniken, Stockholm, Oslo, Copenhagen.

(10) Research units of Medical Research councils in Great Britain, India, South Africa.

(11) Other institutes:

Rehabilitation centres (governmental, municipal, private).

Special institutes for industrial psychology, physiology, industrial safety etc.

Tasks and Organization of Occupational Health Institutes

From the definition of occupational health (as given above) one can see that the concept of occupational health is a wide one. The work requiring specialized knowledge in many fields,—medicine, engineering, chemistry, toxicology, psychology, physiology, statistics, etc. Also a close team-work between the workers in these different spheres is essential. The tasks and organization of one type of institute (based on the experience in Finland) will be discussed here (see also the Third ILO/WHO Expert Committee Report, 1957).

Functions of the institute

The main functions of the institute of occupational health should be research, service, training of occupational health personnel and education to the public.

Research

The research work performed by the institute can be divided into two groups:

(*a*) basic research and

(*b*) practical research to meet national or local problems.

Basic research is, of course, already being carried out in every country, and this activity should be followed by exchange of correspondence and literature with other institutes. Unfortunately international exchange of information in this respect is not easy due to language and other difficulties.

For practical purposes, however, research on local problems in the country is of primary importance. The problems to be studied could be decided by the staff of the institute in collaboration with advisory committees of departments, or research projects could be given to the institute directly by industry, health authorities, factory inspectors, trade unions, social security institutions, etc.

Service

It is dangerous for an occupational health institute to concentrate solely on "pure science" at the expense of practical service, thus getting out of touch with everyday problems and losing its position as an instrument for the practical promotion of occupational health in society. Such practical activities provide numerous fresh problems for research and keep staff in contact with varying groups of people, such as labour representatives, supervisors, engineers, industrial physicians, private practitioners, personnel managers, safety engineers and inspectors at plants, social security personnel, factory inspectors and the man on the job, etc.

Various possibilities for these activities are described under "Personnel". They can be summarised by saying that an institute of occupational health should be prepared to make available on request its facilities, equipment, personnel and skills, to government authorities, management and trade unions in order to investigate specific occupational health problems and give technical advice for their solution. The preparation of occupational health legislation or regulations is a specially suitable field where an institute can help governmental authorities.

Training

The institute of occupational health should be the centre of training and educational activities in this field in the country. Training should be given not only in the institute itself; it is important also to give, assist and promote the training outside the institute in universities, technical and vocational schools, etc. The institute should plan or assist in the planning of teaching programmes, prepare the text-books required for different groups, produce such teaching material as moving pictures, filmstrips, slides, etc. General education and information in occupational health are also given by this kind of institute, with the purpose of promoting understanding and a positive attitude to health work among the workers themselves, employers, engineers, politicians, etc.

The teaching function of the institute could be divided into the following sections:

(*a*) To train specialists in occupational health work for different duties, including administration in ministries, health and labour departments, factory inspection, medical departments in places of employment, institutes, laboratories, employers' and employees' associations, insurance organizations, hospitals, municipal health services, etc.

This training should be given mainly in the institute, with sufficient field experience, and the team should consist of the following groups:

—Industrial physicians;
—Industrial nurses;
—Industrial hygiene and safety engineers, chemists and physicists;
—Occupational psychologists and physiologists;
—Social workers specializing in occupational health problems.

(*b*) To give or assist in giving basic knowledge in occupational health to all groups, interested in these questions. It is important that as many groups as possible should obtain this knowledge during their school or study time. Thus the institute can promote the teaching in vocational and technical schools and institutes by sending teachers there or by training them in these schools and preparing teaching materials, textbooks, etc. Compulsory courses in occupational health should be given specially in vocational and technical schools, institutes and universities, in medical faculties and public health schools, schools of nursing, in departments of social sciences in universities, etc. Also occupational health aspects should be added to general health education given in public and other schools.

(*c*) To arrange refresher or special courses for the groups mentioned in (*a*) above and other groups connected with occupational or public health work such as factory inspectors, public health officers, supervisors, members of safety and health committees, first-aid personnel, vocational counsellors, etc.

Education of the public

The tasks in this field are: to provide general information by giving lectures, showing moving pictures, distributing educational and informative material, etc. in connexion with general meetings and courses for employers, engineers, technicians, supervisors, and trade unions.

This group of activities includes also articles in journals, broadcast talks and television appearances etc. for promoting the knowledge of occupational health in the whole community.

The institute should also have close links with associations of industrial physicians, nurses, hygienists, dentists, safety officers, etc. In some countries the offices of such associations are located in the institute, in which case the staff can easily assist as lecturers in association meetings, arrange refresher courses, conferences and keep personal contact with occupational health personnel doing field work.

A professional journal published by the institute (often in collaboration with the associations mentioned above) also gives valuable information and education.

A good library, which also serves individuals and organizations outside the institute, is an additional advantage.

Organisation and Liaison

Units required and their tasks:

To perform its functions the institute should have sufficient personnel, equipment and space. The personnel could be divided into several working groups or units according to specialty. In addition to these units there could be separate units for research, service and training, but often, especially in smaller countries, the individuals in different units have to participate in all the functions mentioned. In the following paragraphs the required units and their tasks will be described. The necessary units should be: (The list of personnel needed is given in Annex. 2.)

(1) Medical unit.

This is of primary importance and should be available for consultation in various medical fields. The tasks of this unit are:

(*a*) The diagnosis and treatment of occupational diseases;
(*b*) Pre-employment, periodical and other health examinations;
(*c*) Health (physician's) surveys at plant;
(*d*) Medical Examinations for workmen's compensation purposes;
(*e*) Post-mortem and experimental studies of occupational diseases.

(2) Industrial Hygiene (and safety) unit.

The tasks of this unit, which is the responsibility of engineers, chemists and physicists, should be as follows:

(*a*) The control in the plant of air impurities such as gases, dust, vapours, etc. ;
(*b*) Temperature, humidity, noise, illumination, radiation—measurement and control etc. ;
(*c*) Analysis of biological samples from the toxicological aspect;
(*d*) Analysis of toxic or dangerous raw material used in the work;
(*e*) Planning of a technically healthy working environment.

In smaller institutes (see Annex. 2) industrial safety (accident prevention) should also be included in this unit.

(3) Physiological unit.

The unit should take care of research and its application concerning:

Physiology:

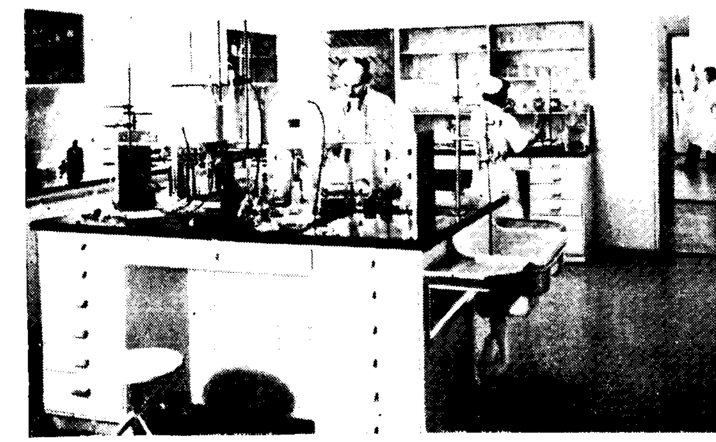
(*a*) The effect of different methods of work on the human organism,
(*b*) The strain imposed by various jobs and the energy required in their performance,
(*c*) Nutrition of workers in different kinds of work,
(*d*) The best working methods (physiologically) in different jobs, suitable working hours and breaks, working positions and other human engineering aspects,
(*e*) Physical fitness and functional tests of heart, lungs, etc.

(4) Toxicology unit.

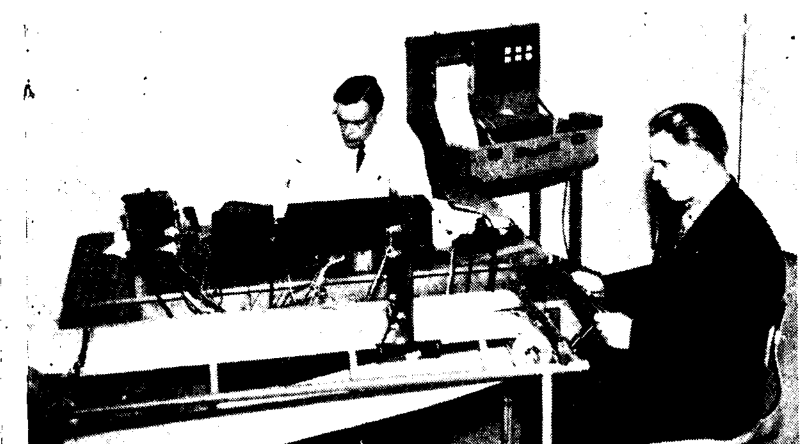
Toxic effects of substances used in industry investigated by animal experimentation.

INSTITUTE OF OCCUPATIONAL HEALTH, HELSINKI, FINLAND

The Building.



Industrial Hygiene Laboratory



Psychological Department (Selection of Drivers)

(5) Psychological unit.

This unit should handle the problems connected with occupational psychology and mental health in industry, as follows:

(*a*) Job analysis;
(*b*) Vocational guidance;
(*c*) Job placement and selection of workers;
(*d*) Study of psychological factors in accidents, and the human side of accident prevention;
(*e*) Study of mental fatigue and its prevention;
(*f*) Human relations in industry;
(*g*) Scientific management, etc.

(6) Rehabilitation unit.

Most countries nowadays consider rehabilitation as one of the activities belonging to industrial medicine. The organization of a rehabilitation unit will not be too difficult when the above-mentioned units are already in operation. We do not, however, mean a complete rehabilitation service with surgical and medical treatment, physiotherapy, vocational training etc. What is necessary here is the arrangement for examination of disabled persons and the planning of rehabilitation for them. This kind of activity already exists in some countries but the work is usually carried out separately from the institutes of occupational health, as for example in Mexico and Norway. The tasks of this kind of unit are the following:

(*a*) To assist the rehabilitation authorities, hospitals, non-governmental organizations, social insurance authorities etc. by examining disabled persons with a view to their rehabilitation, and by establishing a rehabilitation plan in which the necessary treatment is recommended, such as medical treatment, prosthetic appliances, vocational guidance and training, etc.;
(*b*) To promote research, training and knowledge of vocational rehabilitation.

(7) Statistical unit

This should assist all other units of the institute with statistical advice and, in addition:

(*a*) perform statistical surveys and research into occupational health problems;
(*b*) develop and provide statistical methods in occupational health for different organizations, authorities, etc.;
(*c*) carry out statistical service for industry and others, for instance concerning sickness absenteeism recording.

(8) Education and promotion unit

This unit should

(*a*) develop and provide safety and health education, training and propaganda in schools, among workers, supervisors, engineers, safety engineers, safety committees, etc.

(*b*) prepare and distribute safety and health films, posters, booklets, exhibits, slides and other educational material.

(9) Safety unit

This unit, if it is not located in a special safety institute, an insurance organization, technical university or in a ministry (department) of labour, should generally limit its work to technical accident prevention in industry. Its tasks should be the following:

(*a*) Research work on the technical causes of accidents and, in collaboration with the psychological unit, the study of human factors in accidents;

(*b*) Development of safety technique in different industries and occupations;

(*c*) Development of suitable personnel safety equipment in collaboration with physiological and industrial hygiene units;

(*d*) Collect and analyse accident statistics and develop methods of reporting and recording accidents in collaboration with the statistical unit;

(*e*) Provide technical advice on safety methods at plants.

This unit could also be a part of the industrial hygiene unit.

Collaboration with other social and medical fields

In its widest meaning, occupational health includes the application of modern public health measures and medicine to the working population. To this end, occupational health workers should also know all fields of medicine and the institute should collaborate closely with public health departments and those of social and clinical medicines.

The health and working capacity of man is obviously linked also with factors outside the place of work—thus, health education of workers, the prevention of non-occupational illnesses and accidents is extremely important. The following examples further illustrate the importance of collaboration with different departments in a public health agency and institutes:

Medical care of problems of workers ..	Department of Health or of Medical Services
Health problems of pregnant women workers and infant care problems of women workers ..	Department of Maternal and Child Health
Mortality in different professional groups ..	Department of Vital Statistics
Prevention of common infectious diseases and VD and tuberculosis ..	Department of Sanitary Engineering or Environmental Sanitation
Nutrition of workers and their families ..	Department of Nutrition

Collaboration would be easier if the institute of occupational health were located near a public health institute.

Other contacts deal with social insurance, especially accidents, occupational diseases, sickness and disability insurance. The diagnosis of occupational diseases and the medical, physiological and psychological evaluation of invalidity, are tasks of the institute, but on questions of compensation the legal and socio-economic aspects should also be studied. Thus collaboration with insurance organizations is essential.

In addition to medical services the larger industries also have many-sided social activities—for example, housing projects for workers, canteens, physical education, sports and other recreation activities—and here collaboration is also needed with social service agencies, social science institutes or departments in universities and other institutes or organizations.

In the diagnosis and treatment of patients collaboration with different hospitals is important, particularly if the institute has no medical specialists on its staff or no ward departments of its own. By sending patients suffering from various occupational diseases for diagnosis and treatment to other clinics, the institute promotes knowledge of occupational medicine among physicians in general.

The results of research as well as other experiences in the field of occupational health could be used also for the improving of safety and health legislation, and from this aspect too, collaboration with departments of labour and/or health is important.

Administration

Personnel

Personnel requirements to fulfil the tasks of an institute as detailed in "organization" depends of course, on how many of the recommended units are set up. It will be seen that an attempt has been made below to list the personnel required in three different types of occupational health teams—A illustrates a basic team, B a rather more comprehensive team and C a complete team for a central institute of occupational health. This list also gives some idea how to start and develop an institute of occupational health.

PERSONNEL REQUIRED IN THREE DIFFERENT TYPES OF OCCUPATIONAL HEALTH TEAMS

Unit	*Team A*	*Team B*	*Team C*
1. Medical	Physician(s) (trained in occupational and public health) Consultants in Rontgenology and Dermatology Nurse(s) Secretary(s)	Industrial physicians Industrial nurses Consultants in Rontgenology Dermatology Otology Ophthalmology Psychiatry Gynaecology Nurses Secretaries	Industrial physicians Whole or part time specialists in Rontgenology Dermatology Otology Ophthalmology Psychiatry Internal Medicine Gynaecology Orthopaedics and surgery Consultants in other special branches of medicine Nurses — Industrial, poli clinic, laboratory X-ray, visiting and other Social (med.) workers X ray and other technicians Chauffeurs Office and service pers. (secretaries, typists, assistant nurses, cleaners etc.)
2. Industrial hygiene	Engineer and chemist (both trained in occupational health) Laboratory technicians Secretary	Industrial hygiene engineer Industrial hygiene chemist Laboratory technicians Secretary(s)	Industrial hygiene engineers Industrial hygiene chemists Industrial hygiene physicists Laboratory technicians and helpers Secretaries and other office personnel
3. Physiological toxicological	Consultant in occupational physiology	Occupational physiologist Toxicologist Laboratory technicians Secretary	Occupational physiologists (med. and others) Toxicologists Chemists Laboratory technicians Office personnel
4. Psychological ...	—	Occupational psychologist Assistant	Psychologists Assistant personnel Office personnel

Unit	*Team A*	*Team B*	*Team C*
5. Rehabilitation ...	—	Consultant in rehabilitation problems	Med. rehabilitation officer Vocational counsellor Psychologist Social worker Assistant and office personnel
6. Statistical ...	—	Consultant statistician	Statisticians Assistant and office personnel
7. Health education	—	Part-time health educator	Health educators
8. Industrial safety ...	(Safety engineer in unit 2)	(Safety engineers in unit 2)	Safety engineers Assistant personnel
9. Administration ...	Secretary	Secretary and clerical staff	Chief of the institute (physician) Secretaries Financial director General personnel — cashier, bookkeeper, typists, kitchen staff, janitors etc. Librarians and assistant Photographers Technicians for technical workshop Chauffeurs

THE SPACE REQUIRED FOR A RATHER COMPLETE OCCUPATIONAL HEALTH INSTITUTE IS AS FOLLOWS:

1. Medical department

Policlinic (out-patient clinic):

(1) Examination/consulting rooms for physicians
(2) Rooms for nurses
(3) Offices for secretaries
(4) Files
(5) Rooms for physiotherapy
(6) Waiting room for patients
(7) X-ray department
(8) Clinical laboratories

Ward department. (This department could also be in the nearest hospital, where 5-15 beds should be reserved for occupational diseases, observation cases, etc. in an area of 4-5 million inhabitants.)

2. Industrial hygiene department

2-5 laboratory rooms
Offices

3. Physiological-toxicological department
   - 1-3 biochemical laboratories
   - Room for function tests
   - Animal laboratory
   - Animal house
   - Special rooms (climate room, low-and high pressure room, etc.)
   - Offices
4. Psychological department
   - 2-3 examination rooms for individual testing, etc.
   - Test auditorium
   - Special test room with psycho-technical equipment
   - Offices
5. Counselling department for disabled persons
   - 4-5 offices for personnel
6. Statistical department
   - 1-3 offices
   - 1 room for equipment
7. Health education department
   - 1-2 offices
8. Safety department
   - 2-4 offices
9. Administration department
   - Offices
   - Kitchen and cafeteria for personnel
   - Central heating, laundry, stores, garages, etc.
   - Technical workshop
   - Library
   - Auditorium
   - Exhibition hall
   - Apartments for janitors, nurses, etc.

The equipment needed in an institute of occupational health has been listed by Mr. Bloomfield (1) in his paper (mentioned in reference.) A recent complete list has also been published by the Occupational Health Institute of the University of Michigan, Ann Arbor—Encyclopaedia of Instrumentation for Industrial Hygiene.

In these two papers, however, equipment for a psychological department is not mentioned. This equipment depends on the kind of research and psycho-technical tests to be performed and varies considerably.

Administrative structure

Administrative system of the institute, of course, depends greatly on local conditions. Because the problems of occupational health interest many authorities, associations and organizations of different kinds, it is generally felt that these interested groups should be represented in the administrative system of an institute. It is believed too, that the independence and impartiality of an institute is useful in promoting collaboration between groups holding perhaps different opinions, such as employers and employees' organizations, health and labour authorities, etc.

Following chart gives a typical example of the administrative structure of an occupational health institute.

ADMINISTRATIVE STRUCTURE OF A TYPICAL OCCUPATIONAL HEALTH INSTITUTE

BOARD OF MANAGEMENT	— Representatives from—	Ministry (department) of health Ministry (department) of labour Ministry (organization) of social security Employers' central organizations Employees' central organizations
HEAD OF INSTITUTE	— Scientific Council of Advice	Public health administration Public health school and medical faculty Physicians' organizations Factory inspection
	Representatives from	Technical University Medical department in industry Social Insurance institute Employers' and employees' representative
COLLEGIUM (Directors of departments)		Faculty of social sciences and psychology
ADMINISTRATION DEPARTMENT		
MEDICAL DEPT.	— Advisory Committee	
PHYSIOLOGICAL DEPARTMENT	— Advisory Committee	
PSYCHOLOGICAL DEPARTMENT	— Advisory Committee	
OTHER DEPARTMENTS	— Advisory Committee	

The advisory councils or committees are very important for an institute for the authorities, organizations and those in the field. On the advisory committee the members chosen should have expert knowledge of practical problems in the field.

An advisory committee for an industrial hygiene department should include representatives from:

(*a*) Factory inspection
(*b*) Safety department of a big industrial establishment
(*c*) Safety department in an insurance company
(*d*) Air conditioning engineering
(*e*) Illumination engineering
(*f*) Noise prevention engineering
(*g*) Physics (especially X-ray and radio-activity)
(*h*) Analytical chemistry
(*i*) Technical management of a firm
(*j*) Trade union representative working as a safety man

These representatives can give valuable help in planning investigations and are also in a position to put into practice the ideas emanating from the institute.

Finance

Finances of an institute depend on the administration, and are taken care of by the authorities or organization which own or direct the institute—for example, a university, ministries of labour or health, insurance organization etc. Experience in many countries has shown, however, that if the finances of an institute are totally provided by the governmental budget, its activities are not always flexible. It is important that the bulk of an institute's income should be regular and reliable. It should, however, be emphasized that local conditions greatly influence this financial arrangement. If the institute is not governmental, as is recommended above, and many organizations may be associated with the administration of the institute, the following sources of income are possible:

(1) The greatest part of the income, which has to cover expensive basic research, training of personnel, equipment and instruments, library etc., should be based on regular funds—for example, funds emanating from state/government taxes or from social insurance institutions. Because occupational health services are directed towards the working of insured population, it is only natural that sickness and accident insurance organizations would take great interest in keeping insured persons healthy, thus diminishing sickness benefits. They might, therefore, participate in the financing of an institute. This kind of financial arrangement already exists in Leyden, Holland and also the ISSA has made recommendations to its members in this connexion.

(2) (*a*) Gifts and bequests from industry, insurance organizations, trade unions etc., especially for basic research work;
(*b*) Subsidies for special research projects from industries and industrial associations etc.;
(*c*) Fees for service work, examinations and surveys from employers, insurance organizations, government or municipal organizations and clients and patients themselves;
(*d*) Special allocations from associations or foundations all members of which pay yearly subscriptions to the institute, then receiving its services at reduced fees or at gratis.

(3) Subsidies from international bodies such as United Nations, ILO, WHO, or national foundations.

The Institute of Occupational Health, Helsinki, Finland

In Finland we started this kind of an institute in 1951. The task of this institute is to "safeguard and promote health of the working man or woman in all occupations."

Finnish industrialists, considering the basic value of health in production, founded in year 1946 an occupational medical foundation to promote the research and teaching of occupational health. This foundation was reorganized in 1951. At present the Board of Trustees consist of 15 members, 8 of them are nominated by government and they represent Ministries of Health, Labour and Social Welfare, State University, State social insurance institute and technical university. Seven other members represent private agencies such as employers' central federation, trade unions' central association and central organization of private insurance companies. Thus all important circles which should be interested in the health of working population are represented in the administration of the institute and co-operation has been good.

The Institute itself (30,000 cubic metre building—staff 155,—appr. 200 laboratory and office rooms — library — 2 auditoria — exhibition hall) serves the whole country (Finland: Total area 130,085 sq. miles, total population 4.4 millions. Occupational distribution; Agricultural population 42% ; industrial 42% ; other occupations 16% ; Biggest industries; Metal 100,000 workers, wood-paper 70,000; textile clothing 52,000).

The functions of the Institutes are:

1. **Research**

2. Training of occupational health personnel and education of public
3. Service

Departments are:—

1. General for administration, statistics and investigation centre for disabled persons (planning or rehabilitation).

2. Medical (policlinic—20 physicians representing most important specialities, ward department for 35 patients), which functions as central clinic of occupational diseases, as health centre for 100 places of employment representing most important trades in society and as a clinic for assessment of working capacity. From this department health surveys are made into industry and other places of employment. Also some mass-examination methods are used such as X-ray, sight screener and audiometer.

3. Industrial hygiene—One engineer and three chemists studies working environment (ventilation, illumination, noise, radiation, gases, dusts, etc.).

4. Psychological (8 psychologists) is for mental health work at places of employment, vocational guidance, job analysis, selection of workers, etc.

5. Physiological (4 physiologists) is for the study of effects of the human organism at different methods of work, best working methods in muscular work, cardiac and pulmonary function tests, physiology of sports, etc.

Teaching activity is growing all the time. In 1957, approximately 1,300 teaching hours were given to approximately 4,000 students, to medical students, students of technology, nurses, industrial doctors, engineers, social welfare workers etc.

The number of visits in policlinic has been 25,000—30,000, the number of mass X-ray taken in industry 35,000—40,000 yearly, sight-screening examination until 1958 approximately 200,000 in different occupations etc.

Annual budget of the institute is approximately 140,000,000 EMK approximately 2,000,000 Indian rupees—from which governmental subsidy is 18% and the institute itself charges 82% as fees of services made to industry, state and communal agencies, insurance institutes etc.

This institute has been planned for Finnish circumstances and during its existence the every day demands have shown the way how to develop it. We have noticed in my country that this kind of institute is fundamental to safeguard and promote the health of manpower.

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HEALTH HAZARDS IN FOUNDRY INDUSTRY*

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As a basic industry, the foundry industry occupies an important place in the economy of any country. India, too, has a highly developed foundry industry though it has not yet received adequate attention as regards the working conditions and the health status of its workers.

The Indian Labour Year Book, 1951-52 (Govt. of India, 1954) enumerates only 21,490 workers in the foundries from submitted returns. A little consideration shows however that the number of workers actually engaged in this occupation must be several times more. At present, the total number of foundries in India is estimated to be about 1,500. According to a survey carried out by the Foundry Industry Panel appointed by the Engineering Capacity Survey Committee (Jalan 1955), the total number of cupolas in India is estimated at 1,600. Of these 600 are of the medium size and the rest are of small size. Assuming that number of men employed on a medium sized cupola is about 500, while the number engaged on a small sized cupola is about 100, the total number of workers engaged on the 1,600 cupolas at present would not be less than 4,00,000. In judging the right place of this industry however it has also to be remembered, as pointed out by the Foundry Industry Panel, that at present these cupolas work on an average of 10 days a month only with the result that the existing capacity of the industry is idle to the extent of nearly fifty per cent. The various development and expansion projects contemplated under the Second Five-Year Plan, will in the near future considerably increase the demand and volume of castings in different spheres and will inevitably lead to a corresponding increase in the extent of foundry employment, which may thus wellnigh reach a million mark.

Whether from the economic or the employment point of view, the foundry industry and occupation thus take its place on a par with other major industries of our country and a full and comprehensive investigation into the environmental and health conditions of those engaged in this important occupation is a priority problem in the field of industrial health.

An exploratory study was therefore undertaken to bring out a few highlights of this problem. The investigation is not claimed to

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be exhaustive. As will be noticed from subsequent description of the foundry operations in the various factories studied, the occupation bristles with a number of health problems. Of these, only a few could be taken up for investigation, the rest being merely noted for future reference.

Investigation

Six foundries were selected for this investigation. All were situated in the vicinity of Calcutta and employed from 200-800 workers depending on the production capacity of the cupola *i.e.*, whether medium sized or small sized. The employment strength normally varied with the market demand for castings but during the period under review it remained fairly constant. All the foundries were engaged in small sized casting operations producing boiling pans, sanitary ware, rain water and drainage pipes, railway sleepers, etc.

Except for the office which was housed in brick-built buildings, the actual foundry work was carried out in corrugated iron sheds. These were fairly large and the day-light illumination and ventilation in most cases were fairly satisfactory. Except for the office and maintenance staff, all the workers were engaged on a piece rate basis. The factories worked throughout the week from 8 A.M. to 5 P.M. The casting operations were however confined to only four days a week in the larger foundries and only two days a week in the smaller ones. Prior to actually starting this investigation all the foundries were visited by us to ascertain the nature of the foundry occupation and locate the problems for future investigation. The following is a description of the various operations as carried out in the foundries investigated.

Description of the Foundry Operations

The principal steps in the manufacture of ferrous castings are as follows:

(*a*) The preparation of moulding material: This consists in conditioning the sand from which subsequently moulds and cores are prepared. The sand may be prepared in large batches in rotary mixers using fresh sand and certain other ingredients like graphite and powdered bentonite to serve as binders. Before the actual preparation of moulds or cores, the worker may also prepare the sand by fine screening, the ingredients being mixed by hand.

(*b*) Core and mould making: The cores are made by introducing the sand into either metallic or wooden moulds. They are then baked in the so-called drying chambers. These are low roofed ill-ventilated brick chambers with only an exit hole and are fired overnight with coal-fire. The core-maker enters the hot chamber periodically to keep the cores there for baking or to remove them after baking. The cores are allowed to cool, scraped to remove loose sand and are then used in preparing the moulds.

Moulding is done by embedding a metallic or core pattern in sand when after removal of the pattern, a hollow mould or shape is left in the shape of the casting desired. In preparing the moulds the workers handle the sand manually.

(*c*) Pouring: The molten metal that is poured in the moulds is prepared in a cupola into which pig iron, scrap iron, lime-stone and coke are charged from the top. When the metal is ready for casting, it is tapped from the cupola, gathered in a ladle and transported to the pouring area manually by the worker. For collecting the charge the worker has to approach to within 5-6 ft. of the molten stream issuing from the cupola, thus every time exposing himself for 5-10 minutes to intolerable high temperatures. The ladle together with its contents of molten iron weighs as much as 20-30 lbs. and in the foundries we studied some of the pouring operations were carried out as far away as 150-250 ft. from the cupola. As the transport of the hot metal to the pouring site and its subsequent pouring into moulds are done manually in all the foundries, these processes naturally involve heavy physical strain on the workers concerned.

(*d*) Shake out operations: The sand which encloses the mould is immediately removed, the hot castings are taken out and stacked in the store section.

(*e*) The cleaning and repairing section: The castings are transported to the cleaning and repairing section where excess sand and metal are removed. Most of the sand is removed from castings by scrapping; women workers being usually employed for this purpose. Remainder of the sand and excess metal are usually removed by various operations such as friction against iron brushes on a rotating wheel, stationary grinding, chipping or burning.

Job Classification

No classification of the jobs of workers could be conveniently made for the purpose of this study. After a survey of the work it was found that except for a few workers, mostly women engaged in the cleaning and grinding sections or in the core-making sections, the majority of the workers were engaged in the moulding sections of the foundry. Each moulder usually engaged a couple of assistants of his own and the group shared in turns all the work from preparation of moulds to pouring the molten metal, shaking out and cleaning the castings. On the two days of the week when casting was done, the mornings were usually spent in preparing the moulds, the latter half of the day being employed for the pouring operations, removal of the casting and stacking them in the store house. The rest of the week was spent in cleaning and sand conditioning operations. On the basis of these observations, it was felt that categorization of the workers on the basis of the types of job would be misleading. It was therefore decided to study the different operations with reference to the hazards involved and gather only an over-all picture of the health status of the workers concerned.

From the observation of working conditions already mentioned earlier, it appeared that the major health hazard to the workers would be exposure to dust, gases like carbon monoxide, exposure to high and extremes of temperatures, heavy work and physical fatigue. As a preliminary and for reasons already stated, it was decided to study the dust problems followed by an X-ray check-up to ascertain the chest effects of dust inhalation, if any. A preliminary idea of the heat exposure of the workers involved was also obtained, primarily with a view to plan a more exhaustive study on this aspect later on.

Field Studies

(A) *Thermal Environment in Foundries*

A survey of the thermal environment in the six foundries was carried out to assess the heat stagnation inside the workshed and the heat load on the workers. A constant source of tremendous amount of radiant heat in each foundry is the cupola which gives out the molten metal for casting. Also, all castings prepared from molten metal remain hot for a considerable period of time after the pouring operation and contribute to the heat factor. The tin sheds of all the foundries, heated directly from the solar radiation, also help in the accumulation of a great deal of heat inside as there is no proper ventilating arrangement to prevent such heat stagnation. This source of radiant energy, while less important in winter months, must acquire a special importance in a tropical country specially during the hot summer months.

Measurement of environmental warmth in all the six foundries was carried out once during the summer and monsoon months (April to October) and again during the winter season (November to March). The following observations were taken:

(*a*) Dry bulb temperature and wet bulb temperature with Sling Psychrometer;
(*b*) Globe thermometer temperature and
(*c*) Cooling time of unsilvered dry kata thermometer (130°F to 125°F).

Observations were taken in each foundry at different sampling points once in the morning between 10 A.M. and 12 noon, and again in the afternoon between 2 P.M. and 4 P.M. The following sampling points were chosen:

(i) Near the cupola, at a distance of about 4 ft., which is the usual position of the workers for collecting the molten metal in their crucibles;

(ii) Different sites in the shed where the casting operation is going on, and

(iii) General observations where no casting is taking place.

Air temperature, relative humidity, air velocity and effective temperature at each sampling point were computed from these observations. The average of all these measurements in the six foundries gives us some idea of the (i) diurnal and (ii) seasonal variations in the thermal conditions.

Results

A brief summary of the findings from the preliminary survey is given in table I. The table gives the average value of the environmental factors from the six foundries during morning and afternoon and also in the hot (April to October) and cold (November to March) seasons. In most of the foundries casting operation and hence the running of the cupola takes place in the afternoon. Thus the thermal environment should be warmer in the afternoon.

The average air velocity as observed from the dry kata readings (130°F to 125°F) was found to be between 20 and 30 ft. per minute. The effective temperatures were therefore calculated with an average air velocity of 25 ft. per minute.

Discussion

The table shows clearly that near the cupola and casting operations there is considerable variation in the thermal environment during the day, the afternoon observations being much higher than the morning observations, both during the hot and cold seasons.

Though the general observations do not show any significant change in the thermal environment during the day, there is a considerable variation in the hot and cold seasons. Thus while the average dry bulb temperature during hot season is 93°F, during the winter months it is around 80°F.

The average effective temperature during the hot season throughout the day is about 85°E.T. which is much above the limit of comfort range *i.e.*, 80°E.T. The picture is a little different during the cold months. In the morning when there is no casting, effective temperature is 74°E.T.,—well within the comfort range—but in the afternoon it increases to about 78 to 82°E.T. We may therefore conclude that while during the winter months, the thermal environment is not very uncomfortable, in the hot season the workers have

to work under conditions of severe thermal discomfort. Moreover, it will be evident from the globe thermometer readings which often shoot up to more than 110°F, that there is considerable radiant heat exchange near the cupola and casting operations, thus helping the accumulation of heat inside the work shed.

These interesting preliminary findings have thus indicated a need for a more comprehensive study in this aspect and the authors hope to present the results of this subsequent study, at present in hand, at a later date.

(B) *Environmental Dust*

Collection of samples:

The number of sampling points were decided upon by a preliminary visit to each foundry before the actual collection of the samples. The number of samples collected at each operation depended on the nature, frequency and dustiness of the operation. Wherever possible a few samples were taken at various points in the factory to ascertain the general nature of the environment before work. A minimum of three samples was collected at each operation in each foundry. The samples were collected at different hours of the day both in the morning shift as well as in the afternoon shift. They were also taken during the two half-yearly periods—November to April and May to October, to ascertain if there is any seasonal variation in concentration of the dust.

The standard technique, employing the midget impinger, was used in collecting the samples for determinations of dust concentrations. Every attempt was made to secure representative samples from the breathing zone of the workers at various operations. Samples were also taken at various sites in the foundry during the working hours to ascertain the general level of dust concentration at those points.

A number of samples of the moulding and core sands as well as settled dust were also collected and subsequently analysed for free silica.

Method of Analysis:

The standard light field technique using a sedgwickrafter cell and whipple disc was employed for the purpose of dust enumeration. Double-distilled water was employed for diluting the original samples as well as all other work connected with dust counting. Blank determinations were carried out frequently and also with every fresh lot of samples to keep a check on the dust-free quality of the distilled water used. Scrupulous cleanliness was maintained throughout the work so that the blank count never exceeded more than 6 particles per microscopic field.

Table I

Readings of the Environmental Factors

Sampling Point.	Season	Morning (between 10 AM and 12 PM) Dry bulb temp. °F	Wet bulb temp. °F	Globe thermometer temp. °F	Relative Humidity %	Effective temp.	Afternoon (between 2 PM and 4 PM) Dry bulb temp. °F	Wet bulb temp. °F	Globe thermometer temp. °F	Relative Humidity %	Effective temp.
Near Cupola	Hot (Apl. – Oct.)	91	84	92	79	86	99	84	118	66	88
	Cold (Nov. – Mar.)	80	68	82	54	74	92	76	114	50	82
Near Casting Operation	Hot	92	84	93	72	86	98	83	108	66	88
	Cold	80	68	81	57	74	89	73	94	48	80
General Observation	Hot	93	84	95	70	87	94	84	96	65	87
	Cold	80	68	81	55	74	86	72	88	53	78

The determination of free silica in the settled dust and the raw material samples, was done by the modified phosphoric acid method (Durkan, 1946).

Table II

Dust concentration in the six foundries according to operation (Millions of particles per cubic foot of air)

Operation	*No. of Samples*	*Maximum*	*Mean*	±	*Std. Deviation*	*Minimum*
General, before work	26	8·0	4·8	±	1·61	2·6
Grounding	11	61·6	29·	±	14·92	11·7
Moulding	15	36·0	16·0	±	10·21	5·8
Pouring	29	30·6	11·9	±	6·95	5·4
Shake Out	39	57·0	23·5	±	11·81	8·2
Cleaning of castings	18	48·0	28·8	±	13·09	8·4·
General, after work	20	21·9	10·8	±	5·01	3·6

Table II gives a summary of the maximum, minimum and the mean concentrations of dusts found during the course of various operations in these foundries. It will be noted that before the work actually began, the concentration of dust in the working environment ranged from about 2.6 to 8.0 million particles per cubic ft. of air with an average value of 4.8. None of the factories investigated had any dust suction device and this is reflected in the steadily increasing levels of dust concentrations in the factory as the work progressed. Thus the mean dust levels during the working hours, for the moulding, pouring and shake out operations were 16.0 million particles per cubic ft. of air, 11.9 million particles per cubic ft. of air and 23.5 million particles per cubic ft. of air respectively. While these represented the average dust levels near these operations, the workers actually engaged in these operations were exposed to much higher concentrations. The concentrations of dust very close to the breathing zone of such workers were found to be as high as 57.0 million of particles per cubic ft. of air during the shake out operations; 36.0 million particles per cubic ft. of air during the moulding and occasionally as high as 30.6 million particles per cubic ft. of air during the pouring operations.

Table III

Percentage by weight of free silica in the settled dust samples from different operations

Description	*No. of Samples*	*Range*	*Free silica content by weight* *Mean*	±	*Std. Deviation*
Sand mixing operation	12	27·6 — 33·3	28·9	±	1·53
Pan moulding	18	25·9 — 36·5	31·0	±	2·85
Pipe moulding	10	35·2 — 36·4	35·3	±	0·38
Cleaning of castings	8	10·7 — 33·7	26·1	±	9·48
Core making	4	28·8 — 30·5	29·6	±	0·73

General mean 30·1

Table IV

Concentration of dust in terms of free silica particles in different operations

(Millions of particles per cubic foot of air)

Operation	*Maximum*	*Mean*	*Std. Deviation*	*Minimum*
General, before work	2·4	1·4	0·48	0·8
Grinding	18·5	8·9	4·48	3·5
Moulding	10·8	4·8	3·06	1·7
Pouring	9·2	3·6	3·05	1·6
Shake Out	17·1	7·0	2·09	2·5
Cleaning castings	14·4	8·6	3·93	2·5
General, after work	6·6	3·2	1·50	1·1

It is also to be noted that due to the absence of any dust control measures, the general dust levels throughout the factory for some hours after the work remains much higher than before. Thus while the average mean dust level in the morning before work was only 4.8 million particles per cubic ft. of air, in the afternoons it rose to a mean value as high as 10.8.

In the absence of any effort whatsoever at dust minimisation, as all the workers work without any respiratory protective device, it is inevitable that the workers of these foundries should be exposed to heavy concentration of dust particles. While it was not possible for the authors to undertake detailed particle size measurements, it may be mentioned that in a similar study carried out in the American Foundries in Illinois, U.S. (Federal Security Agency, 1950) it was found that 90% or more of all the particles were three microns or less in size being thus well below the limit of five microns prescribed for dangerous silicious dusts. On a priori assumption therefore it would appear that the incidence of silicosis amongst the workers engaged in these factories should be considerably high.

The safe limit of exposure to silicious dusts has not yet been definitely determined. Since the free silica content in certain areas of work or of raw materials may be more than in others, the permissible limit will vary with the actual free silica content of the dust. It has however been considered a good practice to keep concentrations of highly silicious dusts within 5 million particles per cubic ft. of air (Johnstone, 1948).

In the actual evaluation of the degree of hazard in the working environment of the foundries under investigation, it has therefore to

be remembered that the foundry dust is a composite mixture of various materials both inorganic and organic, free silica being only a constituent of the mixed dust so formed. Judgment based on the total dust count of such a composite is therefore liable to be misleading unless it is equated in terms of its dangerous component, viz., the free silica content. To decide upon the relative merit of the working environment in these foundries, the concentrations of dust actually found in various operations have therefore been calculated in terms of the free silica content of the air borne dust.

Table III gives the free silica content as percentage by weight of the various samples of settled dust collected in different operations. Table IV presents the dust level in different operations in terms of the free silica content, these values being calculated according to the formula for composite dusts recommended by the National Silicosis Conference (Mine Safety Appliances Company).

The free silica content by weight of the samples of settled dust from various operations ranged from about 10.7 percent to 36.5 percent, the mean average being about 30.0 percent. The settled dust from the moulding operations had the highest free percentage by weight of free silica with an average of 35.5 percent.

It will be noted from Table IV that even when recalculated on the basis of its free silica content alone, the concentrations of dust particles during the various operations in these foundries were well above the maximum prescribed by the National Conference on silicosis as safe for continuous exposure. However, in all the foundries under investigation, the actual foundry operations were carried out under very tall and open corrugated tin structures, with resulting good ventilation. The natural dilution factor thus operates in favour of the workers and as a consequence it will be noted from Table IV that the mean general concentration of the dust in the environment after work is well within the recommended safety practice.

The exposure of the workers to the dust during the actual operations is heavy, going up to almost 18.5 million particles during grinding and 9.2 to 17.1 million particles per cubic ft. of air during the moulding, shake-out, pouring and cleaning operations respectively. Exposure to such high concentration of dust should seriously jeopardize the health of the workers concerned with enhanced probability of high incidence of silicosis, specially amongst those employed over long years. The redeeming feature of the situation as existing at present is the fact that the foundries concerned are not working at their full capacity. Only in two out of the six foundries studied, the operations of moulding, pouring and shake-out were carried out six days a week and lasted on an average of three hours a day. In the remaining four, this work was confined to only two days a week. The resulting reduction in the total period of exposure consequently reduces the total absorption of the silicious dust and may thus exert a beneficial influence in lowering the incidence of silicosis or chest diseases in these workers.

(C) *X-ray Diagnosis*

For a comprehensive study of the effect of foundry work on the health of the workers, it would have been best to undertake a complete medical examination of the workers. Though a large number of workers complained of various respiratory troubles specially cough and pain, such an examination could not be carried out for more than one reasons. In the absence of the necessary executive authority, both the management and the workers are far from willing to co-operate, because of a fear that any adverse findings would spell trouble for them. Further, the workers being engaged on a piece rate basis are naturally averse to undergo a detailed examination involving much time loss and hence loss of production and earnings for them.

A quick X-ray check-up was about all that could therefore be arranged. In evaluating the effects of dust, a chest rontgenogram is an important tool. While it was fully appreciated that for differential diagnosis, medical procedures such as physical examinations and sputum studies are essential, it was considered worth while to have only an X-ray survey because it enabled us to single out those with abnormal chest pictures so that they could be submitted to more thorough examination, later on. Even then suspicion and superstition could not be entirely overcome and after considerable persuasion only about 50 percent of the workers volunteered for an X-ray check-up.

A Mobile Mass Chest X-ray Unit was used for the X-ray survey. According to the nature of the work carried out, the workers examined were classified into four categories:

(1) Moulders: Consisting of those actively engaged in the operations of moulding, pouring and shake-out;

(2) Fitters: Engaged in maintenance-shop fitting the castings and grinding;

(3) General: Engaged in transport and cleaning of the castings;

(4) Miscellaneous: No definite occupation but engaged in general foundry work including transport and cleaning of castings, charging the cupola and conveying coal depending on the needs of the hour.

Table V

Result of Rontgenographic Examination of 604 foundry workers

Factory No.	No. of workers Employed	Occupational Group	No. of workers X-rayed	Cases of definite positive pathology		Cases of suspicious positive pathology	
				No.	% of occupational group	No.	% of occupational group
I	150	Moulders	42	—	—	1	2·4
		Fitters	45	3	6·7	—	—
		General	2	—	—	—	—
		Miscellaneous	12	1	8·3	—	—
II	200	Moulders	53	1	2·0	1	2·0
		Fitters	5	—	—	—	—
		General	40	1	2·5	—	—
		Miscellaneous	10	—	—	—	—
III	150	Moulders	46	1	2·2	4	8·7
		Fitters	5	—	—	—	—
		General	47	—	—	—	—
		Miscellaneous	9	—	—	—	—
IV	720	Moulders	118	3	2·6	11	9·3
		Fitters	24	—	—	—	—
		General	97	1	1·0	2·0	2·1
		Miscellaneous	49	—	—	1·0	2·0
Total	1220		604	11	1·8	20	3·3

Based on the general characteristics of the rontgenographic shadows the results of the X-ray survey are classified into:

(i) Positive cases: Cases of positive pathology with definite lung fibrosis;

(ii) Suspicious cases: Cases with abnormal scattered shadow markings of the lungs and probably of positive pathology but requiring additional check-up after some time for confirmation;

(iii) Normal cases: Cases with normal lung marking.

Table V presents findings of the X ray survey for the individual factories.

Because of the limitation of the examination already remarked, and the fact that before any definite conclusion can be drawn, it would be desirable to have retakes of the X-ray of the workers concerned after a lapse of six months to a year, it cannot be claimed that all the cases of rontgenographic pulmonary marking mentioned as cases of positive pathology or doubtful positive pathology in the table are necessarily cases of silicosis. Further, in a dusty occupation specially where the workers are exposed to silicious dust, the cases of uncomplicated silicosis are usually rare. There is a tendency and this is specially the case with workers with long exposures to such dusts, for tubercular lesion to be super-imposed. However, since the essential aetiological factor in such cases is the dust inhalation of the subjects concerned, it may be expected that in contrast to uncomplicated tuberculosis, the incidence of such cases will show a progressive increase with the duration of exposure *i.e.*, years of service in the dusty occupation. It will be noted from the data presented later that the incidence of cases of positive pathology in our investigation increases in a like manner with the years of occupation in the foundry industry and is also significantly higher for this particular group of workers in contradistinction to that for comparable groups of workers in other occupations not involving exposure to such dust. There is thus a strong presumptive indication that the cases of positive pathology reported in the present study are those of silicosis.

Table VI

Percentage incidence of cases of positive pathology in foundry workers by occupational groups

Occupational Group	*No. of workers*	*All cases of positive pathology*	*% of occupational Group*
Moulders	259	22	8·5
Fitters	80	4	5·0
General	186	4	2·1
Miscellaneous	80	2	2·5

Table VII.

Percentage incidence of cases of positive pathology in foundry workers by duration of service.

Occupational Group	Service in years 0 – 9			Service in years 10 – 19			Service in years over 20		
	No. of workers	No. of cases	% of service group	No. of workers	No. of cases	% of service group	No. of workers	No. of cases	% of service group
Moulders ...	138	2	1.45	90	9	10.00	31	11	35.50
Fitters ...	55	0	0.00	22	4	18·10	3	0	0.00
General ...	154	1	0.64	25	2	8.00	7	2	28.50
Miscellaneous ...	49	1	2.00	22	0	0.00	9	1	11.10
All workers ...	396	4	1.00	159	15	9.40	50	14	28.00

Table VI presents in a summarised form the conclusions drawn for the data presented in Table V. Since all the workers are exposed to dust to some degree, cases of positive pathology occur in all the occupational groups studied. There is however a close correspondence between the degree of exposure and the incidence of cases of positive pathology. Thus while the incidence of such cases amongst the moulders who are most severely exposed to the silicious dust is as high as 8.5% it decreases in the order of 5.0%, 2.1% and 2.5% in the other three groups whose dust exposure is less.

Table VII gives an analysis of the incidence of cases of positive pathology in the workers in relation to their duration of service. The workers have been distributed in 3 service groups viz., 0—9 years, 10—19 years and over 20 years. It will be noted that the percentage incidence of the cases increases in all the occupational groups with the years of service in the foundry occupation. The correlation between the frequency of cases and dust inhalation is also further corroborated by the fact that the increase in the incidence with duration of service is relatively much higher for the group of moulders who are heavily exposed to dust than for the other three groups.

Table VIII

Incidence of cases of positive pathology in a few industries around Calcutta.

Type of Industry	*Workers Examined*	*No. of cases of positive pathology.*	*% Incidence*
Tobacco	1047	22	2·1
Engineering	2857	76	2·6
Jute	1248	33	2·6
Safety Match	1035	30	2·9
Foundry	605	32	5·3

Table VIII brings out another point in support of our presumptive assumption that the cases of positive pathological chest findings reported in this investigation are those of silicosis or silico-tuberculosis rather than of uncomplicated pulmonary tuberculosis. Our Mass Chest X-ray Unit has been engaged for some years in a systematic chest X-ray check-up of different industrial groups around Calcutta. When the findings of previous study (Rao and Banerjea: 1953) are compared with those in the present investigation, the accelerative role of the dust inhalation in the foundry occupation in the causation of these chest cases becomes all too obvious. Thus while the percentage incidence of cases of positive chest pathology in the present study was as high as 5.3 percent, it was 2.6% for the engineering industry, 2.6% for jute industry, 2.9% for the safety match industry and 2.1% for the tobacco industry.

Summary and Conclusions

Findings of the environmental investigation in six foundries around the city of Calcutta are reported. Data is presented to show the character and concentration of air-borne and settled dust occurring during the various operations in the foundries. Results of a chest rontgenographic study have also been included.

The survey shows that during the actual operations like moulding, pouring, shake-out and cleaning, the workers are exposed to much higher dust concentration than is normally accepted as safe practice. The various factors operating in favour of the workers have been discussed. The rontgenographic examination of volunteers showed that the percentage of cases of positive pathology amongst the volunteers was 5.3 percent. Since unhealthy workers are naturally more apprehensive of the findings of such an examination and hence more likely to avoid or refuse it, the incidence for all workers may have been higher than amongst the volunteers.

The need to protect the workers of these foundries from dust inhalation is thus definitely brought out. This problem is however not easy to solve. While installation of adequate exhaust ventilation would be the measure of choice according to the accepted modern safety engineering practices, practical considerations rule out the possibility of a ready acceptance of such recommendation, as the outlay will involve considerable expenditure for the management. All the foundries investigated were engaged in small castings like boiling pans, sanitary fittings, weights and measures and the work is carried out in a scattered fashion spread over an extensive area. Further they are owned and run by small-scale proprietors. The installation of an exhaust ventilation system of sufficient dimension to cope with all the operations scattered over such a wide area would be expensive and would constitute a heavy financial burden on the managements concerned. By a suitable application of the principles of dilution and diffusion, much can however be done to minimise the concentrations of dust as they occur at present. Better ventilation of the work place can be ensured by installation of wide windows and openings. This would promote better natural ventilation and help further the diffusion and dilution of the dust. A few air blowers, installed at suitable points, would not only help the same purpose but would also considerably mitigate the heat load on the workers thereby rendering the environment more comfortable and congenial to the workers. Finally, frequent moistening of the floors and the sites where the dust is likely to settle, would considerably decrease disturbing the settled dust from constant to and fro movements of the workers and thus go a long way towards further lowering of the existing dust levels.

Acknowledgement

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NEWS—

Dr. C. K. Ramchandar, Secretary General of the Second Asian Conference of Occupational Health to be held at Calcutta in November, 1958, has informed us of the following details about the programme of the conference.

Programme

14th Friday	9·00 a.m. to 1·00 p.m. 2·30 p.m. to 5.00 p.m.	Business meeting of the Asian Committee of ACOH.
15th Saturday	2.00 p.m. to 4.00 p.m. 5.00 p.m.	Registration of Delegates Inauguration of the Conference
16th Sunday	9.00 a.m. 11.00 a.m. to 1.00 p.m. 2.30 p.m. to 4.00 p.m.	Inauguration of Scientific Sessions. Papers by Leaders of various Delegations — Problems and Occupational Health Service in our country.
17th Monday	9.00 a.m. to 1.00 p.m. 2.00 p.m. to 7.00 p.m.	Scientific Sessions Visit to places of interest in and around Calcutta.
18th Tuesday	8.00 a.m. to 8.00 p.m. (2.30 p.m. to 5.00 p.m.)	Visit to a Rubber Factory Symposium on Occupational Health. problems in Rubber Industry—DUNLOPS
19th Wednesday	9·00 a.m. to 1.00 p.m. 2.30 p.m. to 4.00 p.m. 6.00 p.m.	Scientific Sessions Garden Party to Delegates
20th Thursday	8.00 a.m. to 5.00 p.m.	Visits to Jute, Fertilizer and Shoe factories
21st Friday	9.00 a.m. to 12.30 p.m. 2.00 p.m. to 4.00 p.m.	Business Meeting of ACOH Symposium on Social Services in relation to Occupational Health Problems.

22nd Saturday — Visit to a Centre of Heavy Industry — JAMSHEDPUR

23rd Sunday — Symposium on Occupational Health aspects of Heavy Industry.

LIBRARY FOR THE MADRAS BRANCH OF THE S.S.I.M.

The Library of the Madras Branch of the S.S.I.M. was inaugurated on 24th Sept. '58 by Dr. V. R. Thayumanaswami, Director of Medical Services, Madras, at the Simpsons Medical Centre, Madras.

Mr. P. V. Viswanathan, Chief Inspector of Factories, Madras, spoke on the occasion on "The Organization of Industrial Health Services" with special reference to his experiences during his recent study tour in the United Kingdom.

Dr. Thayumanaswami who presided over the meeting emphasized the role of doctors in preventing diseases and hoped that the Library would prove beneficial in disseminating knowledge of industrial medicine to doctors.

Dr. C. M. Ramakrishna proposed a vote of thanks.

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